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EN 15232-1:2017

Energy Performance of Buildings — Energy performance of buildings —
Part 1: Impact of Building Automation, Controls and Building Management —
Modules M10-4, 5, 6, 7, 8, 9, 10

прийнято як національний стандарт
методом підтвердження за позначенням

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та управління будівлями. Модулі M10-4, 5, 6, 7, 8, 9, 10

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

Performance énergétique des bâtiments - Partie 1: Impact de l'automatisation, de la régulation et de la gestion technique - Modules M10-4, 5, 6, 7, 8, 9, 10

Engergieeffizienz von Gebäuden - Teil 1: Einfluss von Gebäudeautomation und Gebäudemanagement - Module M10-4, 5, 6, 7, 8, 9, 10

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

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European foreword

This document (EN 15232-1:2017) has been prepared by Technical Committee CEN/TC 247 "Building Automation, Controls and Building Management", the secretariat of which is held by SNV.

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of an identical text or by endorsement, at the latest by November 2017, and conflicting national standards shall be withdrawn at the latest by November 2017.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 supersedes EN 15232:2012.

The most important changes are:

— respect the presentation of this project in the frame EPB in accordance with the drafting rules;

— a structured updated list of Building Automation and Control (BAC) functions;

— a set of new BMS function introduced in the new EPBD standard EN 16947-1 has been added to the list of functions thus completing the former TBM functions.

This document has been prepared under a mandate [22] given to CEN by the European Commission and the European Free Trade Association.

This document is part of the set of standards on the energy performance of buildings (the set of EPB standards).

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.

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

Introduction

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".

As part of the "EPB set of standards" it complies with the requirements for the set of basic EPB documents EN ISO 52000-1 (see Normative references), CEN/TS 16628 and CEN/TS 16629 (see Bibliography [2] and [3]) developed under a mandate given to CEN by the European Commission and the European Free Trade Association (Mandate M/480).

The standards issued by TC 247 for M/480 belong to the EPB set of standards and are in line with the over-arching standard (EN ISO 52000-1) and drafted in accordance with the basic principles and detailed technical rules developed in the Phase I of the mandate.

Also these standards are clearly identified in the modular structure developed to ensure a transparent and coherent EPB standard set. BAC (Building Automation and Control) is identified in the modular structure as Technical Building System M10. However, the standards of TC 247 deal with control accuracy, control functions and control strategies using standards communications protocol (these last standards do not belong to the EPB standards set).

To avoid a duplication of calculation due to the BAC (avoid double impact), no calculation are done in BAC EPB standard set, but in each underlying standard of EPB set of standards (from M1 to M9 in the Modular Structure), an IDENTIFIER developed and present in the M10 covered by EN 15232-1 is used where appropriate. These way of interaction is described in detailed in the Technical Report (CEN ISO/TR 52000-2) accompanying the over-arching standard. As consequence, the Annex A and Annex B concept as EXCEL sheet with the calculation formulas used in the EPB standards are not applicable for the standards issued by TC 247 for M/480.

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

Further target groups are parties wanting to motivate their assumptions by classifying the building energy performance for a dedicated building stock.

More information is provided in the Technical Report accompanying this standard (CEN/TR 15232-2 [5]).

1 Scope

This European Standard specifies:

— a structured list of control, building automation and technical building management functions which contribute to the energy performance of buildings; functions have been categorized and structured according to building disciplines and so called Building automation and control (BAC);

— a method to define minimum requirements or any specification regarding the control, building automation and technical building management functions contributing to energy efficiency of a building to be implemented in building of different complexities;

— a factor based method to get a first estimation of the effect of these functions on typical buildings types and use profiles;

— detailed methods to assess the effect of these functions on a given building.

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.

Table 1 — Position of this standard (in casu M10–4,5,6,7,8,9,10), within the modular structure of the set of EPB standards

	Over-arching	Building (as such)	Technical Building System									
Submodule	Descriptions	Descriptions	Descriptions	Heating	Cooling	Ventilation	Humidification	Dehumidification	Domestic Hot waters	Lighting	Building automation and control	PV, wind, ..
sub1	M1	M2		M3	M4	M5	M6	M7	M8	M9	M10	M11
1	General	General	General									
2	Common terms and definitions; symbols, units and subscripts	Building Energy Needs	Needs									
3	Application	(Free) Indoor Conditions without Systems	Maximum Load and Power									
4	Ways to Express Energy Performance	Ways to Express Energy Performance	Ways to Express Energy Performance								x	
5	Building Functions and Building Boundaries	Heat Transfer by Transmission	Emission and control								x	
6	Building Occupancy and Operating Conditions	Heat Transfer by Infiltration and Ventilation	Distribution and control								x	
7	Aggregation of Energy Services and Energy Carriers	Internal Heat Gains	Storage and control								x	
8	Building Partitioning	Solar Heat Gains	Generation and control								x	
9	Calculated Energy Performance	Building Dynamics (thermal mass)	Load dispatching and operating conditions								x	
10	Measured Energy Performance	Measured Energy Performance	Measured Energy Performance								x	
11	Inspection	Inspection	Inspection									
12	Ways to Express Indoor Comfort		BMS									
13	External Environment Conditions											
14[a]	Economic Calculation											

[a] The shaded modules are not applicable.

2 Normative references

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

EN 13779, *Ventilation for non-residential buildings — Performance requirements for ventilation and room-conditioning systems*

EN 15193-1, *Energy performance of buildings — Energy requirements for lighting*

EN 15243:2007, *Ventilation for buildings — Calculation of room temperatures and of load and energy for buildings with room conditioning systems*

EN 15316 (all parts), *Heating systems in buildings — Method for calculation of system energy requirements and system efficiencies*

EN 15316-2, *Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 2: Space emission systems (heating and cooling), Module M3-5, M4-5*

EN 15316-4-5, *Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-5: District heating and cooling, Module M3-8-5, M4-8-5, M8-8-5, M11-8-5*

EN 16798-5-1, *Energy performance of buildings — Modules M5-6, M5-8, M6-5, M6-8, M7-5, M7-8 — Ventilation for buildings — Calculation methods for energy requirements of ventilation and air conditioning systems — Part 5-1: Distribution and generation (revision of EN 15241) — Method 1*

EN 16798-7, *Energy performance of buildings — Part 7: Ventilation for buildings — Modules M5-1, M5-5, M5-6, M5-8 — Calculation methods for the determination of air flow rates in buildings including infiltration*

EN 16798-9, *Energy performance of buildings — Part 09: Ventilation for buildings — Module M4-1, M4-4, M4-9 — Calculation methods for energy requirements — Calculation methods for energy requirements of cooling systems — General*

EN 16798-13, *Energy performance of buildings — Part 13: Module M4-8 — Calculation of cooling systems — Generation*

EN 16798-15, *Energy performance of buildings — Part 15: Module M4-7 — Calculation of cooling systems — Storage — General*

EN 16947 series, *Energy Performance of Buildings — Building Management*

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

EN ISO 50001:2011, *Energy management systems — Requirements with guidance for use (ISO 50001:2011)*

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

EN ISO 52016-1, *Energy performance of buildings — Energy needs for heating and cooling, internal temperatures and sensible and latent head loads — Part 1: Calculation procedures (ISO 52016-1)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 7345:1995, in EN ISO 52000-1:2017 and the following apply.

3.1
auxiliary energy
electrical energy used by technical building systems to support energy transformation to satisfy energy needs

Note 1 to entry: 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 to entry: In EN ISO 9488 the energy used for pumps and valves is called "parasitic energy".

[SOURCE: EN ISO 52000-1]

3.2
building automation and control
BAC
products, software, and engineering services for automatic controls, monitoring and optimization, human intervention, and management to achieve energy-efficient, economical, and safe operation of building services equipment

[SOURCE: EN ISO 52000-1:2017, modified – The symbol BAC was added.]

3.3
building automation and control system
BACS
system, comprising all products, software and engineering services for automatic controls (including interlocks), monitoring, optimization, for operation, human intervention, and management to achieve energy-efficient, economical, and safe operation of building services

Note 1 to entry: BACS is also referred to as BMS (Building management system).

Note 2 to entry: The use of the word 'control' does not imply that the system/device is restricted to control functions. Processing of data and information is possible.

Note 3 to entry: If a building control system, building management system, or building energy management system complies with the requirements of the EN ISO 16484- series, it should be designated as a building automation and control system (BACS).

Note 4 to entry: Building services is divided in technical, infrastructural and financial building services and energy management is part of technical building management.

Note 5 to entry: Building energy management system is part of a BMS.

Note 6 to entry: Building energy management system comprising data collection, logging, alarming, reporting, and analysis of energy usage etc. The system is designed to reduce the energy consumption, improve the utilization, increase the reliability, and predict the performance of the technical building systems, as well as optimize energy usage and reducing its cost.

[SOURCE: EN ISO 16484-2:2004, modified – Notes 1, 4 and 5 have been added.]

3.4
building management
BM
totality of services involved in the management operation and monitoring of buildings (including plants and installations)

Note 1 to entry: Building management can be assigned as part of facility management.

[SOURCE: CEN/TS 15379:2006, modified – Second part of the definition became Note 1 to entry.]

3.5
control function
BAC effect of programs and parameters

Note 1 to entry: BAC functions are referred to as control functions, I/O, processing, optimization, management and operator functions. They are listed in the BAC FL (function list) for a specification of work.

Note 2 to entry: Function is a program unit that delivers exactly one data element, which can be a multiple value (i.e. an array or a structure). Functions can be an operand in a program. [EN 61131-3]

3.6
delivered energy
energy, expressed per energy carrier, supplied to the technical building systems through the assessment boundary, to satisfy the uses taken into account or to produce the exported energy

Note 1 to entry: Delivered energy can be calculated for defined energy uses or it can be measured.

[SOURCE: EN ISO 52000-1]

3.7
energy carrier
substance or phenomenon that can be used to produce mechanical work or heat or to operate chemical or physical processes

[SOURCE: EN ISO 52000-1]

3.8
energy need for heating or cooling
heat to be delivered to or extracted from a thermally conditioned space to maintain the intended space temperature conditions during a given period of time

Note 1 to entry: 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.

3.9
energy efficiency
ratio or other quantitative relationship between an output of performance, service, goods or energy, and an input of energy

EXAMPLE Efficiency conversion energy; energy required/energy used; output/input; theoretical energy used to operate/energy used to operate.

Note 1 to entry: Both input and output need to be clearly specified in quantity and quality, and be measureable.

[SOURCE: EN ISO 50001-1:2011 modified - Symbol removed]

3.10
energy efficiency improvement
increase in energy efficiency as a result of technological, behavioural or economic changes

[SOURCE: EN ISO 50001-1:2011]

3.11
integrated building automation and control systems
BACS designed to be interoperable and with the ability to be connected to one or more specified 3rd party building automation and control devices/systems through open data communication network or interfaces performed by standardized methods, special services and permitted responsibilities for system integration

EXAMPLE Interoperability between 3rd party BACS devices/systems for HVAC, domestic hot water, lighting, electrical power distribution, energy metering, elevators and escalators, other plants, as well as systems for communications, access control, security, life safety etc.

3.12
integrated function
BAC effect of programs, shared data points and parameters for multi-discipline interrelationships between various building services and technologies

3.13
measured energy performance
energy performance based on measured amounts of delivered and exported energy

Note 1 to entry: The measured rating is the weighted sum of all energy carriers used by the building, as measured by meters or derived from measured energy by other means. It is a measure of the in-use performance of the building after correction or extrapolation. This is particularly relevant to certification of actual energy performance.

Note 2 to entry: Also known as "operational rating".

[SOURCE: EN ISO 52000-1]

3.14
set-point temperature of a conditioned zone
internal (minimum) temperature, as fixed by the control system in normal heating mode, or internal (maximum) temperature, as fixed by the control system in normal cooling mode

Note 1 to entry: The corrected value of a temperature setpoint is used for the calculation of energy performance. It enables the impact of the accuracy of the control system on the energy performance to be taken into account.

3.15
thermally activated building systems
TABS
massive building fabric actively heated or cooled by integrated air or water based systems

3.16
technical building management
TBM
process(es) and services related to operation and management of buildings and technical building system through the interrelationships between the different disciplines and trades

Note 1 to entry: The disciplines and trades comprise all technical building services for the purpose of optimized maintenance and energy consumption.

EXAMPLE Optimization of buildings through interrelationships ranging from heating, ventilation and air conditioning (HVAC) to lighting and day lighting to life safety and security to electric power systems and energy monitoring and metering; to its services, including communications and maintenance and to its management.

3.17
technical building system
technical equipment for heating, cooling, ventilation, humidification, dehumidification, domestic hot water, lighting and electricity production

Note 1 to entry: A technical building system can refer to one or to several building services (e.g. heating, heating and DHW).

Note 2 to entry: A technical building system is composed of different subsystems.

Note 3 to entry: Electricity production can include cogeneration and photovoltaic systems.

[SOURCE: EN ISO 52000-1]

4 Symbols, subscripts and abbreviations

4.1 Symbols

For the purposes of this document,, the symbols given in EN ISO 52000-1:2017, Clause 4 and Annex C and the specific symbols listed in Table 2 apply.

Table 2 — Symbols and units

Symbol	Quantity	Unit
a	normalized level, e.g. occupancy or gains	-
$\overline{\beta}$	mean part load	-
Φ	heat flow rate, thermal power	kW

4.2 Subscripts

For the purposes of this document, the subscript given in EN ISO 52000-1:2017, Clause 4 and Annex C and the specific subscripts listed in Table 3 apply.

Table 3 — Subscripts

Subscript	Term	Subscript	Term	Subscript	Term
amb	ambient	end	end	th	thermal
BAC	building automation and control	r	room	trans	transfer
cor	correction	ref	reference		
DHW	domestic hot water	sta	start		

5 Description of the method

5.1 Output of the method

This standard describes two methods of how to calculate the contribution of building automation and controls to the energy performance of buildings. The two methods are:

— Detailed method: Output of the detailed method is a list of automation, control and management function types that is used to run a detailed calculation of building energy performance based on other EPBD standards. Beside this the detailed method would also allow classification of a building automation and control system according to a set of criteria defined in this standard. There is no limitation regarding the time step.

— Factor based method: Output of the factor based method is the energy demand of a building according to a given building automation and control classification. The time step of the output is a yearly step.

5.2 General description of the method(s)

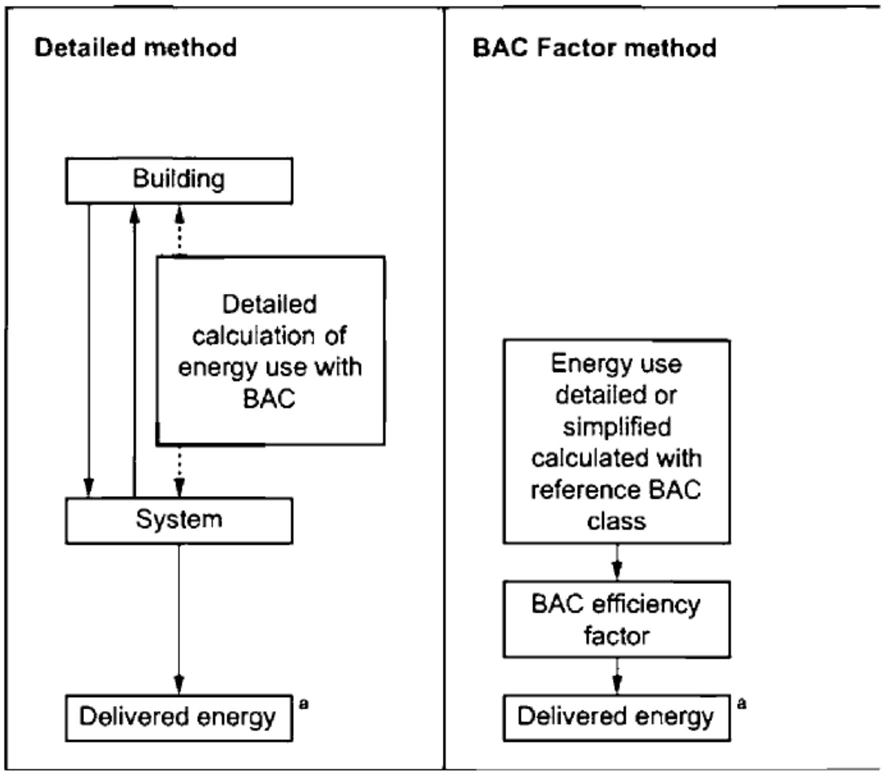
Two methods are given:

— method 1, defined in Clause 6 "Method 1 – Detailed method", is meant for a detailed energy performance analysis of a building in case detailed information about the building, the HVAC systems and especially the type of automation, control and management functions is available that can be applied in a holistic EPBD calculation method.

— method 2, defined in Clause 7 "Method 2 – Factor based method" is intended for easily calculating a rough estimate of the impact of building automation, control and management on the energy performance of a building just based on a given energy performance (either a consumption metered, or a demand calculated) correlated to a certain BAC efficiency classification of the building.

5.3 Selection criteria between the methods

For the calculation of the impact of building automation, control and management functions on the building energy performance the detailed method is method 1 in this standard. The following Figure 1 illustrates how to use the detailed method compared to the simplified BAC Factor method.



Key

a delivered energy is the total energy, expressed per energy carrier (gas, oil, electricity etc.) used for heating, cooling, ventilation, domestic hot water or lighting

NOTE Arrows illustrate only the calculation process and do not represent energy and/or mass flows.

Figure 1 — Detailed method in comparison with BAC Factor method

The detailed method should be used only when a sufficient knowledge about automation, control and management functions used for the building and the energy systems is available. The application of the detailed calculation procedure implies that all automation, control and management functions that have to be account for the operation of a building and its energy systems are known. Clause 6 gives a general survey of those functions and declares how to use them in the context of energy performance calculations.

5.4 BAC and TBM functions having an impact on the energy performance of buildings

Building Automation and Control (BAC) provide effective control functions for any building energy system, e.g. heating, ventilating, cooling, hot water and lighting appliances, that lead to improve operational and energy efficiencies. Complex and integrated energy saving functions and routines can be configured based on the actual use of a building, depending on real user needs, to avoid unnecessary energy use and CO_2 emissions.

Technical Building Management (TBM) functions as part of Building Management (BM) provide information about operation, maintenance, services and management of buildings, especially for energy management – measurement, recording trending, and alarming capabilities and diagnosis of unnecessary energy use. Energy management provides requirements for documentation, controlling, monitoring, optimization, determination and to support corrective action and preventive action to improve the energy performance of buildings. Standard EN 15232 can be used to evaluate the contribution of these building management functions to the energy performance of buildings.

The BAC functions described in Table 4 are based on the energy demand and supply model for a building in Figure 2.

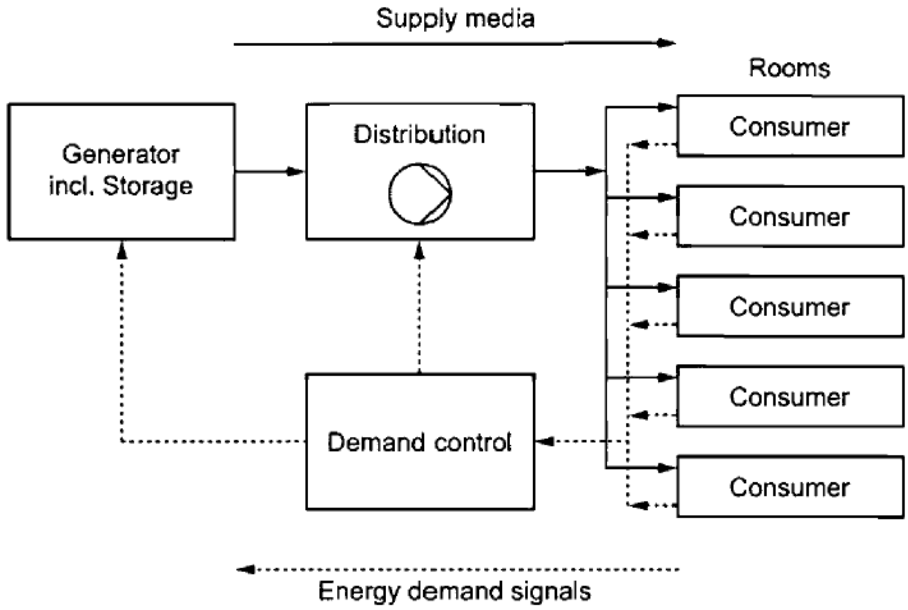


Figure 2 — Energy demand and supply model (Example: Heating plant)

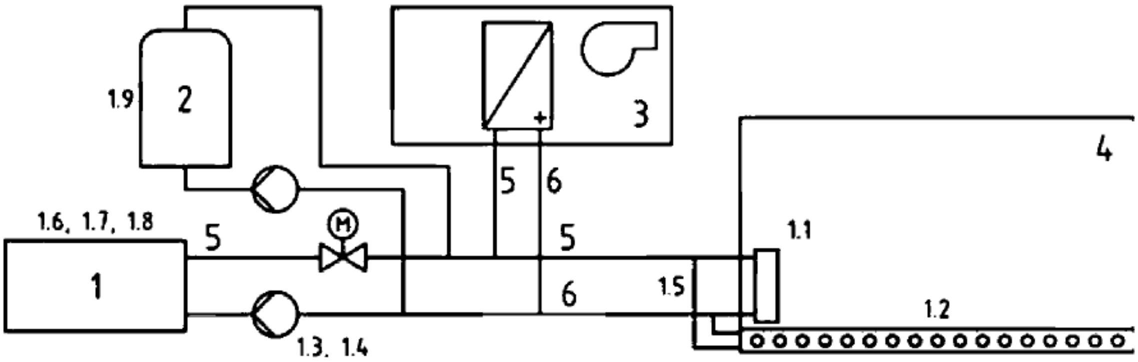
Rooms represent the source of the energy demand. Suitable equipment should ensure comfortable conditions in the rooms with regard to temperature, humidity, air quality and light as needed and with due consideration of minimum or maximum requirements specified in local regulations.

Supply media is provided to the consumer according to energy demand keeping losses in distribution and generation to an absolute minimum.

The building automation and control functions described in Table 4 are aligned in accordance with the energy demand and supply model. The relevant energy-efficiency functions are handled starting with the room, via distribution up through generation.

The most common BAC and TBM functions having an impact on the energy performance of buildings have been described and summarized in Table 4.

The following Figures 3 to 7 illustrate basic system designs for heating, domestic hot water, cooling, ventilation and air conditioning purposes. The numbers refer to the control functions summarized in Table 4. These basic elements can be combined to more or less complex systems that also account for local, regional or national specifics. The building automation and control functions defined in Table 4 are according to these basic system designs. Air side system control of HVAC shall be treated as ventilation and air-conditioning control, separately from heat generators, chillers, terminal units and water and refrigerant side controls.

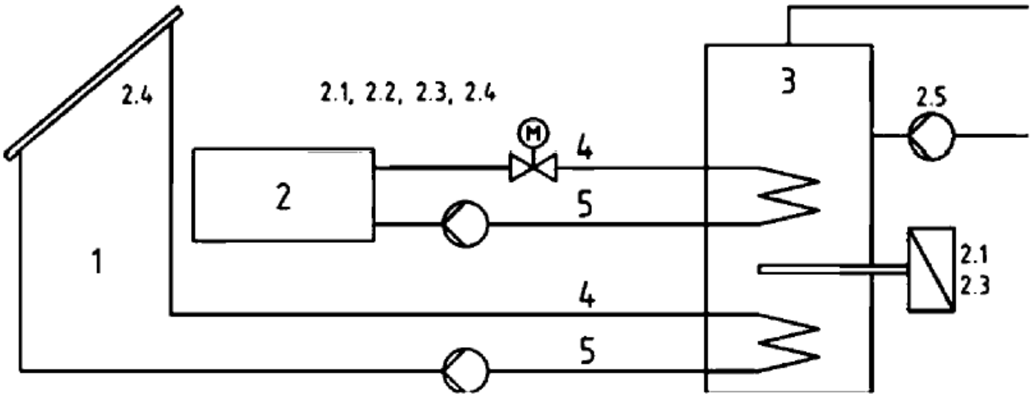


Key

1 heat generator
2 thermal energy storage
3 air handling unit
4 room
5 heating water supply
6 heating water return

NOTE The numbers in red refer to the numbers in Table 4.

Figure 3 — Space heating system

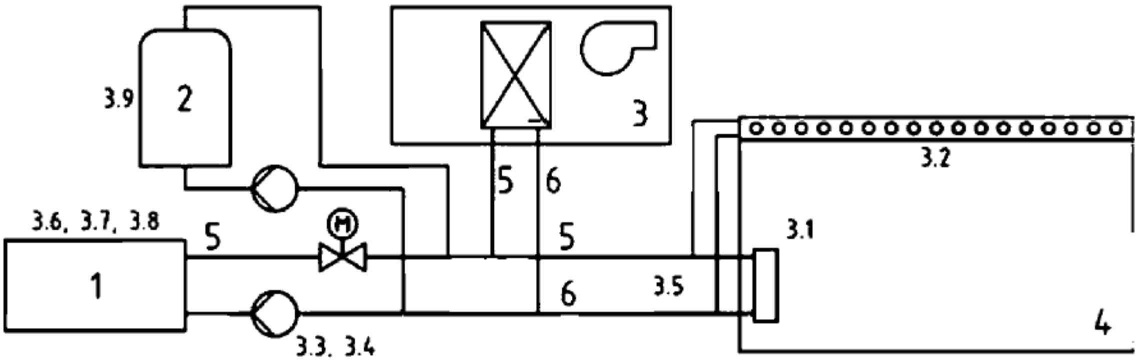


Key

1 solar collector
2 boiler/district heating heat pump
3 domestic hot water storage
4 heating water supply
5 heating water return

NOTE The numbers in red refer to the numbers in Table 4.

Figure 4 — Domestic hot water heating system



Key

1 chiller

2 thermal energy storage

3 air handling unit

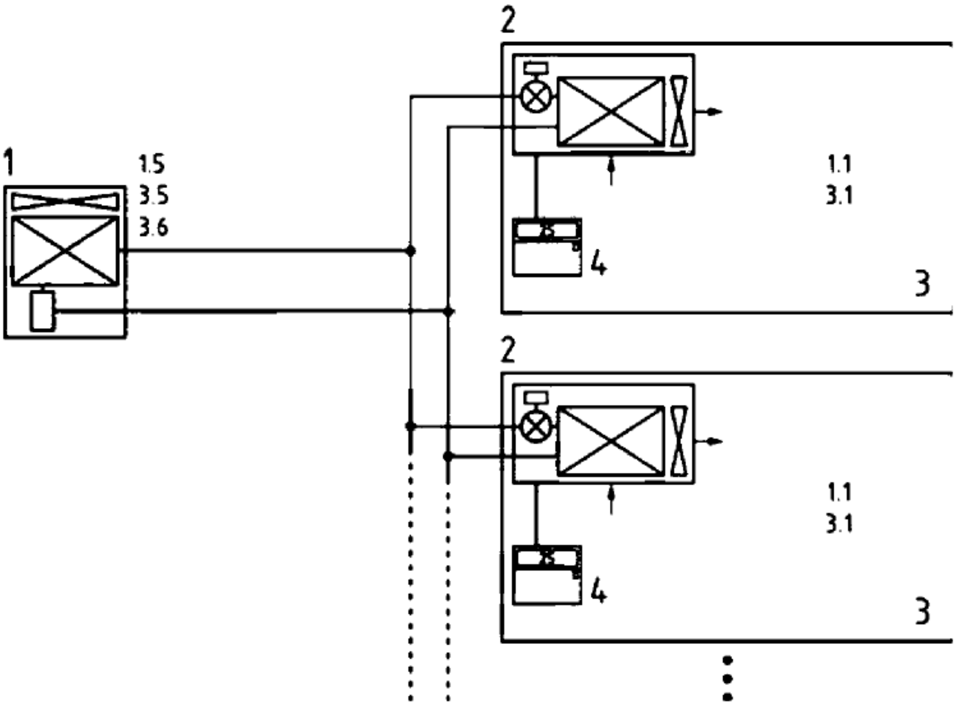
4 room

5 chilled water supply

6 chilled water return

NOTE The numbers in red refer to the numbers in Table 4.

Figure 5 — Cooling system



Key

1 outdoor unit

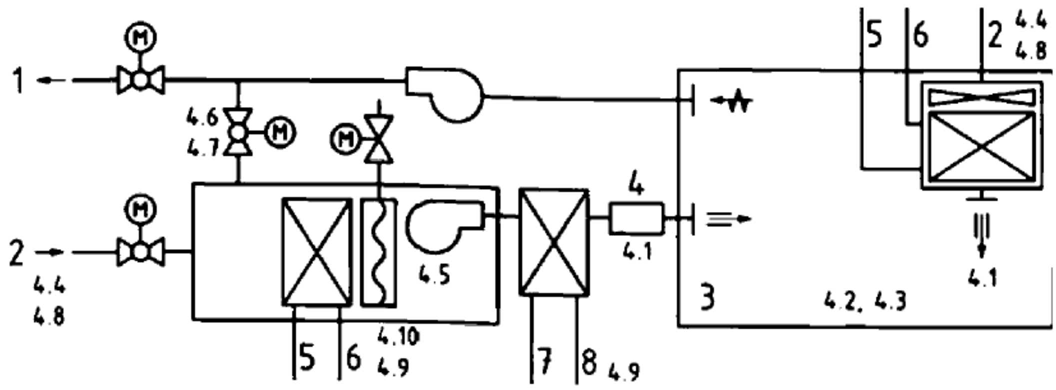
2 indoor unit

3 room 1

4 room 2

NOTE The numbers in red refer to the numbers in Table 4.

Figure 6 — Split system/VRF (heating and/or cooling)



Key

1 exhaust air

2 outside air

3 room

4 variable air volume

5 chilled water supply

6 chilled water return

7 heating water

8 heating water return

NOTE The numbers in red refer to the numbers in Table 4.

Figure 7 — Ventilation and air-conditioning System

Table 4 — BAC and TBM functions having an impact on the energy performance of buildings

Automatic control			
1	Heating control		
1.1	Emission control	HEAT_EMIS_CTRL_DEF	M3–5
		The control function is applied to the heat emitter (radiators, underfloor heating, fan-coil unit, indoor unit) at room level; for type 1 one function can control several rooms	
	0	No automatic control of the room temperature	
	1	Central automatic control: There is only central automatic control acting either on the distribution or on the generation. This can be achieved for example by an outside temperature controller conforming to EN 12098–1 or EN 12098–3; one system can control several rooms	
	2	Individual room control: By thermostatic valves or electronic controller	
	3	Individual room control with communication: Between controllers and BACS (e.g. scheduler, room temperature setpoint)	
	4	Individual room control with communication and occupancy detection: Between controllers and BACS; Demand control/occupancy detection (this function level is usually not applied to any slow reacting heat emission systems with relevant thermal mass, e.g. floor heating, wall heating)	

1.2	Emission control for TABS (heating mode)		HEAT_EMIS_CTRL_TABS	M3–5
	0	No automatic control of the room temperature		
	1	Central automatic control: The central automatic control for a TABS zone (which comprises all rooms which get the same supply water temperature) typically is a supply water temperature control loop whose set-point is dependent on the filtered outside temperature, e.g. the average of the previous 24 h.		
	2	Advanced central automatic control: This is a central automatic control of the TABS zone that is designed and tuned to achieve an optimal self-regulating of the room temperature within the required comfort range (specified by the room temperature heating set-point). "Optimal" means that the room temperatures of all rooms of the TABS zone remain during operation periods in the comfort range, to meet comfort requirements, but also is as low as possible to reduce the energy demand for heating.		
	3	Advanced central automatic control with intermittent operation and/or room temperature feedback control: a) Advanced central automatic control with intermittent operation. This is an advanced central automatic control according to 2) with the following supplement: The pump is switched off regularly to save electrical energy, either with a fast frequency - typically 6 h on/off cycle time - or with a slow frequency, corresponding to 24 h on/off cycle time. If the TABS is used for cooling, intermittent operation with 24 h on/off cycle time can also be used to reject the heat to the outside air if the outside air is cold. b) Advanced central automatic control with room temperature feedback control. This is an advanced central automatic control according to 2) with the following supplement: The supply water temperature set-point is corrected by the output of a room temperature feedback controller, to adapt the set-point to non-predictable day-to-day variation of the heat gain. Since TABS reacts slowly, only day-to-day room temperature correction is applied, an instant correction cannot be achieved with TABS. The room temperature that is fed back is the temperature of a reference room or another temperature representative for the zone. c) Advanced central automatic control with intermittent operation and room temperature feedback control		
1.3	Control of distribution network hot water temperature (supply or return)		HEAT_DISTR_CTRL_TMP	M3–6
		Similar function can be applied to the control of direct electric heating networks		
	0	No automatic control		
	1	Outside temperature compensated control: Actions generally lower the mean flow temperature		
	2	Demand based control: e.g. based on indoor temperature control variable; Actions generally lower the mean flow temperature		

1.4	Control of distribution pumps in networks	HEAT_DISTR_CTRL_PMP	M3-6
		The controlled pumps can be installed at different levels in the network. Control is to reduce the auxiliary energy demand of the pumps.	
	0	No automatic control	
	1	On/off control: switch on and off automatically, pumps run with no control at maximum speed	
	2	Multi-Stage control: Speed of pumps is controlled by a multi-step control	
	3	Variable speed pump control: constant or variable Δp based on pump unit (internal) estimations	
	4	Variable speed pump control: variable Δp following an external demand signal, e.g. hydraulic requirement, ΔT, energy optimization	
1.5	Intermittent control of emission and/or distribution	HEAT_DISTR_CTRL	M3-5 / M3-6
		One controller can control different rooms/zones having same occupancy patterns	
	0	No automatic control	
	1	Automatic control with fixed time program: To lower the operation time	
	2	Automatic control with optimum start/stop: To lower the operation time	
	3	Automatic control with demand evaluation: To lower the operation time	
1.6	Heat generator control for combustion and district heating	HEAT_GEN_CTRL_CD	M3-8
		The goal consists generally in minimizing the heat generator operation temperature	
	0	Constant temperature control	
	1	Variable temperature control depending on outside temperature	
	2	Variable temperature control depending on the load: e.g. depending on supply water temperature setpoint	
1.7	Heat generator control (heat pump)	HEAT_GEN_CTRL_HP	M3-8
		The goal consists generally in minimizing the heat generator operation temperature and by this in maximizing the heat generator efficiency	
	0	Constant temperature control	
	1	Variable temperature control depending on outside temperature	
	2	Variable temperature control depending on the load: e.g. depending on supply water temperature setpoint	

1.8	Heat generator control (outdoor unit)		HEAT_GEN_CTRL_OU	M3–8
		The goal consists generally in maximizing the heat generator efficiency		
	0	On/Off-control of heat generator		
	1	Multi-stage control of heat generator capacity depending on the load or demand (e.g. on/off of several compressors)		
	2	Variable control of heat generator capacity depending on the load or demand (e.g. hot gas bypass, inverter frequency control)		
1.9	Sequencing of different heat generators		HEAT_GEN_CTRL_SEQ	M3–8
		This control function only applies to a system with a set of different heat generator sizes or types including Renewable Energy Sources		
	0	Priorities only based on running time		
	1	Control according to fixed priority list: e.g. heat pump prior to hot water boiler		
	2	Control according to dynamic priority list (based on current efficiency and capacity of generators)e.g. solar, geothermal heat, cogeneration plant, fossil fuels)		
	3	Control according to dynamic priority list (based on predicted and current load, efficiency and capacity of generators)		
1.10	Control of Thermal Energy Storage (TES) charging		HEAT_TES_CTRL	M3–7
		The TES is part of the heating system.		
	0	Continuous storage operation		
	1	2-sensor charging of storage		
	2	Load prediction based storage operation		
2	Domestic hot water supply control			
2.1	Control of DHW storage charging with direct electric heating or integrated electric heat pump		DHW_STRG_CTRL_EL	M8–7 / M8–8
	0	Automatic on/off control		
	1	Automatic on/off control and scheduled charging enable		
	2	Automatic on/off control and scheduled charging enable and multi-sensor storage management		
2.2	Control of DHW storage charging using hot water generation		DHW_STRG_CTRL_HG	M8–7 / M8–8
	0	Automatic on/off control		
	1	Automatic on/off control and scheduled charging enable		

	2	Automatic on/off control, scheduled charging enable and demand based supply temperature control or multi-sensor storage management		
2.3	Control of DHW storage charging with solar collector and supplementary heat generation		DHW_STRG_CTRL_SOL	M8-7 / M8-8
	0	Manual control		
	1	Automatic control of solar storage charge (Prio. 1) and supplementary storage charge (Prio. 2)		
	2	Automatic control of solar storage charge (Prio. 1) and supplementary storage charge (Prio. 2) plus demand based supply temperature control or multi-sensor storage management		
2.4	Control of DHW circulation pump		DHW_CIRC_CTRL	M8-6
	0	No control, continuous operation		
	1	With time program		
3	Cooling control			
3.1	Emission control		CLG_EMIS_CTRL_DEF	M4-5
		The control function is applied to the emitter (cooling panel, fan-coil unit or indoor unit) at room level; for type 1 one function can control several rooms		
	0	No automatic control of the room temperature		
	1	Central automatic control: There is only central automatic control acting either on the distribution or on the generation. This can be achieved for example by an outside temperature controller conforming to EN 12098-1 or EN 12098-3		
	2	Individual room control: By thermostatic valves or electronic controller		
	3	Individual room control with communication: Between controllers and BACS (e.g. scheduler, room temperature setpoint)		
	4	Individual room control with communication and occupancy detection: Between controllers and BACS; Demand control/occupancy detection (this function level is usually not applied to any slow reacting cool emission systems with relevant thermal mass, e.g. floor cooling)		
3.2	Emission control for TABS (cooling mode)		CLG_EMIS_CTRL_TABS	M4-5
	0	No automatic control of the room temperature		
	1	Central automatic control: The central automatic control for a TABS zone (which comprises all rooms which get the same supply water temperature) typically is a supply water temperature control loop whose set-point is dependent on the filtered outside temperature, e.g. the average of the previous 24 h.		

	2	Advanced central automatic control: This is a central automatic control of the TABS zone that is designed and tuned to achieve an optimal self-regulating of the room temperature within the required comfort range (specified by the room temperature cooling set-point). "Optimal" means that the room temperatures of all rooms of the TABS zone remain during operation periods in the comfort range, to meet comfort requirements, but also is as high as possible to reduce the energy demand for cooling.	
	3	Advanced central automatic control with intermittent operation and/or room temperature feedback control: a) Advanced central automatic control with intermittent operation. This is an advanced central automatic control according to 2) with the following supplement: The pump is switched off regularly to save electrical energy, either with a fast frequency - typically 6 h on/off cycle time - or with a slow frequency, corresponding to 24 h on/off cycle time. If the TABS is used for cooling, intermittent operation with 24 h on/off cycle time can also be used to reject the heat to the outside air if the outside air is cold. b) Advanced central automatic control with room temperature feedback control. This is an advanced central automatic control according to 2) with the following supplement: The supply water temperature set-point is corrected by the output of a room temperature feedback controller, to adapt the set-point to non-predictable day-to-day variation of the heat gain. Since TABS reacts slowly, only day-to-day room temperature correction is applied, an instant correction cannot be achieved with TABS. The room temperature that is fed back is the temperature of a reference room or another temperature representative for the zone. c) Advanced central automatic control with intermittent operation and room temperature feedback control	
3.3	Control of distribution network chilled water temperature (supply or return)	CLG_DISTR_CTRL_TMP	M4–6
		Similar function can be applied to the control of direct electric cooling (e.g. compact cooling units, split units) for individual rooms	
	0	Constant temperature control	
	1	Outside temperature compensated control: Actions generally raise the mean flow temperature	
	2	Demand based control: e.g. based on indoor temperature control variable; Actions generally raise the mean flow temperature	
3.4	Control of distribution pumps in hydraulic networks	CLG_DISTR_CTRL_PMP	M4–6
		The controlled pumps can be installed at different levels in the network	
	0	No automatic control	
	1	On off control: To reduce the auxiliary energy demand of the pumps	
	2	Multi-Stage control: To reduce the auxiliary energy demand of the pumps	

	3	Variable speed pump control: constant or variable Δp based on pump unit (internal) estimations to reduce the auxiliary energy demand of the pumps		
	4	Variable speed pump control: variable Δp following an external demand signal, e.g. hydraulic requirements, ΔT, energy optimization to reduce the auxiliary energy demand of the pumps		
3.5	Intermittent control of emission and/or distribution		CLG_DISTR_CTRL	M4-5 / M4-6
		One controller can control different rooms/zones having same occupancy patterns		
	0	No automatic control		
	1	Automatic control with fixed time program: To lower the operation time		
	2	Automatic control with optimum start/stop: To lower the operation time		
	3	Automatic control with demand evaluation: To lower the operation time		
3.6	Interlock between heating and cooling control of emission and/or distribution		CLG_GEN_CTRL	M4-8
		To avoid at the same time heating and cooling in the same room depends on the system principle (e.g. cooling panel/heat emitter, TABS/ventilation, several indoor units)		
	0	No interlock: the two systems are controlled independently and can provide simultaneously heating and cooling		
	1	Partial interlock (depending on the HVAC system): The control function is set up in order to minimize the possibility of simultaneous heating and cooling. This is generally done by defining a sliding setpoint for the supply temperature of the centrally controlled system		
	2	Total interlock: The control function enables to warranty that there will be no simultaneous heating and cooling.		
3.7	Generator control for cooling		CLG_GEN_CTRL	M4-8
		The goal consists generally in maximizing the chiller water temperature		
	0	Constant temperature control		
	1	Variable temperature control depending on outside temperature		
	2	Variable temperature control depending on the load: This includes control according to room temperature		
3.8	Sequencing of different chillers (generators for chilled water)		CLG_GEN_CTRL_SEQ	M4-8
		This control function only applies to a system with a set of different chiller sizes or chilled water generator types including Free Cooling and/or Renewable Energy Sources		

	0	Priorities only based on running time	
	1	Fixed Sequencing based on loads only: e.g. depending on the generators characteristics, e.g. absorption chiller vs. centrifugal chiller	
	2	Priorities based on generator efficiency and characteristics: The generator operational control is set individually to available generators so that they operate with an overall high degree of efficiency (e.g. outside air, river water, geothermic heat, refrigeration machines)	
	3	Load prediction based sequencing: The sequence is based on e.g. COP and available power of a device and the predicted required power.	
3.9	Control of Thermal Energy Storage (TES) charging	CLG_TES_CTRL	M4–7
		The TES is part of the cooling/chilled water system.	
	0	Continuous storage operation	
	1	Time-scheduled storage operation	
	2	Load prediction based storage operation	
4	Ventilation and air-conditioning control		
	This section is for building energy systems that bring air into the building: both ventilation and air conditioning systems. Heating and Cooling of air requires additional heating and cooling devices. Control functions related to heating/cooling systems are defined in sections 1 and 3 resp.		
4.1	Supply air flow control at the room level (e.g. fan on/off)	VENT_RMFLOW_CTRL	M5–5
	Control of supply air flow related to occupancy (availability of air flow, i.e. fan on/off control)).		
	0	No automatic control: The system runs constantly (e.g. manual controlled switch)	
	1	Time control: The system runs according to a given time schedule	
	2	Occupancy detection: The system runs dependent on the occupancy (light switch, infrared sensors etc.)	
4.2	Room air temperature control by the ventilation system (all-air systems; combination with static systems as cooling ceiling, radiators, etc.)	VENT_RTEMP_CTRL	M5–5 / M5–6
	Room air temperature depends on air flow (4.1, 4.5) as well as supply air temperature (4.9). This control function is related to a closed loop controller for the room air temperature acting on the air flow or supply air temperature. It can work with or without an additional static heating system (radiators etc.). Minimum air flow rates are maintained.		
	0	On-off control: fixed air flow rate and fixed supply air temperature at the room level; Room temperature setpoints are set individually.	

	1	Continuous control: either air flow rate or supply air temperature at the room level can be varied continuously ; Room temperature setpoint s are set individually	
	2	Optimized control: Minimum energy demand by optimized control. Both air flow rate as well as supply air temperature at the room level are controlled dependent on heating/cooling load.	
4.3	Coordination of room air temperature control by ventilation and by static system	VENT_RTEMP_COORD	M5-5 / M5-6
	Interaction of the different systems has to be coordinated.		
	0	Interaction is not coordinated, e.g. closed loop controllers are dedicated to each system to maintain the room air temperature independently.	
	1	Interaction is coordinated, i.e. only one system is controlled by a closed loop controller for the room air temperature and the other system conditions the room only to that extent that allows the closed loop controller to benefit from internal and external heat gains.	
4.4	Outside air flow control	VENT_OAFLOW_CTRL	M5-6 / M5-8
	This control function is applied to ventilation systems that allow varying the OA ratio or flow respectively.		
	0	Fixed OA ratio/OA flow: The system runs according to a given OA ratio, e.g. modified manually.	
	1	Staged (low/high) OA ratio/OA flow: depending on a given time schedule	
	2	Staged (low/high) OA ratio/OA flow: depending on the occupancy, e.g. light switch, infrared sensors etc.	
	3	Variable control: The system is controlled by sensors which detect the number of people or indoor air parameters or adapted criteria (e.g. CO_2, mixed gas or VOC sensors). The used parameters shall be adapted to the kind of activity in the space.	
4.5	Air flow or pressure control at the air handler level	VENT_AHUFLOW_CTRL	M5-6 / M5-8
	0	No automatic control: Continuously supplies of air flow for a maximum load of all rooms	
	1	On off time control: Continuously supplies of air flow for a maximum load of all rooms during nominal occupancy time	
	2	Multi-stage control: To reduce the auxiliary energy demand of the fan	
	3	Automatic flow or pressure control without pressure reset: Load dependent supplies of air flow for the demand of all connected rooms.	
	4	Automatic flow or pressure control with pressure reset: Load dependent supplies of air flow for the demand of all connected rooms (for variable air volume systems with VFD).	

4.6	Heat recovery control: icing protection		VENT_HRICE_CTRL	M5-5
	This control function is to avoid icing of the heat exchanger.			
	0	Without icing protection control: There is no specific action to avoid icing of the heat exchanger		
	1	With icing protection control: A control loop enables to warranty that the exhaust air temperature leaving the heat exchanger is not too low to avoid frosting		
4.7	Heat recovery control: prevention of overheating		VENT_HRHEAT_CTRL	M5-5
	This control function is to avoid overheating at the heat recovery unit.			
	0	Without overheating control: There is no specific action to avoid overheating		
	1	With overheating control: During periods where the effect of the heat exchanger will no more be positive a control loop between "stops" and "modulates" or bypass the heat exchanger		
4.8	Free mechanical cooling		VENT_FREECOOL_CTRL	M5-8
	0	No automatic control		
	1	Night cooling: The amount of outside air is set to its maximum during the unoccupied period provided: 1) the room temperature is above the setpoint for the comfort period; 2) the difference between the room temperature and the outside temperature is above a given limit; if free night cooling will be realized by automatically opening windows there is no air flow control		
	2	Free cooling: Both the amount of outside air and recirculation air are modulated during all periods of time to minimize the amount of mechanical cooling. Calculation is performed on the basis of temperatures		
	3	H,x-directed control: The amount of outside air and recirculation air are modulated during all periods of time to minimize the amount of mechanical cooling. Calculation is performed on the basis of temperatures and humidity (enthalpy).		
4.9	Supply air temperature control at the AHU level		VENT_AHUSAT_CTRL	M5-5
	There might be several supply air temperatures in an air conditioning system: the supply air temperature at the outlet of the AHU, the supply air temperature at the outlet of central re-heaters as well as supply air temperature at the room level (terminal re-heat boxes). This control function is about how to determine the supply air temperature setpoint (in case there is one) at the air handler level not how to control the temperature (e.g. control of heat emission at the water-to-air HX).			
	0	No automatic control: No control loop enables to act on the supply air temperature;		
	1	Constant setpoint: A control loop enables to control the supply air temperature, the setpoint is constant and can only be modified by a manual action		

	2	Variable setpoint with outside temperature compensation: A control loop enables to control the supply air temperature. The setpoint is a simple function of the outside temperature (e.g. linear function)		
	3	Variable setpoint with load dependent compensation: A control loop enables to control the supply air temperature. The setpoint is defined as a function of the loads in the room. This can normally only be achieved with an integrated control system enabling to collect the temperatures or actuator position in the different rooms		
4.10	Humidity control		VENT_HUM_CTRL	M6–5 / M7–5
	The control of the air humidity may include humidification and/or dehumidification. Controllers may be applied as "humidity limitation control" or "constant control"			
	0	No automatic control: No control loop enables to act on the air humidity		
	1	Dew point control: Supply air or room air humidity is expressed with the dew point temperature and reheat of the supply air to bring the relative humidity to the setpoint		
	2	Direct humidity control: Supply air or room air humidity; a control loop enables the supply air or room air humidity at a given setpoint. The setpoint is either fixed and predefined by the user or an fluctuating optimal value at a minimum energy but within min/max limits of room air condition		
5	Lighting control			
5.1	Occupancy control		LIGHT_OCC_CTRL	M9–5
	0	Manual on/off switch: The luminaire is switched on and off with a manual switch in the room		
	1	Manual on/off switch + additional sweeping extinction signal: The luminaire is switched on and off with a manual switch in the room. In addition, an automatic signal automatically switches off the luminaire at least once a day, typically in the evening to avoid needless operation during the night		
	2	Automatic detection Auto On/Dimmed Off: The control system switches the luminaire(s) automatically on whenever the illuminated area is occupied, and automatically switches them to a state with reduced light output (of no more than 30 % of the normal 'on state') no later than 10 min after the last occupancy in the illuminated area. In addition, no later than 20 min after the last occupancy in the room as a whole is detected, the luminaire(s) is automatically and fully switched off Auto On/Auto Off: The control system switches the luminaire(s) automatically on whenever the illuminated area is occupied, and automatically switches them entirely off no later than 10 min after the last occupancy is detected in the illuminated area		

	3	Automatic detection Manual On/ Partial Auto On /Dimmed Off: The luminaire(s) can only be switched on by means of a manual switch or automatically by occupancy detection sensor located in (or very close to) the area illuminated by the luminaire(s), and, if not switched off manually, is/are automatically switched to a state with reduced light output (of no more than 30 % of the normal 'on state') no later than 10 min after the last occupancy in the illuminated area. In addition, no later than 20 min after the last occupancy in the room as a whole is detected, the luminaires are automatically and fully switched off Manual On/ Partial Auto On /Auto Off: The luminaire(s) can only be switched on by means of a manual switch or automatically by occupancy detection sensor located in (or very close to) the area illuminated by the luminaire(s), and, if not switched off manually, is automatically and entirely switched off by the automatic control system no later than 20 min after the last occupancy is detected in the illuminated area	
5.2	Light level/Daylight control (daylight harvesting)	LIGHT_LEVEL_CTRL	M9-5
	0	Manual central: Luminaires are controlled centrally, there is no manual switch in the room/zone	
	1	Manual: Luminaires can be switched off with a manual switch in the room	
	2	Automatic switching: The luminaires are automatically switched off when more than enough daylight is present to fully provide minimum illuminance required and switched on when there is not enough daylight.	
	3	Automatic dimming: The luminaires are dimmed down and finally fully switched off when daylight is available. The luminaires will be switched on again and dimmed up if the amount of daylight is decreasing.	
6	Blind control		
6.1	Blind control	BLIND_CTRL	M2.5/M2.8/M9-5
	There are two different motivations for blind control: solar protection to avoid overheating and to avoid glaring		
	0	Manual operation: Mostly used only for manual shadowing, energy saving depends only on the user behaviour	
	1	Motorized operation with manual control: Mostly used only for easiest manual (motor supported) shadowing, energy saving depends only on the user behaviour	
	2	Motorized operation with automatic control: Automatic controlled dimming to reduce cooling energy	
	3	Combined light/blind/HVAC control: To optimize energy use for HVAC, blind and lighting for occupied and non-occupied rooms	
7	Technical home and building management		

	The Technical Home and Building Management enables to adapt easily the operation to the user needs. One shall check at regular intervals that the operation schedules of heating, cooling, ventilation and lighting is well adapted to the actual used schedules and that the setpoints are also adapted to the needs. – Attention shall be paid to the tuning of all controllers this includes setpoints as well as control parameters such as PI controller coefficients. – Heating and cooling setpoints of the room controllers shall be checked at regular intervals. The users often modify these setpoints. A centralized system enables to detect and correct extreme values of setpoints due to misunderstanding of users. – If the Interlock between heating and cooling control of emission and/or distribution is only a partial interlock. The setpoint shall be regularly modified to minimize the simultaneous use of heating and cooling. – Alarming and monitoring functions will support the adaptation of the operation to user needs and the optimization of the tuning of the different controllers. This will be achieved by providing easy tools to detect abnormal operation (alarming functions) and by providing easy way to log and plot information (monitoring functions).			
7.1	Setpoint management		BMS_SP	M10–12
	Management, set back and adaptation of BAC setpoints according to the room/zone operating modes			
	0	Manual setting room by room individually		
	1	Adaptation from distributed/decentralized plant rooms only		
	2	Adaptation from a central room (e.g. work station, web operation; room operating units are excluded)		
	3	Adaptation from a central room (e.g. work station, web operation; room operating units are excluded) with frequent set back of user inputs		
7.2	Runtime management		BMS_RT	M10–12
	Adaptation of system/plant operating hours according to given time schedule and/or calendar			
	0	Manual setting (plant enabling)		
	1	Individual setting following a predefined schedule including fixed preconditioning phases		
	2	Individual setting following a predefined schedule; adaptation from a central room (e.g. work station, web operation; room operating units are excluded); variable preconditioning phases		
7.3	Detecting faults of technical building systems and providing support to the diagnosis of these faults		BMS_FD	M10–12
	0	No central indication of detected faults and alarms		
	1	With central indication of detected faults and alarms		

	2	With central indication of detected faults and alarms including diagnosing functions		
7.4	Reporting information regarding energy consumption, indoor conditions		BMS_RPR	M10–12
	0	Indication of actual values only (e.g. temperatures, meter values)		
	1	Trending functions and consumption determination		
	2	Analysing, performance evaluation, benchmarking of indoor environment and energy		
7.5	Local energy production and renewable energies		BMS_RES	M10–12
	Managing local renewable energy sources and other local energy productions as CHP			
	0	Uncontrolled generation depending on the fluctuating availability of RES and or run time of CHP; overproduction will be fed into the grid		
	1	Coordination of local RES and CHP with regard to local energy demand profile including energy storage management; Optimization of own consumption		
7.6	Heat recovery and heat shifting		BMS_HRC	M10–12
	Using of waste heat recovery on the building level and heat shifting			
	0	Instantaneous use of waste heat or heat shifting		
	1	Managed use of waste heat or heat shifting (including charging/discharging TES)		
7.7	Smart grid integration		BMS_SG	M10–12
	Interactions between building and any smart grid including demand side management			
	0	No harmonization between grid and building energy systems; building is operated independently from the grid load		
	1	Building energy systems are managed and operated depending on grid load; demand side management is used for load shifting		

5.5 BAC Efficiency Class

Four different BAC efficiency classes (A, B, C, D) of functions are defined both for non-residential and residential buildings.

— Class D corresponds to non-energy efficient BAC. Building with such systems shall be retrofitted. New buildings shall not be built with such systems.

— Class C corresponds to standard BAC.

— Class B corresponds to advanced BAC and some specific TBM functions.

— Class A corresponds to high-energy performance BAC and TBM functions.

The BAC implementation is categorized as class D: If the minimum functions to be in class C are not implemented.

To be in class C: Minimum functions defined in Table B.1 shall be implemented.

To be in class B: Building automation function plus some specific functions defined in Table 4 shall be implemented in addition to class C. Room controllers shall be able to communicate with a building automation system.

To be in class A: Technical building management function plus some specific functions defined in Table 4 shall be implemented in addition to class B. Room controllers shall be able for demand controlled HVAC (e.g. adaptive setpoint based on sensing of occupancy, air quality, etc.) including additional integrated functions for multi-discipline interrelationships between HVAC and various building services (e.g. electricity, lighting, solar shading, etc.)

5.6 BAC and TBM functions assigned to the BAC efficiency classes

BAC and TBM functions described and summarized in Table 4 are assigned to the BAC efficiency classes as defined in 5.5, depending on their use in residential or non-residential buildings. The assignment of functions to the BAC efficiency classes is listed in Table 5.

Table 4 and Table 5 should be applied in the following way:

a) For the definition of the building automation and controls (BAC) and technical building management (TBM) functions to be implemented for a new building or for the renovation of an existing building:

   1) building owners, architects or engineers can put a-marker in front of each of the functions they want to be implemented. They will use the indicated boxes as a help tool to determine in which BAC class A, B, C, D the function they have specified is located. To achieve for example BAC class B the marker shall be in a line where indicated boxes cover classes D to B;

   2) it will be a simplified alternative – especially for specification at an early stage of a project – to specify only the classes of function A, B, C, D;

b) For the definition of minimum requirements for BAC and TBM functions for new buildings as well as for renovations of buildings:

   1) Public authorities defining can define the minimum class to be achieved. Unless differently specified this class is C;

c) For the definition of inspection procedures of technical systems as well as inspectors applying these procedures to check if the level of BAC and TBM functions implemented is appropriate:

   1) public authorities can request the use of the table to inspect the BAC functions in place;

   2) inspectors can put an X in front of each of the BAC functions which is implemented;

   3) they will then be able to determine the class A, B, C, D of functions already implemented. To be in a given class all the X shall correspond to indicated boxes for this class;

d) For the definition and implementation of calculation methods which take into account the impact of BAC and TBM functions on the energy performance of buildings, as well as software developers implementing these calculation methods and designers using them:

   1) public authorities can request that the impact of the BAC and TBM functions defined in Table 4 is taken into account;

2) software developers can develop software user interfaces enabling to input the list of BAC and TBM functions which are implemented according to Table 4. They can provide a simplified input mode based on the class of functions A, B, C, and D according to Table 5.

e) For checking that the impact of all BAC and TBM functions is taken into account when assessing the energy performance of a building:

1) designers will only have to input either the class of functions (A, B, C, D) or the detailed list of functions in the software enabling assessment of the energy performance of a building.

When determining the BAC efficiency class only those BAC and TBM functions having a relevant impact have to be considered:

— BAC and TBM functions with the purpose to control or monitor a plant or part of a plant which is not installed in the building do not have to be considered when determining the class even if they are indicated for that class. For example, to be in class B for a building with no cooling system no individual room control with communication is required for emission control of cooling systems.

— If a specific control function type is required to be in a certain BAC efficiency class, it does not necessarily mean that this function type has to be foreseen everywhere in the building: if the designer can give good reasons that the application of a function type does not bring a benefit in a specific case this function type can be ignored. For example, if the designer can show that the heating load of a set of rooms depend on the out temperature only and can be compensated with one central controller, no individual room control by thermostatic valves or electronic controllers is required to be in class C.

— Not all BAC and TBM functions in Table 4 are applicable to all types of building services. Therefore, a BAC or TBM function that has no substantial impact on the energy used for the corresponding service Heating, Cooling, Ventilation, DHW or Lighting will not be taken into account when classifying the BAC functionality. The impact is not seen substantial if the share of energy consumption related to the service controlled by the function is less than about 5 % of the total energy consumption of the building. Further information is given in CEN/TR 15232-2.

Table 5 — Function list and assignment to BAC efficiency classes

			Definition of classes							
			Residential				Non residential			
			D	C	B	A	D	C	B	A
Automatic control										
1	Heating control									
1.1	Emission control									
	The control function is applied to the heat emitter (radiators, underfloor heating, fan-coil unit, indoor unit) at room level; for type 1 one function can control several rooms									
	0	No automatic control	x				x			
	1	Central automatic control	x				x			
	2	Individual room control	x	x			x	x		
	3	Individual room control with communication	x	x	x	x[a]	x	x	x	x[a]
	4	Individual room control with communication and occupancy detection (not applied to slow reacting heating emission systems, e.g. floor heating)	x	x	x	x	x	x	x	x
1.2	Emission control for TABS (heating mode)									
	0	No automatic control	x				x			
	1	Central automatic control	x	x			x	x		
	2	Advanced central automatic control	x	x	x		x	x	x	
	3	Advanced central automatic control with intermittent operation and/or room temperature feedback control	x	x	x	x	x	x	x	x
1.3	Control of distribution network hot water temperature (supply or return)									
	Similar function can be applied to the control of direct electric heating networks									
	0	No automatic control	x				x			
	1	Outside temperature compensated control	x	x			x	x		
	2	Demand based control	x	x	x	x	x	x	x	x

			Definition of classes							
			Residential				Non residential			
			D	C	B	A	D	C	B	A
1.4	Control of distribution pumps in networks									
	The controlled pumps can be installed at different levels in the network									
	0	No automatic control	x				x			
	1	On off control	x	x			x	x		
	2	Multi-Stage control	x	x	x		x	x	x	
	3	Variable speed pump control (pump unit (internal) estimations)	x	x	x	x	x	x	x	x
	4	Variable speed pump control (external demand signal)	x	x	x	x	x	x	x	x
1.5	Intermittent control of emission and/or distribution									
	One controller can control different rooms/zones having same occupancy patterns									
	0	No automatic control	x				x			
	1	Automatic control with fixed time program	x	x			x	x		
	2	Automatic control with optimum start/stop	x	x	x		x	x	x	
	3	Automatic control with demand evaluation	x	x	x	x	x	x	x	x
1.6	Heat generator control (combustion and district heating)									
	0	Constant temperature control	x				x			
	1	Variable temperature control depending on outside temperature	x	x			x	x		
	2	Variable temperature control depending on the load	x	x	x	x	x	x	x	x
1.7	Heat generator control (heat pump)									
	0	Constant temperature control	x				x			
	1	Variable temperature control depending on outside temperature	x	x			x	x		
	2	Variable temperature control depending on the load	x	x	x	x	x	x	x	x

			Definition of classes							
			Residential				Non residential			
			D	C	B	A	D	C	B	A
1.8	Heat generator control (outdoor unit)									
	0	On/Off-control of heat generator	x				x			
	1	Multi-stage control of heat generator	x	x	x		x	x	x	
	2	Variable control of heat generator	x	x	x	x	x	x	x	x
1.9	Sequencing of different heat generators									
	0	Priorities based on fixed priority list	x				x			
	1	Priorities only based on loads	x	x			x	x		
	2	Priorities dynamically based on generator efficiency and characteristics	x	x	x		x	x	x	
	3	Load prediction based sequencing (various parameters)	x	x	x	x	x	x	x	x
1.10	Control of Thermal Energy Storage (TES) operation									
	0	Continuous storage operation	x				x			
	1	2-sensor charging of storage	x	x			x	x		
	2	Load prediction based storage operation	x	x	x	x	x	x	x	x
2	Domestic hot water supply control									
2.1	Control of DHW storage charging with direct electric heating or integrated electric heat pump									
	0	Automatic on/off control	x				x			
	1	Automatic on/off control and scheduled charging enable	x	x			x	x		
	2	Automatic on/off control and scheduled charging enable and multi-sensor storage management	x	x	x	x	x	x	x	x

			Definition of classes							
			Residential				Non residential			
			D	C	B	A	D	C	B	A
2.2	Control of DHW storage charging using hot water generation									
	0	Automatic on/off control	x				x			
	1	Automatic on/off control and scheduled charging enable	x	x			x	x		
	2	Automatic on/off control, scheduled charging enable and demand-based supply temperature control or multi-sensor storage management	x	x	x	x	x	x	x	x
2.3	Control of DHW storage charging with solar collector and supplementary heat generation									
	0	Manual control	x				x			
	1	Automatic control of solar storage charge (Prio. 1) and supplementary storage charge (Prio. 2)	x	x			x	x		
	2	Automatic control of solar storage charge (Prio. 1) and supplementary storage charge (Prio. 2) plus demand based supply temperature control or multi-sensor storage management	x	x	x	x	x	x	x	x
2.4	Control of DHW circulation pump									
	0	No control, continuous operation	x				x			
	1	With time program	x	x	x	x	x	x	x	x

			Definition of classes							
			Residential				Non residential			
			D	C	B	A	D	C	B	A
3	Cooling control									
3.1	Emission control									
	The control function is applied to the emitter (cooling panel, fan-coil unit or indoor unit) at room level; for type 1 one function can control several rooms									
	0	No automatic control	x				x			
	1	Central automatic control	x				x			
	2	Individual room control	x	x			x	x		
	3	Individual room control with communication	x	x	x	x[a]	x	x	x	x[a]
	4	Individual room control with communication and occupancy detection (not applied to slow reacting cooling emission systems, e.g. floor cooling)	x	x	x	x	x	x	x	x
3.2	Emission control for TABS (cooling mode)									
	0	No automatic control	x				x			
	1	Central automatic control	x	x			x	x		
	2	Advanced central automatic control	x	x	x		x	x	x	
	3	Advanced central automatic control with intermittent operation and/or room temperature feedback control	x	x	x	x	x	x	x	x
3.3	Control of distribution network chilled water temperature (supply or return)									
	Similar function can be applied to the control of direct electric cooling (e.g. compact cooling units, split units) for individual rooms									
	0	Constant temperature control	x				x			
	1	Outside temperature compensated control	x	x			x	x		
	2	Demand based control	x	x	x	x	x	x	x	x

			Definition of classes							
			Residential				Non residential			
			D	C	B	A	D	C	B	A
3.4	Control of distribution pumps in networks									
	The controlled pumps can be installed at different levels in the network									
	0	No automatic control	x				x			
	1	On off control	x	x			x	x		
	2	Multi-Stage control	x	x	x		x	x	x	
	3	Variable speed pump control (pump unit (internal) estimations)	x	x	x	x	x	x	x	x
	4	Variable speed pump control (external demand signal)	x	x	x	x	x	x	x	x
3.5	Intermittent control of emission and/or distribution									
	One controller can control different rooms/zones having same occupancy patterns									
	0	No automatic control	x				x			
	1	Automatic control with fixed time program	x	x			x	x		
	2	Automatic control with optimum start/stop	x	x	x		x	x	x	
	3	Automatic control with demand evaluation	x	x	x	x	x	x	x	x
3.6	Interlock between heating and cooling control of emission and/or distribution									
	0	No interlock	x				x			
	1	Partial interlock (dependent on the HVAC system)	x	x	x		x	x	x	
	2	Total interlock	x	x	x	x	x	x	x	x
3.7	Generator control for cooling									
	The goal consists generally in maximizing the chilled water supply temperature									
	0	Constant temperature control	x				x			
	1	Variable temperature control depending on outside temperature	x	x	x		x	x	x	
	2	Variable temperature control depending on the load	x	x	x	x	x	x	x	x

			Definition of classes							
			Residential				Non residential			
			D	C	B	A	D	C	B	A
3.8	Sequencing of generators for chilled water									
	0	Priorities only based on running times	x				x			
	1	Priorities only based on loads	x	x			x	x		
	2	Priorities based on generator efficiency and characteristics	x	x	x		x	x	x	
	3	Load prediction based sequencing	x	x	x	x	x	x	x	x
3.9	Control of Thermal Energy Storage (TES) operation									
	0	Continuous storage operation	x				x			
	1	Time-scheduled storage operation	x	x			x	x		
	2	Load prediction based storage operation	x	x	x	x	x	x	x	x
4	Ventilation and air-conditioning control									
4.1	Supply air flow control at the room level									
	0	No automatic control	x				x			
	1	Time control	x	x	x		x	x	x	
	2	Occupancy detection	x	x	x	x	x	x	x	x
4.2	Room air temp. control (all-air systems)									
	0	on-off control	x				x			
	1	variable control	x	x			x	x		
	4	Demand control	x	x	x	x	x	x	x	x
4.3	Room air temp. control (Combined air-water systems)									
	0	No coordination	x				x			
	1	Coordination	x	x	x	x	x	x	x	x
4.4	Outside air (OA) flow control									
	0	Fixed OA ratio/OA flow	x	x			x			
	1	Staged (low/high) OA ratio/OA flow (time schedule)	x	x	x		x	x		

			Definition of classes							
			Residential				Non residential			
			D	C	B	A	D	C	B	A
	2	Staged (low/high) OA ratio/OA flow (occupancy)	x	x	x		x	x	x	
	3	Variable control	x	x	x	x	x	x	x	x
4.5	Air flow or pressure control at the air handler level									
	0	No automatic control	x				x			
	1	On off time control	x	x			x	x		
	2	Multi-stage control	x	x	x		x	x	x	
	3	Automatic flow or pressure control (without reset)	x	x	x	x	x	x	x	x
	4	Automatic flow or pressure control (with reset)	x	x	x	x	x	x	x	x
4.6	Heat recovery control: icing protection									
	0	Without icing protection	x				x			
	1	With icing protection	x	x	x	x	x	x	x	x
4.7	Heat recovery control: prevention of overheating									
	0	Without overheating control	x				x			
	1	With overheating control	x	x	x	x	x	x	x	x
4.8	Free mechanical cooling									
	0	No automatic control	x				x			
	1	Night cooling	x	x			x	x		
	2	Free cooling	x	x	x	-	x	x	x	-
	3	H,x- directed control	x	x	x	x	x	x	x	x
4.9	Supply air temperature control									
	0	No automatic control	x				x			
	1	Constant setpoint	x	x			x	x		
	2	Variable setpoint with outside temperature compensation	x	x	x		x	x	x	
	3	Variable setpoint with load dependant compensation	x	x	x	x	x	x	x	x

			Definition of classes							
			Residential				Non residential			
			D	C	B	A	D	C	B	A
4.10	Humidity control									
	0	No automatic control	x				x			
	1	Dew point control	x	x			x	x		
	2	Direct humidity control	x	x	x	x	x	x	x	x
5	Lighting control									
5.1	Occupancy control									
	0	Manual on/off switch	x	x			x			
	1	Manual on/off switch + additional sweeping extinction signal	x	x	x		x	x		
	2	Automatic detection (auto on)	x	x	x	x	x	x	x	
	3	Automatic detection (manual on)	x	x	x	x	x	x	x	x
5.2	Light level/Daylight control									
	0	Manual (central)	x				x	x		
	1	Manual (per room/zone)	x	x			x	x		
	2	Automatic switching	x	x	x		x	x	x	
	3	Automatic dimming	x	x	x	x	x	x	x	x
6	Blind control									
	0	Manual operation	x				x			
	1	Motorized operation with manual control	x	x			x			
	2	Motorized operation with automatic control	x	x	x		x	x		
	3	Combined light/blind/HVAC control	x	x	x	x	x	x	x	x
7	Technical home and building management									
7.1	Setpoint management									
	0	Manual setting room by room individually	x	x			x			
	1	Adaptation from distributed/decentralized plant rooms only	x	x	x		x	x		

			Definition of classes							
			Residential				Non residential			
			D	C	B	A	D	C	B	A
	2	Adaptation from a central room	x	x	x	x	x	x	x	
	3	Adaptation from a central room with frequent set back of user inputs	x	x	x	x	x	x	x	x
7.2	Runtime management									
	0	Manual setting (plant enabling)	x	x			x			
	1	Individual setting following a predefined time schedule including fixed preconditioning phases	x	x	x		x	x		
	2	Individual setting following a predefined time schedule; adaptation from a central room; variable preconditioning phases	x	x	x	x	x	x	x	x
7.3	Detecting faults of technical building systems and providing support to the diagnosis of these faults									
	0	No central indication of detected faults and alarms	x	x			x			
	1	With central indication of detected faults and alarms	x	x	x		x	x		
	2	With central indication of detected faults and alarms/diagnosing functions	x	x	x	x	x	x	x	x
7.4	Reporting information regarding energy consumption, indoor conditions									
	0	Indication of actual values only (e.g. temperatures, meter values)	x	x			x	x		
	1	Trending functions and consumption determination	x	x	x		x	x	x	

			Definition of classes							
			Residential				Non residential			
			D	C	B	A	D	C	B	A
	2	Analysing, performance evaluation, benchmarking	x	x	x	x	x	x	x	x
7.5	Local energy production and renewable energies									
	0	Uncontrolled generation depending on the fluctuating availability of RES and or run time of CHP; overproduction will be fed into the grid	x	x			x	x		
	1	Coordination of local RES and CHP with regard to local energy demand profile including energy storage management; Optimization of own consumption	x	x	x	x	x	x	x	x
7.6	Waste heat recovery and heat shifting									
	0	Instantaneous use of waste heat or heat shifting	x				x			
	1	Managed use of waste heat or heat shifting (including charging/discharging TES)	x	x	x	x	x	x	x	x
7.7	Smart Grid integration									
	0	No harmonization between grid and building energy systems; building is operated independently from the grid load	x	x			x	x		
	1	Building energy systems are managed and operated depending on grid load; demand side management is used for load shifting	x	x	x	x	x	x	x	x
[a] In case of slow reacting heat and cool emission systems, e.g. floor heating, wall heating, etc. functions 1.1.3 and 3.1.3 are allocated to BAC class A.										

5.7 Applying BAC for EMS and maintaining BAC energy efficiency

5.7.1 General

Once a BACS is installed two main questions arise, in view of EN 15232:

a) How can a BAC support an Energy Management System (EMS) for the building part?

b) Which related activities have to be provided to maintain and to improve the impact of BAC/TBM on the energy efficiency in buildings and to upgrade its current system class?

5.7.2 Applying BAC for EMS

EMS as specified by EN ISO 50001 is intended to improve energy performance by managing energy use systematically. EN ISO 50001 sets the requirements for continual improvement of more efficient and sustainable energy use for production/process, transportation and buildings.

The use of BAC/TBM systems encourages different levels and functions of organization to implement an EMS in buildings and simplifies and significantly improves the continuous EMS process for buildings.

A good approach is described in Annexe E. This Annex explains in detail how to apply and use BAC/TBMS for an EMS for buildings.

Table E.1 outlines BAC/TBMS requirements, options and functions used to support implementation and processing of the different stages of EN ISO 50001 concerning EMS in buildings.

Annexe E also shows that a dedicated skilled BAC/TBMS team has to be dedicated to the project.

5.7.3 Maintaining BAC energy efficiency

The experience from real projects shows that an installed BAC will deviate dramatically from desired sustainable optimization and expected energy efficiency over time due to lack of services.

The required BAC services on the project site to keep the functionality and the objectives of a System Class (D), C, B, A. shall be provided.

The actions required to upgrade from one system class to another and its related services, e.g. from D- > C- > B- > A shall be specified.

NOTE An upgrade from one class to a higher system class could also be considered (e.g. from D to C, C to B, B to A, etc.).

The required services for continuous improvement of the BAC impact concerning efficient and sustainable energy use in buildings are described in Annex F.

Annex F describes the minimum activities of a commissioned BACS to ensure the maintainability of its current system class on the one hand and the procedure how to upgrade to a higher class at the request of the customer on the other hand.

6 Method 1 - Detailed calculation procedure of the BAC contribution to the energy performance of buildings (Detailed method)

6.1 Output data

The output data of this method is a list of building automation and control functions and to each such function the chosen function type. The following chapters describe approaches to take into account the impact of BAC and TBM function in the assessment of energy performance indicators defined in EN 15217, EN ISO 52000-1 and connected standards.

It will be explained:

— the main approaches used in these standards to take into account the contribution of the BAC and TBM functions;

— an overview of links between these standards and the BAC and TBM functions;

— a detailed description of the ways each BAC and TBM functions can be dealt with in connection with the relevant standards. Especially when the relevant standard does not describe explicitly how to deal with BAC and TBM function, this standard provides this explicit description.

The control functions defined in Table 4 shall be taken into account when applying the standards defined in Table 6 and 7.

CEN/TR 15232-2:2016, 5.3.6 gives more detailed information on the relations between the BAC and TBM functions in Table 4 and the standards referenced in Table 6 and 7.

Table 6 — Automation and control functions

Function		Standard
Heating, Cooling and domestic hot water control		
	Emission control	EN 15316-2:2017, 7.2, 7.3, EN 15243:2007, 14.3.2.1 and Annex G EN 15316-2:2017, 6.5.1 EN ISO 52016-1
	Control of distribution network water temperature	EN 15316-2 EN 16798-9
	Control of distribution pump	EN 15316-3 EN 16798-9
	Intermittent control of emission and/or distribution.	EN ISO 52016-1 EN 15316-3 EN 15243
	Interlock between heating and cooling control of emission and/or distribution	EN 15243
	Generation control and sequencing of generators	EN 15316-4-1 to EN 15316-4-5:2017, 7.4.6 EN 16798-9 EN 16798-13 EN 16947-1
	Thermal energy storage control	EN 15316 series EN 16798-15
Ventilation and air conditioning control		
	Air flow control at the room level	EN 16798-7 EN 13779
	Air flow or pressure control at the air handler level	EN 16798-5-1
	Heat exchanger defrost and overheating control	EN 16798-5-1
	Free mechanical cooling	EN 16798-13
	Supply temperature control	EN 16798-5-1
	Humidity control	EN 16798-5-1
Lighting control		EN 15193-1
	Combined light/blind/HVAC control (also mentioned below)	None
Blind control		EN ISO 52016-1

Table 7 — Technical building management with energy efficiency functions overview

Function	Standard
Setpoint management	EN 16947 series
Run time management	EN 16947 series
Local energy production and renewable energies	EN 16947 series
Waste heat recovery and heat shifting	EN 16947 series
Smart Grid integration	EN 16947 series
Detecting faults of building and technical systems and providing support to the diagnosis of these faults	None
Reporting information regarding energy consumption, indoor conditions and possibilities for improvement	EN ISO 52000-1

6.2 Calculation time steps

The methods described in paragraph 6 are suitable for the following calculation time steps:

— yearly (seasonal);

— monthly;

— hourly;

or the statistical Bin-method can be applied.

Beside Bin-method, the output time step is the same as the input time-step.

This method can be used within a dynamic calculation scheme.

6.3 Input data - Source of data

Input data about products that are required for the (calculation or test or ...) method(s) described in this standard shall be the data supplied by the manufacturer or any third party if they are declared according to relevant EN (or EN ISO) product standards (in the CEN area) or equivalent ISO or national standards (outside the CEN area).

6.4 Calculation procedure

6.4.1 Applicable timestep

This procedure can be used with the following time-steps:

— yearly;

— monthly;

— hourly.

This procedure is suitable for dynamic simulations.

6.4.2 Energy performance calculation

6.4.2.1 Energy calculation

The standards enabling to calculate the impact of BAC and TBM functions on energy performance use different approaches to calculate this impact.

Five approaches are common to different standards:

— direct approach;

— operating mode approach;

— time approach;

— setpoint approach;

— correction coefficient approach.

6.4.2.2 Direct approach

When the calculation of energy performance is performed using detailed simulation method or even hourly simulation method as described in EN ISO 52016-1, it is possible to directly calculate the impact of a number of functions e.g. impact of intermittent heating, varying temperature between heating and cooling setpoints, movable solar shadings etc.

6.4.2.3 Operating mode approach

Automatic control enables to operate climate systems under different operating mode e.g. for ventilation system: occupied mode/unoccupied mode, for intermittent heating normal mode, no heating mode, set back mode, peak power mode.

The approach to calculate the impact of the automatic control on the energy consumption is to calculate the energy consumption sequentially for each operating mode. The total energy consumption is obtained by summing the energy consumption during each operating mode.

Each operating mode corresponds to a given state of the control system. The calculations are performed for each operating mode by considering the relevant state of the control system: e.g. fan on/off.

6.4.2.4 Time approach

This approach can be used when the control system has a direct impact on the operating time of a device (e.g. control of a fan, a luminaire).

The energy consumption for a certain time period is given by Formula (1):

$$E = P \cdot \Delta t \cdot k_{\mathrm{ctr}} \tag{1}$$

where

E	is the energy consumption for the time period;
P	is the input power of the controlled system;
Δt	is the duration of the time period;
k_{ctr}	is a characteristic coefficient which represents the impact of the control system. It is the ratio between the time where the control switches the system on and the duration of the time period.

By extension the time approach can be used if the control system modulates the operation of the system instead of switching it on and off. k_{ctr} represents in this case an equivalent operating time ratio.

6.4.2.5 Setpoint approach

This approach can be used when the control system has a direct impact on the control accuracy, i.e. the deviation between controlled variable and the corresponding setpoint.

Exemplarily in the calculation of the energy needs according to EN ISO 52016-1 a deviation from the room temperature setpoint, which takes into account the impact of the control system is applied.

The following impacts shall be taken into account:

— emission control of heating and cooling;

— intermittent control of emission and or distribution;

— optimizing the operation by the tuning of the different controllers;

— detecting faults of building and technical systems and providing support to the diagnosis of these faults;

— the impact of the room controller;

— the impact of the intermittent heating controller

The calculation of the energy used is performed by Formula (2):

$$E = k_{\text{trans}} \cdot \left(\left(\vartheta_{\text{set}} + \Delta\vartheta_{\text{ctr}} \right) - \vartheta_{\text{ref}} \right) \Delta t \tag{2}$$

Where

E	is the energy demand or consumption of the time period;
k_{trans}	is a transfer coefficient;
ϑ_{set}	is the setpoint which shall be maintained by the control system;
$\Delta\vartheta_{\text{ctr}}$	represents the impact of the actual control system, it will be equal to 0 if the control system was perfect, and will be positive in case of heating and negative in case of cooling;
ϑ_{ref}	is a reference temperature e.g. the outside temperature;
Δt	is the duration of the time period.

In this approach:

ϑ_{set}	depends on the control system type used. It can be constant or variable;
$\Delta\vartheta_{\text{ctr}}$	is a characteristic of the quality of the control system itself and of the controlled system. It can be defined by a product standard or a product certification provided this standard takes into account not only the controller but also the controlled system;
k	enables the influence of the plant or of the building controlled to be taken into account;
ϑ_{ref}	enables the boundary conditions to be taken into account, such as for example the climate;

$\vartheta_{set} + \Delta\vartheta_{ctr}$ is called the equivalent temperature setpoint.

6.4.2.6 Correction coefficient approach

This approach is used when the control system has a more complex impact such as for example a combined effect on time, temperature etc.

The calculation of the energy demand or consumption is performed by Formula (3):

$$E = E_{ref} \cdot k_{ctr} \tag{3}$$

where

- E is the energy demand or consumption;
- E_{ref} is the energy consumption in the reference case, e.g. if the system is controlled ideally, or if a BAC or TBM function is not present, or if the system is assumed to be controlled such that it is simple to calculate the energy performance;
- k_{ctr} is the correction coefficient which represents the increase or decrease of energy consumption as compared to the energy consumption E_{ref} of the reference case.

The values of k_{ctr} depend on the control type but vary also with the climate, building type etc. Tables or formulae should be provided for example in national annexes to determine the impact of these parameters on k_{ctr}.

6.4.2.7 Equivalence between the different approaches

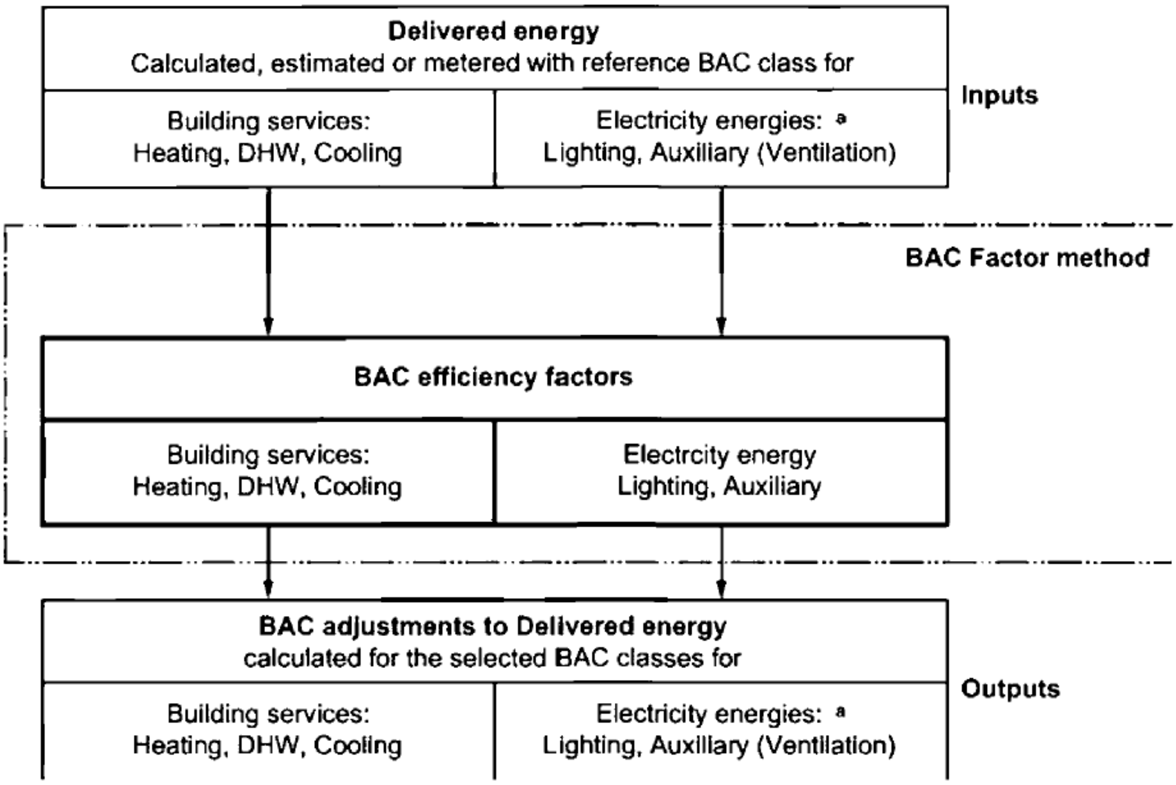
The parameters of the operating mode approach, times approach (k_{ctr}) and of the setpoint approach ($\Delta\vartheta_{ctr}$) can generally be determined from the description of the control system and of the user profile.

The parameter of the correction coefficient approach k_{ctr} shall be determined by prior simulations. These simulations enable to define the tables or formulas giving the value of k_{ctr} in function of relevant parameters: building type, system type, user profile, climate etc.

7 Method 2 - Factor based calculation procedure of the BAC impact on the energy performance of buildings (BAC factor method)

7.1 Output data

The BAC factor method described here has been established to allow a simple calculation of the impact of building automation, control and management functions on the building energy performance. The following Figure 8 illustrates how to use this approach.



Key

a electricity energy = overall energy use for auxiliary and lighting

NOTE 1 Delivered energy is the total energy, expressed per energy carrier (gas, oil, electricity etc.)

NOTE 2 Arrows illustrate only the calculation process and do not represent energy and/or mass flows

Figure 8 — BAC Factor method

The BAC factor method gives a rough estimation of the impact of BAC and TBM functions on thermal and electric energy demand of the building according to the efficiency classes A, B, C and D (defined in Clause 5). The BAC factor method is specially appropriated to the early design stage of a building because there is no special information needed about any specific control and automation function just the recent (if it is an existing building) or reference building automation class and the classification of the building as expected or predefined.

7.2 Calculation interval

This procedure is designed for a yearly calculation period and calculation interval.

7.3 Calculation procedure - Energy calculation

This method gives the opportunity to simply evaluate the impact of BAC and TBM functions on building energy performance by using BAC efficiency factors. The factors are related to the annual energy use of a building including:

— thermal and auxiliary energy input to the space heating system, calculated according to the EN 15316 series;

— thermal and auxiliary energy input to the cooling system, calculated according to EN 15255;

— thermal energy input to the domestic hot water system, calculated according to the EN 15316 series;

— electric energy input to the lighting system, calculated according to EN 15193-1;

— electric energy input to the ventilation system, calculated according to EN 15241.

In principle, it will be possible to calculate the energy use of the building using any dedicated calculation algorithm, e.g. EPBD standards within Europe (as mentioned above), ISO-standards outside Europe or any national or regional code available. Anyhow, the calculation procedure used to estimate the energy input data of the BAC factor method will account for the specific building, its specific use, and specific climatic conditions as well the building is located at. Thus, BAC factors are independent on any of these specifics, e.g. climatic parameters.

The BAC efficiency factors were obtained by performing transient pre-calculations for different building types as mentioned in EN 15217. Thereby each building type is characterized by a significant user profile of occupancy and internal heat gains due to people and equipment, respectively. The BAC efficiency classes A, B, C and D as defined in Clause 4 were represented by different levels of control accuracy and control quality. The impact of different climate conditions on the BAC factors was treated as neglectable since the main impact of climatic conditions is on the energy input data which again are derived from preparatory energy performance calculations. Further background information about these pre-calculations as well as boundary conditions is given in Annex C.

Finally, four sets of BAC efficiency factors $f_{BAC,H}$, $f_{BAC,C}$, $f_{BAC,DHW}$, and $f_{BAC,el}$ were extracted from the results of the energy performance calculations. They are available for the assessment of:

— thermal energy for space heating and cooling ($f_{BAC,H}$, $f_{BAC,C}$) according to Tables A.5 and A.6); and

— thermal energy for domestic hot water generation ($f_{BAC,DHW}$ according to Tables A.7 and A.8); and

— electric energy for ventilation, lighting and auxiliary devices ($f_{BAC,el}$ according to Table A.9).

The energy input to the building energy systems (energy use) accounts for building energy demand, total thermal losses of the systems as well as auxiliary energy required to operate the systems. Each of the energy systems installed in a building shall be assessed with the right BAC factor taking into account the correlations given in Table 8.

Table 8 — Relations between building energy systems and BAC efficiency factors

Energy use		Energy need[a]		System losses[b]	Auxiliary energy[c]	BAC factor
Heating	=	$Q_{H,nd}$	+	$Q_{H,ls}$		$f_{BAC,H}$
			+		$W_{H,aux}$	$f_{BAC,el}$
Cooling	=	$Q_{C,nd}$	+	$Q_{C,ls}$		$f_{BAC,C}$
			+		$W_{C,aux}$	$f_{BAC,el}$
Ventilation	=				$W_{V,aux}$	$f_{BAC,el}$
Lighting[d]	=				W_{L}	$f_{BAC,el}$
DHW	=	$Q_{DHW,nd}$		$Q_{DHW,ls}$		$f_{BAC,DHW}$

[a] Energy need for heating and cooling should both be calculated with EN ISO 52016-1.

[b] System losses of a heating system should be estimated by using the EN 15316 series for different process areas whereas losses of a cooling system should be estimated by using EN 15255.

[c] The auxiliary energy required by the systems should be calculated by using the EN 15316 series (heating systems), EN 15241 (ventilation systems) and EN 15193-1 (lighting systems) respectively.

[d] The impact of lighting control should be evaluated separately with EN 15193-1.

The whole calculation sequence of the BAC efficiency factor method is depicted in Figure 9. As to be seen one of the BAC efficiency classes as described in Table 5 shall be defined as a reference case first. Normally class C which corresponds to a state-of-the-art building automation and control system is set as reference case. For this reference case, the annual energy use of the building energy systems shall be calculated either in a detailed or a more simplified matter using an appropriate calculation method or it shall be measured. The BAC factors then allow to easily assessing the energy performance of a building operating with a building automation and control system different to that system defined as the reference case. Since the relevant efficiency factors have to be set in relation against each other also building energy performance is in relation to a reference case.

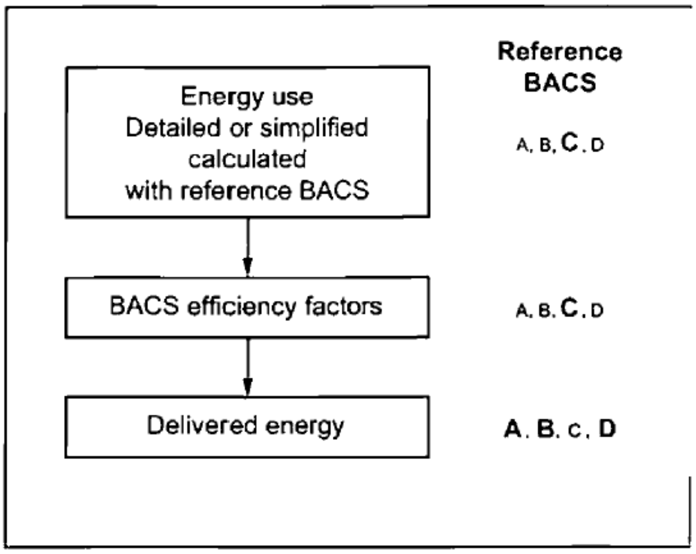


Figure 9 — Calculation sequence of BAC efficiency factor method

The BAC efficiency factors have to be used as illustrated in the following equations to calculate the BAC assessed energy inputs to the systems.

Heating system

$$Q_{\mathrm{H,tot,BAC}} = \left(Q_{\mathrm{H,nd,B}} + Q_{\mathrm{H,ls}}\right) \cdot \frac{f_{\mathrm{BAC,H}}}{f_{\mathrm{BAC,H,ref}}} \tag{4}$$

$$W_{\mathrm{H,aux,BAC}} = W_{\mathrm{H,aux}} \cdot \frac{f_{\mathrm{BAC,el}}}{f_{\mathrm{BAC,el,ref}}} \tag{5}$$

Cooling system

$$Q_{\mathrm{C,tot,BAC}} = \left(Q_{\mathrm{C,nd,B}} + Q_{\mathrm{C,ls}}\right) \cdot \frac{f_{\mathrm{BAC,C}}}{f_{\mathrm{BAC,C,ref}}} \tag{6}$$

$$W_{\mathrm{C,aux,BAC}} = W_{\mathrm{C,aux}} \cdot \frac{f_{\mathrm{BAC,el}}}{f_{\mathrm{BAC,el,ref}}} \tag{7}$$

Ventilation system

$$W_{\mathrm{V,aux,BAC}} = W_{\mathrm{V,aux}} \cdot \frac{f_{\mathrm{BAC,el}}}{f_{\mathrm{BAC,el,ref}}} \tag{8}$$

Lighting system

$$W_{\mathrm{L,BAC}} = W_{L} \cdot \frac{f_{\mathrm{BAC,el}}}{f_{\mathrm{BAC,el,ref}}} \tag{9}$$

DHW system

$$Q_{\mathrm{DHW,BAC}} = Q_{DHW} \cdot \frac{f_{\mathrm{BAC,DHW}}}{f_{\mathrm{BAC,DHW,ref}}} \tag{10}$$

Where

$Q_{H,tot,BAC}$	is the total heating energy related to BAC efficiency class;
$Q_{H,nd,B}$	is the heating energy needs of the building;
$Q_{H,ls}$	is the energy losses of the heating system;
$Q_{C,tot,BAC}$	is the total cooling energy related to a BAC efficiency class;
$Q_{C,nd,B}$	is the cooling energy needs of the building;
$Q_{C,ls}$	is the energy losses of the cooling system;
$W_{H,aux,BAC}$	is the electrical auxiliary energy for heating related to BAC efficiency class;
$W_{C,aux,BAC}$	is the electrical auxiliary energy for cooling related to BAC efficiency class;
$W_{V,aux,BAC}$	is the electrical auxiliary energy for ventilation related to BAC efficiency class;
$W_{L,BAC}$	is the electrical energy for the lighting related to BAC efficiency class;
$W_{H,aux}$	is the electrical auxiliary energy for heating;
$W_{C,BAC}$	is the electrical auxiliary energy for cooling;
$W_{V,aux}$	is the electrical auxiliary energy for ventilation;
W_{L}	is the electrical energy for the lighting;
$f_{BAC,H}$	is the BAC efficiency factor for thermal energy (heating);
$f_{BAC,C}$	is the BAC efficiency factor for thermal energy (cooling);
$f_{BAC,el}$	is the BAC efficiency factor for electric energy;
$f_{BAC,H,ref}$	is the BAC efficiency factor for thermal energy (heating) for reference BAC;
$f_{BAC,C,ref}$	is the BAC efficiency factor for thermal energy (cooling) for reference BAC;
$f_{BAC,el,ref}$	is the BAC efficiency for electric energy for reference BAC.

8 Simplified input data correlations

There is no simplified input data correlation.

9 Quality control

No quality control criteria have been established to check if the standard has been correctly applied, i.e. that the calculation performed is credible and pertinent to the calculated building.

10 Compliance check

No provisions are supplied to check if the method was correctly applied.

Annex A
(informative)

BAC efficiency factors

A.1 Overall BAC efficiency factors for the thermal energy $f_{BAC,th}$

The BAC efficiency factors in Table A.1 and Table A.2 for thermal energy (heating, DHW and cooling) are classified depending on the building type and the efficiency class the BAC/TBM system is related to. The factors for efficiency class C are defined to be 1 as this class represents a standard functionality of BAC and TBM system. The use of efficiency classes B or A always leads to lower BAC efficiency factors, i.e. an improvement of building performance.

Table A.1 — Overall BAC efficiency factors $f_{BAC,th}$ - Non-residential buildings

Non-residential building types	Overall BAC efficiency factors $f_{BAC,th}$			
	D	C Reference	B	A
	Non energy efficient	Standard	Advanced	High energy performance
Offices	1,51	1	0,80	0,70
Lecture hall	1,24	1	0,75	0,5 [a]
Education buildings (schools)	1,20	1	0,88	0,80
Hospital	1,31	1	0,91	0,86
Hotels	1,31	1	0,85	0,68
Restaurants	1,23	1	0,77	0,68
Wholesale and retail trade service buildings	1,56	1	0,73	0,6[a]
Other types - sport facilities - storage - industrial buildings - etc.		1		

[a] These values highly depend on heating/cooling demand for ventilation.

Table A.2 — Overall BAC efficiency factors $f_{BAC,th}$ - Residential buildings

Residential building types	Overall BAC efficiency factors $f_{BAC,th}$			
	D	C Reference	B	A
	Non energy efficient	Standard	Advanced	High energy performance
Single family houses Apartment block Other residential buildings or similar residential buildings	1,10	1	0,88	0,81

A.2 Overall BAC efficiency factors for electric energy $f_{BAC,el}$

Electric energy in this context means lighting energy and electric energy required for auxiliary devices as defined in Table 4. The BAC efficiency factors in Table A.3 and Table A.4 for electric energy (i.e. lighting energy and electric energy required for auxiliary devices (but not electric energy for the equipment) are classified depending on the building type and the efficiency class of the BAC and TBM system. The factors for efficiency class C are defined to be 1 as this class represents a standard functionality of BAC and TBM system. The use of efficiency classes B or A always leads to lower BAC efficiency factors, i.e. an improvement of building performance.

Table A.3 — Overall BAC Efficiency factors $f_{BAC,el}$ - Non-residential buildings

Non-residential building types	Overall BAC efficiency factors $f_{BAC,el}$			
	D	C Reference	B	A
	Non energy efficient	Standard	Advanced	High energy performance
Offices	1,10	1	0,93	0,87
Lecture hall	1,06	1	0,94	0,89
Education buildings (schools)	1,07	1	0,93	0,86
Hospital	1,05	1	0,98	0,96
Hotels	1,07	1	0,95	0,90
Restaurants	1,04	1	0,96	0,92
Wholesale and retail trade service buildings	1,08	1	0,95	0,91
Other types - sport facilities - storage - industrial buildings - etc.		1		

Table A.4 — Overall BAC efficiency factors $f_{BAC,el}$ - Residential buildings

Residential building types	Overall BAC efficiency factors $f_{BAC,el}$			
	D	C Reference	B	A
	Non energy efficient	Standard	Advanced	High energy performance
Single family houses Multi family houses Apartment block Other residential buildings or similar residential buildings	1,08	1	0,93	0,92

A.3 Detailed BAC efficiency factors for heating and cooling

Table A.5 — Detailed BAC Efficiency factors $f_{BAC,H}$ and $f_{BAC,C}$ - Non-residential buildings

Non-residential building types	Overall BAC efficiency factors $f_{BAC,H}$ and $f_{BAC,C}$							
	D		C Reference		B		A	
	Non energy efficient		Standard		Advanced		High energy performance	
	$f_{BAC,H}$	$f_{BAC,C}$	$f_{BAC,H}$	$f_{BAC,C}$	$f_{BAC,H}$	$f_{BAC,C}$	$f_{BAC,H}$	$f_{BAC,C}$
Offices	1,44	1,57	1	1	0,79	0,80	0,70	0,57
Lecture hall	1,22	1,32	1	1	0,73	0,94	0,3[a]	0,64
Education buildings (schools)	1,20	-	1	1	0,88	-	0,80	-
Hospital	1,31	-	1	1	0,91	-	0,86	.
Hotels	1,17	1,76	1	1	0,85	0,79	0,61	0,76
Restaurants	1,21	1,39	1	1	0,76	0,94	0,69	0,6
Wholesale and retail trade service buildings	1,56	1,59	1	1	0,71	0,85	0,46 [a]	0,55
Other types - sport facilities - storage - industrial buildings - etc.			1	1				
[a] These values highly depend on heating/cooling demand for ventilation.								

Table A.6 — Detailed BAC efficiency factors $f_{BAC,H}$ and $f_{BAC,C}$ - Residential buildings

Residential building types	Overall BAC efficiency factors $f_{BAC,H}$ and $f_{BAC,C}$							
	D		C Reference		B		A	
	Non energy efficient		Standard		Advanced		High energy performance	
	$f_{BAC,H}$	$f_{BAC,C}$	$f_{BAC,H}$	$f_{BAC,C}$	$f_{BAC,H}$	$f_{BAC,C}$	$f_{BAC,H}$	$f_{BAC,C}$
Single family houses Apartment block Other residential buildings or similar residential buildings	1,09	-	1	-	0,88	-	0,81	-

A.4 Detailed BAC efficiency factors for DHW

The BAC efficiency factors for DHW systems are calculated based on the conditions described in C.4.

Detailed factors are accounting for the BAC impact on energy performance of DHW systems by covering DHW as a single functionality. The detailed factors for non-residential building types are available in (Table A.7) or for residential building types in (Table A.8).

Table A.7 — Detailed BAC efficiency factors $f_{BAC,DHW}$ - Non-residential buildings

Non-residential building types	Overall BAC efficiency factor $f_{BAC,DHW}$			
	D	C Reference	B	A
	Non energy efficient	Standard	Advanced	High energy performance
Offices Lecture hall Education buildings (schools) Hospital Hotels Restaurants Wholesale and retail trade service buildings Other types: - sport facilities - storage - industrial buildings - etc.	1,11	1,00	0,90	0,80

Table A.8 — Detailed BAC efficiency factors $f_{BAC,DHW}$ – Residential buildings

Residential building types	Overall BAC efficiency factor $f_{BAC,DHW}$			
	D	C Reference	B	A
	Non energy efficient	Standard	Advanced	High energy performance
Single family houses Apartment block Other residential buildings or similar residential buildings	1,11	1,00	0,90	0,80

A.5 Detailed BAC efficiency factors for lighting and auxiliary energy

Factors for non-residential building types are available as detailed factors (Table A.9) accounting for different BAC impacts on energy performance of electricity for lighting and auxiliary energy.

Table A.9 — Detailed BAC Efficiency factors $f_{BAC,el,L}$ and $f_{BAC,el,aux}$ – Non-residential buildings

Non-residential building types	Overall BAC efficiency factors							
	D		C Reference		B		A	
	Non energy efficient		Standard		Advanced		High energy performance	
	$f_{BAC,el,L}$	$f_{BAC,el,aux}$	$f_{BAC,el,L}$	$f_{BAC,el,aux}$	$f_{BAC,el,L}$	$f_{BAC,el,aux}$	$f_{BAC,el,L}$	$f_{BAC,el,aux}$
Offices	1,1	1,15	1	1	0,85	0,86	0,72	0,72
Lecture hall	1,1	1,11	1	1	0,88	0,88	0,76	0,78
Education buildings (schools)	1,1	1,12	1	1	0,88	0,87	0,76	0,74
Hospital	1,2	1,1	1	1	1	0,98	1	0,96
Hotels	1,1	1,12	1	1	0,88	0,89	0,76	0,78
Restaurants	1,1	1,09	1	1	1	0,96	1	0,92
Wholesale and retail trade service buildings	1,1	1,13	1	1	1	0,95	1	0,91
Other types - sport facilities - storage - industrial buildings - etc.	-	-	1	1	-	-	-	-

Annex B
(informative)

Minimum BAC function type requirements

Table B.1 defines the minimum functional type requirements of BAC and TBM functions described in Table 4.

Unless differently specified this list shall be used for the following:

— to specify the minimum functions to be implemented for a project;

— to define the BAC function to take into account for the calculation of energy consumption of a building when the BAC functions are not defined in detail;

— to calculate the energy use for the reference case in step 1 of the BAC efficiency factor method (first box in Figure 8 in Clause 7).

Unless differently specified by public authorities the minimum level of function types to be implemented corresponds to Table B.1.

Table B.1 — Minimum BAC function type requirement

			Residential	**Non-residential**
Automatic control				
1	Heating control			
1.1	Emission control			
	2	Individual room control	x	x
1.2	Emission control for TABS (heating mode)			
	1	Central automatic control	x	x
1.3	Control of distribution network hot water temperature (supply or return)			
	Similar function can be applied to the control of direct electric heating networks			
	1	Outside temperature compensated control	x	x
1.4	Control of distribution pumps in networks			
	The controlled pumps can be installed at different levels in the network			
	1	On off control	x	x
1.5	Intermittent control of emission and/or distribution			
	One controller can control different rooms/zones having same occupancy patterns			
	1	Automatic control with fixed time	x	x

			Residential	Non-residential
		program		
1.6	Heat generator control (combustion and district heating)			
	1	Variable temperature control depending on outside temperature	x	x
1.7	Heat generator control (heat pump)			
	0	On/off control of heat generator	x	x
1.8	Heat generator control (outdoor unit)			
	1	Multi-stage control of heat generator	x	x
1.9	Sequencing of different heat generators			
	1	Priorities only based on loads	x	x
1.10	Control of Thermal Energy Storage (TES) charging			
	1	2-sensor charging of storage	x	x
2	Domestic hot water supply control			
2.1	Control of DHW storage charging with direct electric heating or integrated electric heat pump			
	1	Automatic on/off control and scheduled charging enable	x	x
2.2	Control of DHW storage charging using heating water generation			
	1	Automatic on/off control and scheduled charging enable	x	x
2.3	Control of DHW storage charging with solar collector and supplementary heat generation			
	1	Automatic control of solar storage charge (Prio. 1) and supplementary storage charge (Prio. 2)	x	x
2.4	Control of DHW circulation pump			
	1	With time program	x	x
3	Cooling control			
3.1	Emission control			
	2	Individual room control	x	x
3.2	Emission control for TABS (cooling mode)			
	1	Central automatic control	x	x

			Residential	Non-residential
3.3	Control of distribution network chilled water temperature (supply or return)			
	Similar function can be applied to the control of direct electric cooling (e.g. compact cooling units, split units) for individual rooms			
	1	Outside temperature compensated control	x	x
3.4	Control of distribution pumps in networks			
	The controlled pumps can be installed at different levels in the network			
	1	On off control	x	x
3.5	Intermittent control of emission and/or distribution			
	One controller can control different rooms/zones having same occupancy patterns			
	1	Automatic control with fixed time program	x	x
3.6	Interlock between heating and cooling control of emission and/or distribution			
	1	Partial interlock (dependent on the HVAC system)	x	x
3.7	Different chiller selection control			
	The goal consists generally in maximizing the chiller operation temperature			
	1	Variable temperature control depending on outside temperature	x	x
3.8	Sequencing of different chillers			
	1	Priorities only based on loads	x	x
3.9	Control of Thermal Energy Storage (TES) operation			
	1	Time-scheduled storage operation	x	x
4	Ventilation and air-conditioning control			
4.1	Supply air flow control at the room level			
	1	Time control	x	x
4.2	Room air temperature control (all-air systems)			
	1	variable capacity control	x	x
4.3	Room air temperature control (air-water systems)			
	0	No coordination		x
	1	Coordination	x	

			Residential	Non-residential
4.4	Outside Air flow control			
	0	Fixed OA ratio/OA flow	x	
	1	Staged (low/high) OA ratio/OA flow (time scheduled)		x
4.5	Air flow or pressure control at the air handler level			
	1	On off time control	x	x
4.6	Heat recovery control: icing protection			
	1	With icing protection	x	x
4.7	Heat recovery control (prevention of overheating)			
	1	With overheating control	x	x
4.8	Free mechanical cooling			
	1	Night cooling	x	x
4.9	Supply air Temperature control			
	1	Constant setpoint	x	x
4.10	Humidity control			
	1	Dew point control	x	x
5	Lighting control			
5.1	Occupancy control			
	0	Manual on/off switch	x	
	1	Manual on/off switch + additional sweeping extinction signal		x
5.2	Light level/Daylight control			
	0	Manual (central)	x	x
6	Blind Control			
	1	Motorized operation with manual control	x	
	2	Motorized operation with automatic control		x
7	Technical home and building management			
7.1	Setpoint management			
	0	Manual setting room by room individually	x	
	1	Adaptation from distributed/decentralized plant rooms only		x

			Residential	Non-residential
7.2	Run time management			
	0	Manual setting (plant enabling)	x	
	1	Individual setting following a predefined time schedule including fixed preconditioning phases		x
7.3	Detecting faults of technical building systems and providing support to the diagnosis of these faults			
	0	No central indication of detected faults and alarms	x	
	1	With central indication of detected faults and alarms		x
7.4	Reporting information regarding energy consumption, indoor conditions			
	0	Indication of actual values only (e.g. temperatures, meter values)	x	x
7.5	Local energy production and renewable energies			
	0	Uncontrolled generation depending on the fluctuating availability of RES and or run time of CHP; overproduction will be fed into the grid	x	x
7.6	Waste heat recovery			
	0	Instantaneous use of waste heat or heat shifting	x	x
7.7	Smart Grid interaction			
	0	building is operated independently from the grid load	x	x

Annex C
(informative)

Determination of the BAC efficiency factors

C.1 Determination procedure

BACS efficiency factors were calculated based on the results delivered from a large set of simulation runs. These simulations have been conducted with the building energy simulation tool TRNSYS. The impact of different BAC and TBM functions on the energy performance of buildings was found by comparing the annual energy consumptions of a standardized room (EPBD 2006) for different BAC and TBM functionalities representing the BAC efficiency classes as defined in 5.3. The functionalities were represented by:

— time of operation for the heating and/or cooling system;

— definition of temperature setpoints for heating/cooling (energy dead band). Temperature setpoints are defined in dependence on the BAC efficiency class as described in Table 6 to account for different control accuracies;

— definition of outside airflow characteristic (constant/variable).

The room used as a reference for these calculations can be described by the following properties:

— dimensions: 5 m x 4 m x 3 m;

— floor space: 20 m^2;

— exterior wall:

a) 15 m^2 (including windows of 8 m^2);

b) orientation: west;

— U-Values:

a) 0,34 W m^{-2} K^{-1} (exterior wall);

b) 0,65 W m^{-2} K^{-1} (internal wall);

c) 0,4 W m^{-2} K^{-1} (floor/ceiling);

d) 1,4 W m^{-2} K^{-1} (window, SHGC = 0,58).

— thermal mass: medium C = 50 W h m^{-2} K^{-1}.

Room temperatures in adjacent zones have been treated as identical so that there is an adiabatic boundary condition for internal walls.

Different user profiles have been applied to cover the most common building types as mentioned in EN 15217. The modelling approaches regarding user profiles as well as functionality of BAC efficiency classes are described in detail in C.2.

Simulations have been performed for average weather conditions represented by TRY04 (reference station Würzburg, Germany, (Deutscher Wetterdienst DWD, Offenbach, http://www.dwd.de/EN/climate_environment/climateenvironment_node.html).

Space heating, cooling and air conditioning devices have been modelled as follows:

— heating: operating hours and temperature setpoints as declared in Tables C.1 to C.7;

— cooling: operating hours and temperature setpoints as declared in Tables C.1 to C.7;

— air conditioning: operating hours and temperature setpoints as declared in Tables C.1 to C.7.

The operating hours and setpoints are determining the energy need. The expenditure energy for the a discrete system is nearly independent from the absolute value of the energy need so that it is only necessary to calculate the factors depending on the different energy needs. Heat recovery systems are taking into account by calculating the energy need also.

The auxiliary energy is depending in most cases from the flow in pumps or fans while the energy for control systems is nearly constant. The auxiliary energy is therefore given by the relation between design flow and actual flow (i.e. demand oriented ventilation). Note that the auxiliary energy is the cube of this relation.

All calculations (simulations) are made with a single node room temperature model.

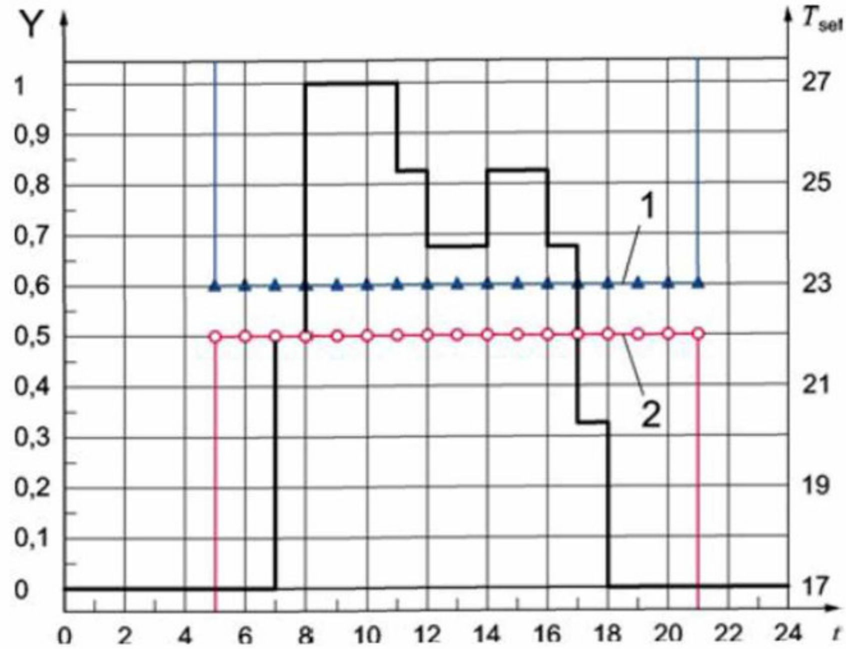
Energy required for artificial lighting was not taken into account when BAC efficiency factors were determined because the impact of lighting control is evaluated separately within EN 15193-1 this effect is not taken into account when BAC efficiency factors were determined for artificial lighting.

C.2 Detailed modelling approaches and user profiles

C.2.1 General

BAC efficiency class C was defined as a reference. That is why its boundary conditions are described first to clarify the differences to classes D, B, and A, respectively. The following figures exemplify the user profile of an office building. The user profiles of other buildings are described in C.3.

C.2.2 Efficiency class C (reference)



Key

1 cooling

2 heating

Y normalized level of occupancy

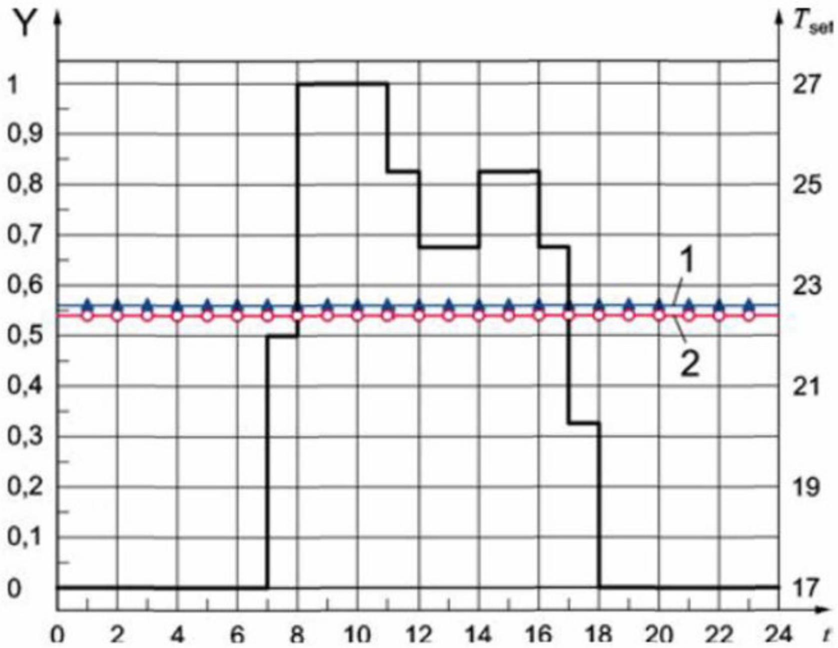
t time

T_{set} temperature setpoint

Figure C.1 — User profiles, temperatures and operation times for BAC efficiency class C; office

There is a small difference of about 1 K between heating and cooling temperature setpoint. The operation of the HVAC system starts two hours before occupancy and finishes three hours after occupied period is ended.

C.2.3 Efficiency class D



Key

1 cooling

2 heating

Y normalized level of occupancy

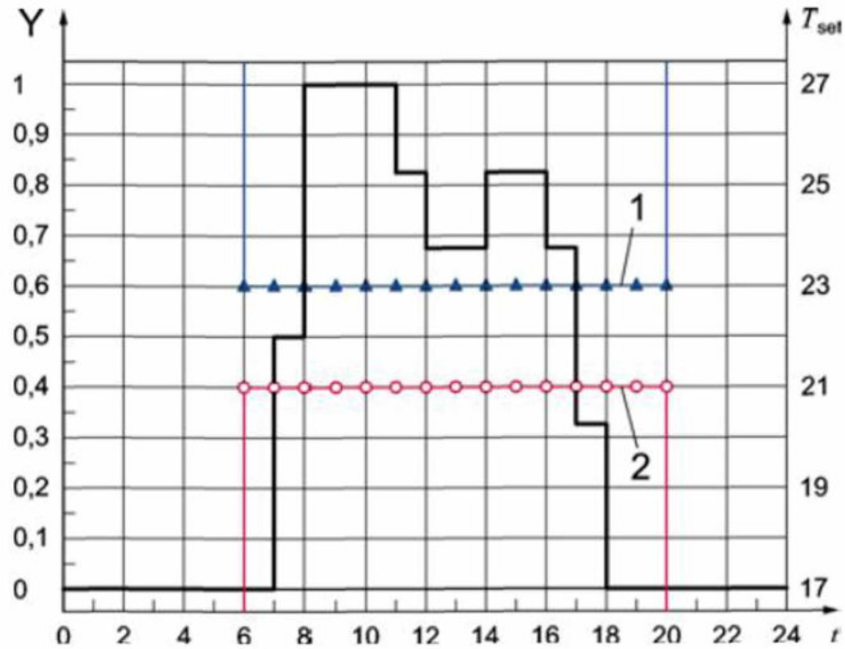
t time

T_{set} temperature setpoint

Figure C.2 — User profiles, temperatures and operation times for BAC efficiency class D; office

Efficiency class D represents a worse case than class C. For this reason, the temperature setpoints for heating and cooling are similar which is again related to no energy dead band. The HVAC operates with no interruption.

C.2.4 Efficiency class B



Key

1 cooling

2 heating

Y normalized level of occupancy

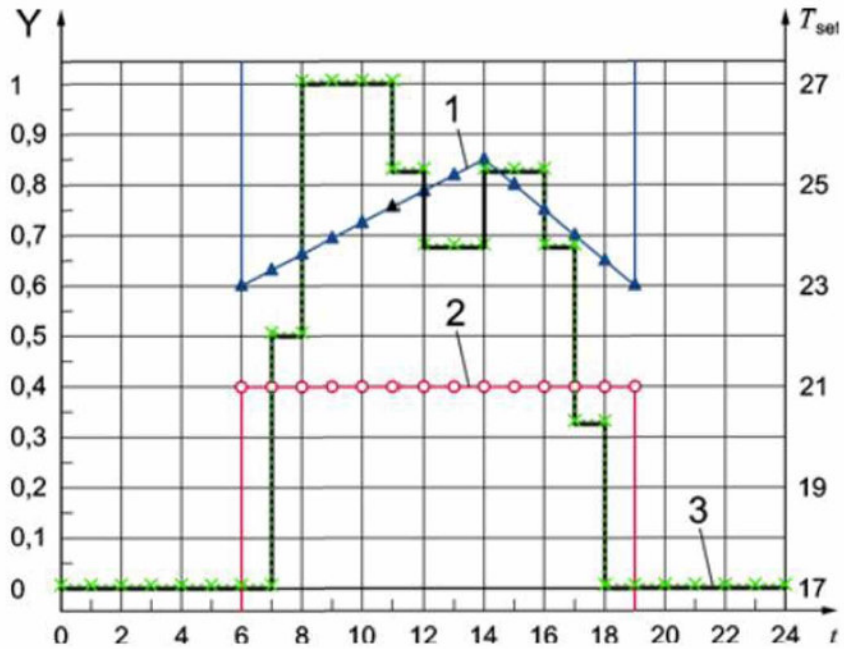
t time

T_{set} temperature setpoint

Figure C.3 — User profiles, temperatures and operation times for BAC efficiency class B; office

Efficiency class B allows a better adaptation of operating time by optimizing start/stop times. The actual temperature setpoints for heating and cooling are under observation by a superior management system which leads to a bigger zero energy band than in efficiency class C.

C.2.5 Efficiency class A



Key

1 cooling

2 heating

3 normalized level of ventilation

Y normalized level of occupancy

t time

T_{set} temperature setpoint

Figure C.4 — User profiles, temperatures and operation times for BAC efficiency class A; office

Efficiency class A further improves energy performance by applying advanced BAC and TBM functions, e.g. adaptive cooling setpoints or ventilation air flows related to the occupancy detection.

C.3 Boundary condition

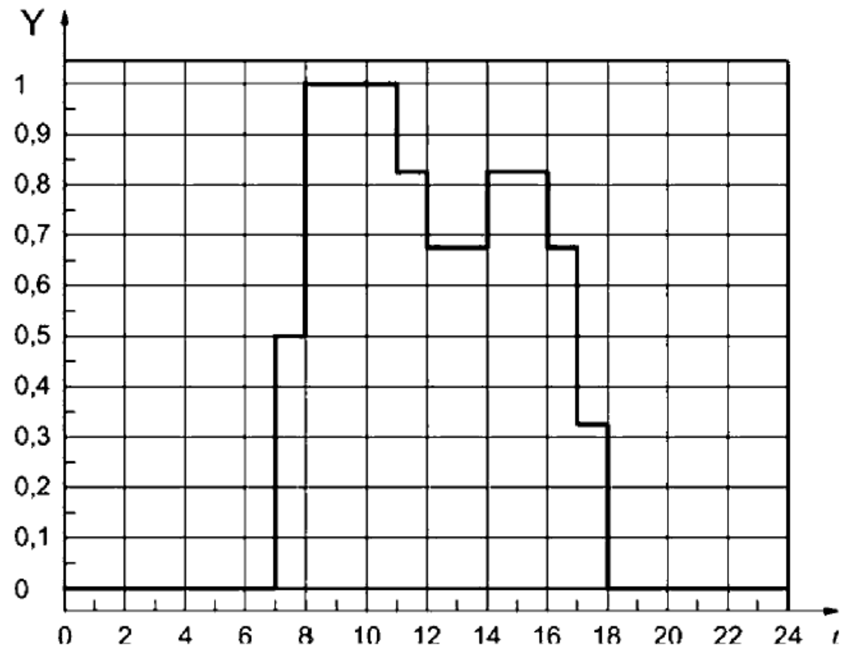
C.3.1 General

For each building type both the user profile and relevant boundary conditions are given in Tables C.1 to C.7. Boundary conditions include temperature setpoints for heating and cooling, operation time for heating, cooling, and lighting systems, number of persons (population density), internal thermal gains, ventilation air change, shading control, and number of workdays/weekends. Heat gains due to persons are between 70 and 100 W/person depending on room air temperature and is defined according to VDI 2078 [12]. Number of persons in a room can be calculated from required space given in the tables. Given heat gains (persons and equipment) are available during occupied period only.

Cooling setpoint temperature varies between 24°C and 27°C depending on ambient air temperature which represents an often used static comfort model for summer conditions.

The shading of BAC efficiency classes B and A depends on a threshold value for solar irradiation (200W/m² and 130 W/m² resp.) when shading controller starts his activity.

C.3.2 Office



Key

Y normalized level of occupancy

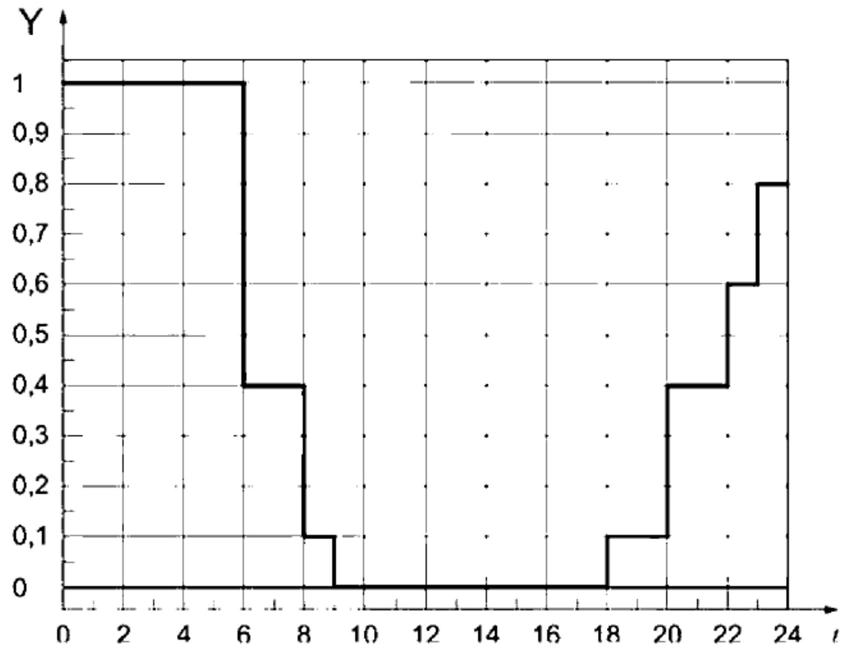
t time in hours

Figure C.5 — User profiles for an office

Table C.1 — Boundary conditions for BAC efficiency classes: office

Office		BAC efficiency class			
		D	C	B	A
Heating	Temperature setpoint	22,5 °C	22/15 °C	21/15 °C	21/15 °C
	Operation time	00:00 - 24:00	05:00 - 21:00	06:00 - 20:00	06:00 - 19:00
Cooling	Temperature setpoint	22,5 °C	23 °C	23 °C	$T_C = f(T_{amb})$
	Operation time	00:00 - 24:00	05:00 - 21:00	06:00 - 20:00	06:00 - 19:00
Lighting	Power	13 W/m²	13 W/m²	13 W/m²	13 W/m²
	Operation time	07:00 - 18:00	07:00 - 18:00	07:00 - 18:00	07:00 - 18:00
Gains	Persons	13,3 m²/Pers.	13,3 m²/Pers.	13,3 m²/Pers.	13,3 m²/Pers.
	Equipment	10 W/m²	10 W/m²	10 W/m²	10 W/m²
Ventilation	Air change	0 /h	0 /h	0 /h	0 /h
Solar	Shading factor	0,3 manual	0,5 manual	0,7 (200 W/m²)[a]	0,7 (130 W/m²) [a]
User profile	Workday/weekend	5/2	5/2	5/2	5/2
[a] For further explanations refer to C.3					

C.3.3 Hotel



Key

Y normalized level of occupancy

t time in hours

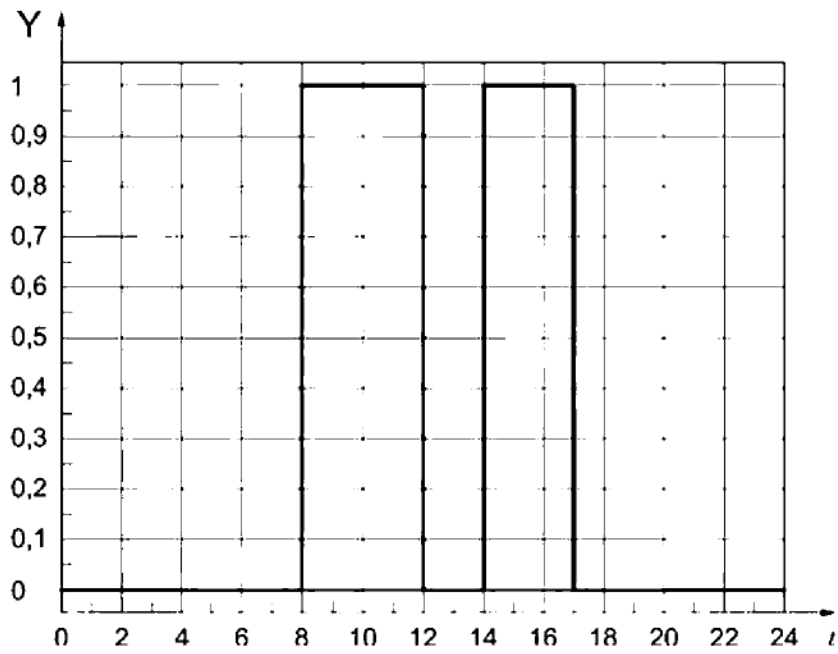
Figure C.6 — User profiles for a hotel

Table C.2 — Boundary conditions for BAC efficiency classes: hotel

Hotel		BAC efficiency class			
		D	C	B	A
Heating	Temperature setpoint	22,5 °C	22/15 °C	21/15 °C	21/15 °C
	Operation time	00:00 - 24:00	00:00 - 11:00 16:00–24:00	00:00 - 10:00/ 17:00–24:00	00:00 - 09:00/ 18:00–24:00
Cooling	Temperature setpoint	22,5 °C	23 °C	23 °C	$T_C = f(T_{amb})$
	Operation time	00:00 - 24:00	14:00 - 10:00	06:00 - 20:00	17:00 - 09:00
Lighting	Power	10 W/m²	10 W/m²	10 W/m²	10 W/m²
	Operation time	18:00 – 08:00	18:00 – 08:00	16:00 – 10:00	18:00 – 08:00
Gains	Persons	10 m²/Pers.	10 m²/Pers.	10 m²/Pers.	10 m²/Pers.
	Equipment	4 W/m²	4 W/m²	4 W/m²	4 W/m²
Ventilation	Air change	1,3 /h	1,3 /h	1,3 /h	1,3 /h
Solar	Shading factor	0,3 manual	0,5 manual	0,7 (200 W/m²)[a]	0,7 (130 W/m²) [a]
User profile	Workday/weekend	7/0	7/0	7/0	7/0

[a] For further explanations refer to C.3

C.3.4 Education, school



Key

Y normalized level of occupancy

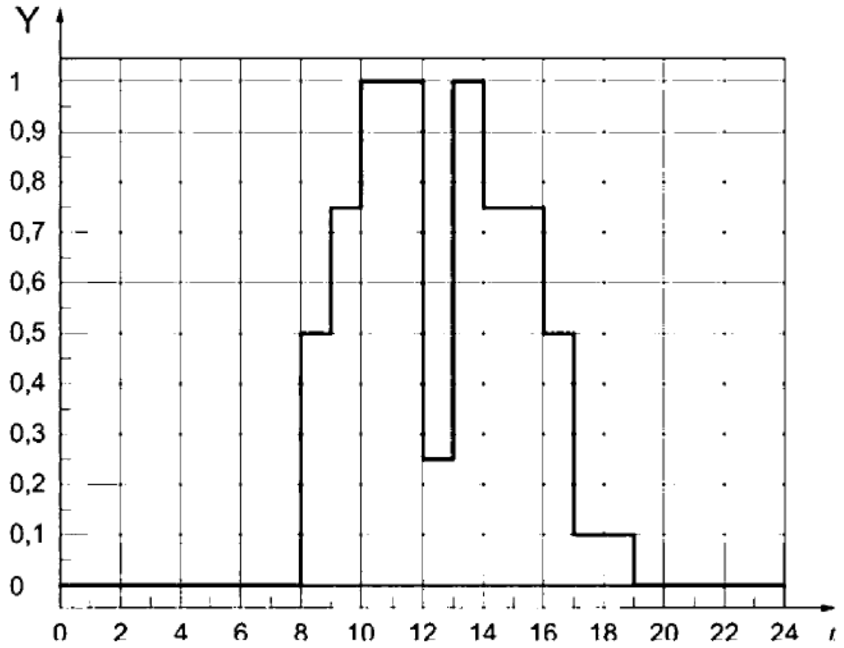
t time in hours

Figure C.7 — User profiles for a class room

Table C.3 — Boundary conditions for BAC efficiency classes: class room

Education/school		**BAC efficiency class**			
		D	**C**	**B**	**A**
Heating	Temperature setpoint	22,5 °C	22/15 °C	21/15 °C	21/15 °C
	Operation time	00:00 - 24:00	06:00 - 19:00	06:30 – 17:30	07:00 - 12:00 / 13:30 – 17:30
Cooling	Temperature setpoint				
	Operation time				
Lighting	Power	13 W/m²	13 W/m²	13 W/m²	13 W/m²
	Operation time	07:00 - 18:00	07:00 - 18:00	07:00 - 18:00	07:00 - 18:00
Gains	Persons	3,3 m²/Pers.	3,3 m²/Pers.	3,3 m²/Pers.	3,3 m²/Pers.
	Equipment	4 W/m²	4 W/m²	4 W/m²	4 W/m²
Ventilation	Air change	0 /h	0 /h	0 /h	0 /h
Solar	Shading factor	0,3 manual	0,5 manual	0,7 (200 W/m²)[a]	0,7 (130 W/m²) [a]
User profile	Workday/weekend	5/2	5/2	5/2	5/2
[a] For further explanations refer to C.3					

C.3.5 Lecture hall



Key

Y normalized level of occupancy

t time in hours

Figure C.8 — User profiles for a lecture hall

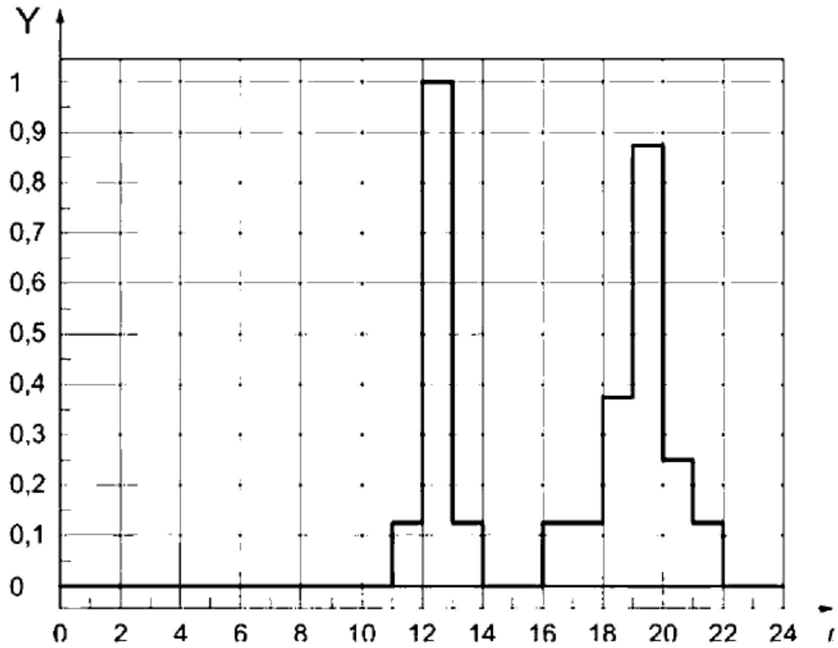
Table C.4 — Boundary conditions for BAC efficiency classes: lecture hall

Lecture hall		BAC efficiency class			
		D	C	B	A
Heating	Temperature setpoint	22,5 °C	22/15 °C	21/15 °C	21/15 °C
	Operation time	05:00 - 22:00	06:00 - 21:00	07:00 - 20:00	08:00 - 19:00
Cooling	Temperature setpoint	22,5 °C	23 °C	23 °C	$T_C = f(T_{amb})$
	Operation time	05:00 - 22:00	06:00 - 21:00	07:00 - 20:00	07:00 - 20:00
Lighting	Power	25 W/m²	25 W/m²	25 W/m²	25 W/m²
	Operation time	07:00 - 20:00	07:00 - 20:00	07:00 - 20:00	07:00 - 20:00
Gains	Persons	1 m²/Pers.	1 m²/Pers.	1 m²/Pers.	1 m²/Pers.
	Equipment	4 W/m²	4 W/m²	4 W/m²	4 W/m²
Ventilation	Air change	10 /h	10 /h	10 /h	10 /h[b]
Solar	Shading factor	0,3 manual	0,5 manual	0,7 (200 W/m²)[a]	0,7 (130 W/m²) [a]
User profile	Workday/weekend	5/2	5/2	5/2	5/2

[a] For further explanations refer to C.3

[b] Occupancy detection

C.3.6 Restaurant



Key

Y normalized level of occupancy

t time in hours

Figure C.9 — User profiles for a restaurant

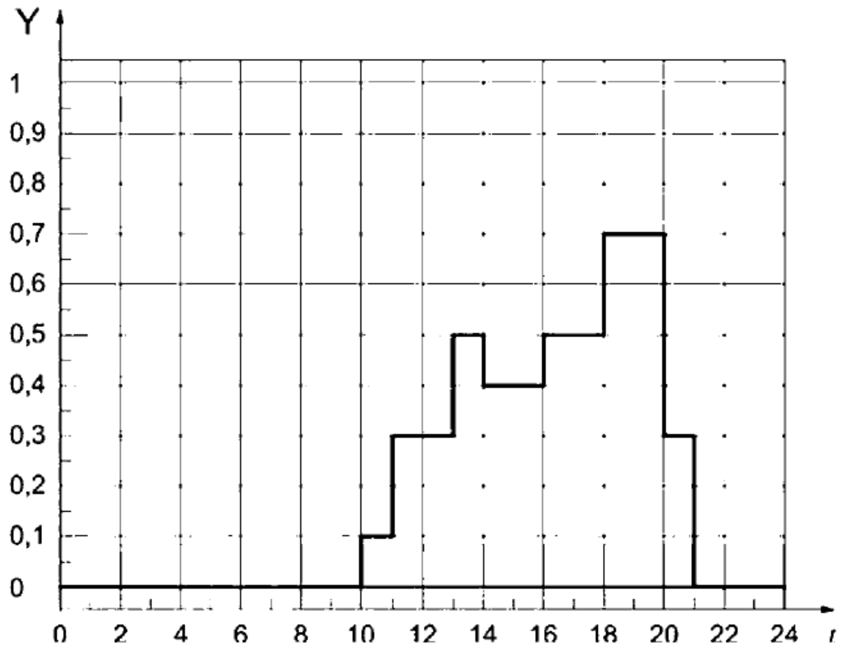
Table C.5 — Boundary conditions for BAC efficiency classes: restaurant

Restaurant		**BAC efficiency class**			
		D	**C**	**B**	**A**
Heating	Temperature setpoint	22,5 °C	22/15 °C	21/15 °C	21/15 °C
	Operation time	00:00 - 24:00	09:00 - 24:00	10:00 - 23:00	11:00 - 22:00
Cooling	Temperature setpoint	22,5 °C	23 °C	23 °C	$T_C = f(T_{amb})$
	Operation time	00:00 - 24:00	09:00 - 24:00	10:00 - 23:00	11:00 - 22:00
Lighting	Power	10 W/m²	10 W/m²	10 W/m²	10 W/m²
	Operation time	10:00 - 23:00	10:00 - 23:00	10:00 - 23:00	10:00 - 23:00
Gains	Persons	1 m²/Pers.	1 m²/Pers.	1 m²/Pers.	1 m²/Pers.
	Equipment	2 W/m²	2 W/m²	2 W/m²	2 W/m²
Ventilation	Air change	8,5 /h	8,5 /h	8,5 /h	8,5 /h[b]
Solar	Shading factor	0,3 manual	0,5 manual	0,7 (200 W/m²)[a]	0,7 (130 W/m²) [a]
User profile	Workday/weekend	7/0	7/0	7/0	7/0

[a] For further explanations refer to C.3

[b] Occupancy detection

C.3.7 Wholesale centre



Key

Y normalized level of occupancy

t time in hours

Figure C.10 — User profiles for a wholesale centre

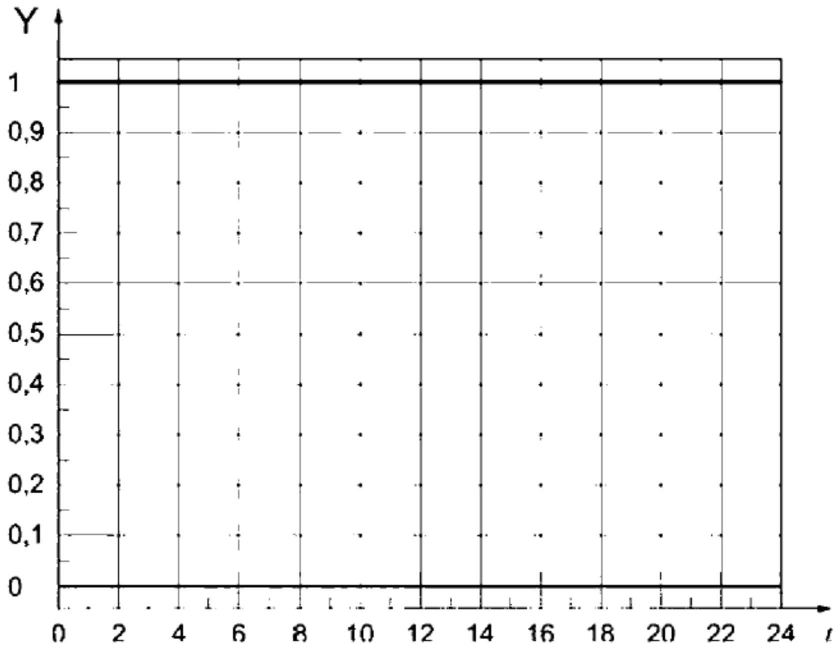
Table C.6 — Boundary conditions for BAC efficiency classes: wholesale centre

Wholesale centre		BAC efficiency class			
		D	C	B	A
Heating	Temperature setpoint	22,5 °C	22/15 °C	21/15 °C	21/15 °C
	Operation time	00:00 - 24:00	08:00 - 23:00	09:00 - 22:00	10:00 - 21:00
Cooling	Temperature setpoint	22,5 °C	23 °C	23 °C	$T_C = f(T_{amb})$
	Operation time	00:00 - 24:00	09:00 - 24:00	10:00 - 23:00	11:00 - 22:00
Lighting	Power	15 W/m²	15 W/m²	15 W/m²	15 W/m²
	Operation time	10:00 - 23:00	10:00 - 23:00	10:00 - 23:00	10:00 - 23:00
Gains	Persons	5 m²/Pers.	5 m²/Pers.	5 m²/Pers.	5 m²/Pers.
	Equipment	3,5 W/m²	3,5 W/m²	3,5 W/m²	3,5 W/m²
Ventilation	Air change	1,3 /h	1,3 /h	1,3 /h	1,3 /h[b]
Solar	Shading factor	0,3 manual	0,5 manual	0,7 (200 W/m²)[a]	0,7 (130 W/m²)[a]
User profile	Workday/weekend	6/1	6/1	6/1	6/1

[a] For further explanations refer to C.3

[b] Occupancy detection

C.3.8 Hospital



Key

Y normalized level of occupancy

t time in hours

Figure C.11 — User profiles for a hospital

Table C.7 — Boundary conditions for BAC efficiency classes: hospital

Hospital		BAC efficiency class			
		D	**C**	**B**	**A**
Heating	Temperature setpoint	22,5 °C	22/15 °C	21/15 °C	21/15 °C
	Operation time	00:00 - 24:00	09:00 - 24:00	10:00 - 23:00	11:00 - 22:00
Cooling	Temperature setpoint				
	Operation time				
Lighting	Power	15 W/m²	15 W/m²	15 W/m²	15 W/m²
	Operation time	10:00 - 23:00	10:00 - 23:00	10:00 - 23:00	10:00 - 23:00
Gains	Persons	0,7 m²/Pers.	0,7 m²/Pers.	0,7 m²/Pers.	0,7 m²/Pers.
	Equipment	4 W/m²	4 W/m²	4 W/m²	4 W/m²
Ventilation	Air change	3,3 /h	3,3 /h	3,3 /h	3,3 /h[b]
Solar	Shading factor	0,3 manual	0,5 manual	0,7 (200 W/m²)[a]	0,7 (130 W/m²) [a]
User profile	Workday/weekend	7/0	7/0	7/0	7/0

[a] For further explanations refer to C.3

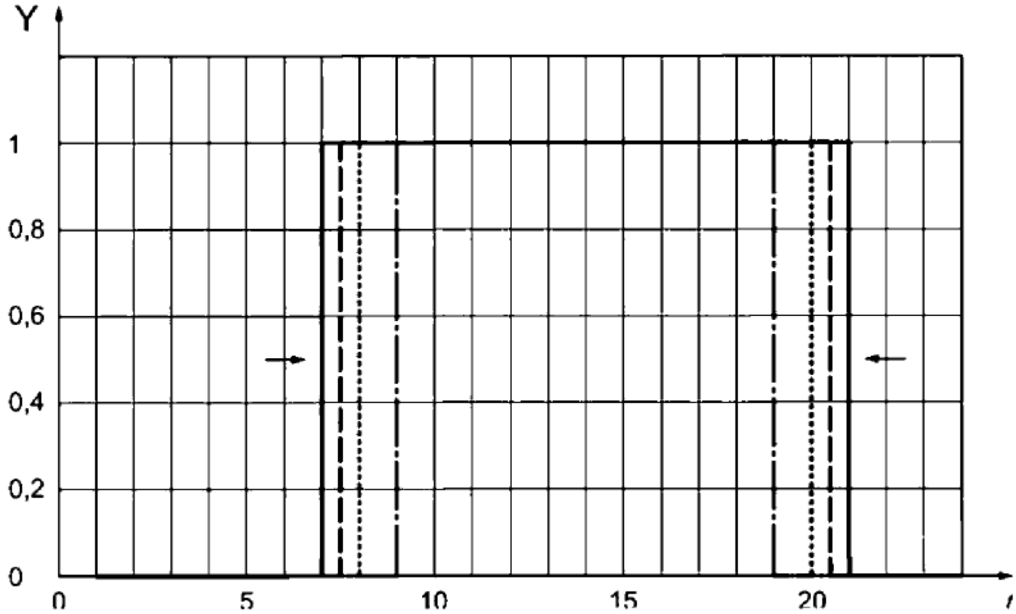
[b] Occupancy detection

C.4 BAC efficiency classes - Domestic Hot Water (DHW)

The impact of BAC functions on the energy performance of DHW-generation systems is based on

— operation timer; the time when the storage tank is loaded and hold at the setpoint temperature;

— mean DHW storage tank temperature.



Key

Y normalized level of occupancy

t time in hours

Figure C.12 — Operation time for DHW system for different BAC efficiency classes

The second impact on energy performance is coming from the mean storage tank temperature during operation. The mean temperatures for the different BAC efficiency classes are assumed as follows:

Table C.8 — Mean DHW storage tank temperature for BAC efficiency classes

BAC - Class	D	C	B	A
Storage tank temperature	48°C	47°C	46°C	45°C

C.5 Impact of geographical location on the BAC efficiency factors

All simulations in this standard to calculate BAC efficiency factors are based on the weather conditions of the City of Würzburg (Germany) and are taken from the corresponding TRY (Test-reference-year). In the TRY are values for the outside temperature, the solar radiation, the humidity and so on for each hour of a year. Test-reference-years are representing typical weather conditions without extremes.

Results from calculations with the used weather conditions can be transferred direct in other countries because of the mean part load of the heating demand.

Figure C.13 shows the different outside temperatures for cities in the south to north of Europe are shown over the whole year (8,760 h/year). The cities are:

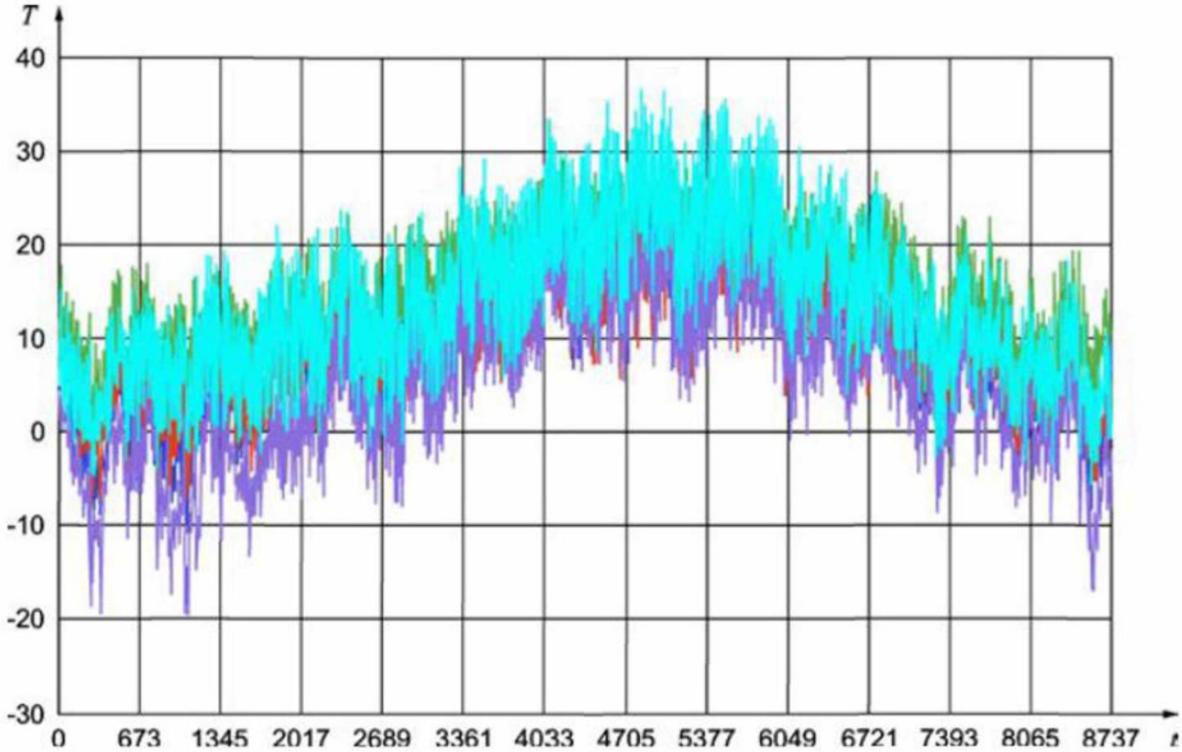
— Würzburg (Germany);

— Paris (France);

— Rom (Italy);

— Stockholm (Sweden);

— Madrid (Spain).



Key

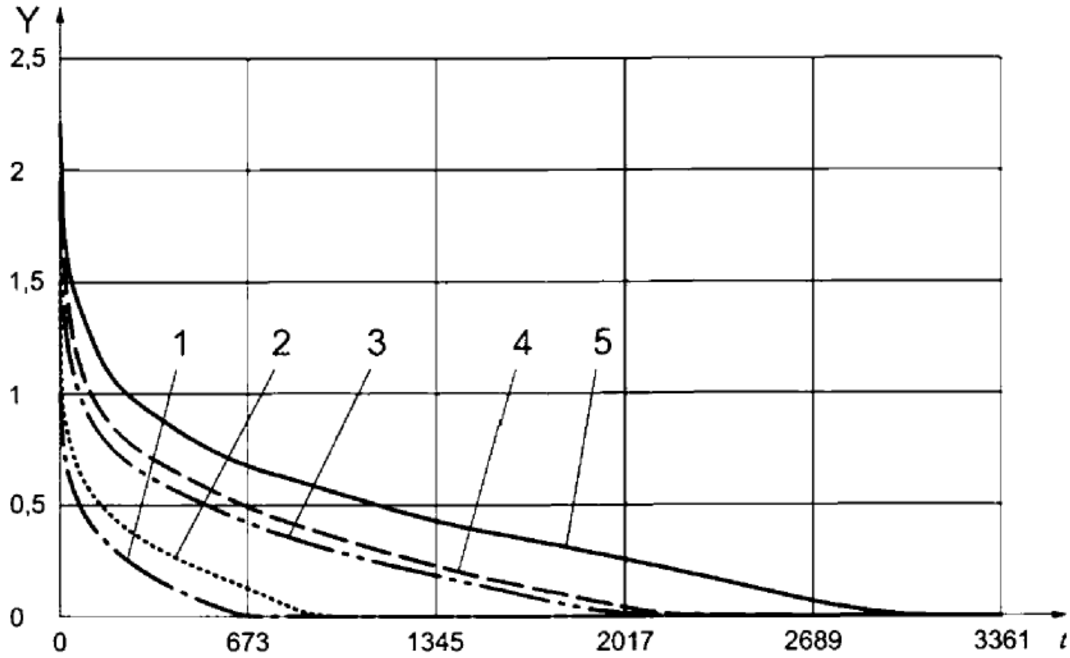
T temperature

t time in hours over a year

Figure C.13 — Outside temperatures for different cities in Europe

Based on the TRY for each City the heat load is calculated for the reference room used for the calculations in this standard.

By using the annual load duration curve (Figure C.14) of the same cities it is noticeable that the heating hours in the north are much more higher than in the south and that also the maximum heating load in the north is much higher than in the south but the shapes of the different curves are nearly the same.



Key

1 Madrid, Spain
2 Rom, Italy
3 Paris, France
4 Würzburg, Germany
5 Stockholm, Sweden
t time in hours per year
Y normalized heat load

Figure C.14 — Annual load duration curves for different cities in Europe

The same result taking into account that the area below the annual duration curve represents the energy for heating it is possible to determine a mean part load:

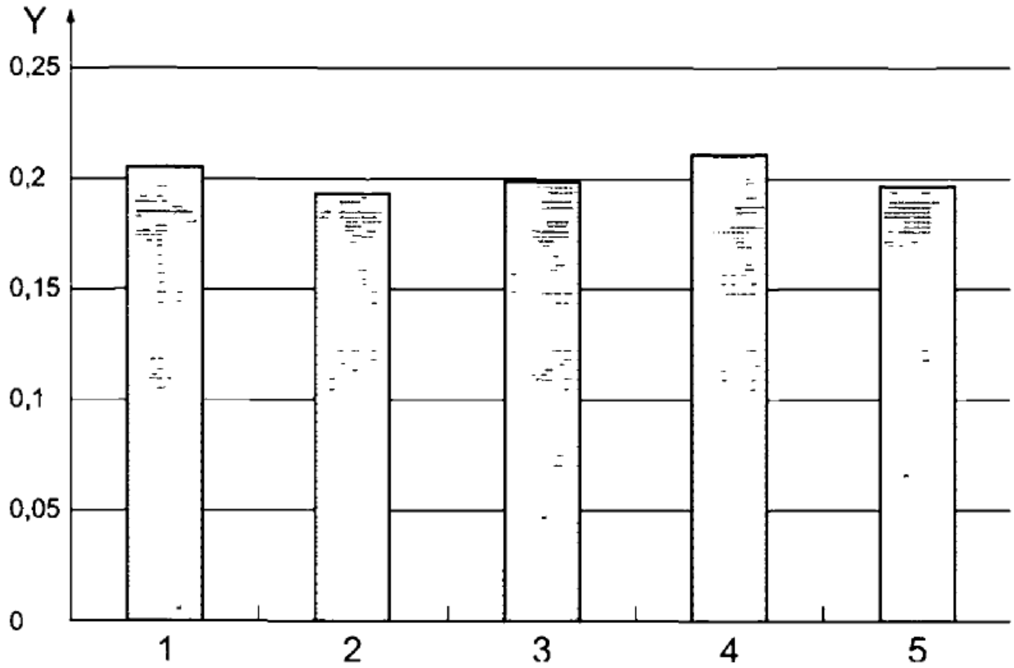
$$\bar{\beta} = \frac{\int_0^{t_H} \dot{Q} \cdot dt}{\Phi \cdot t_H} \qquad \text{(C.1)}$$

Where

Φ is the maximum heat load;

t_H is heating hours.

The calculation of the mean part load for each city is shown in Figure C.15.



Key

1 Würzburg, Germany

2 Paris, France

3 Rom, Italy

4 Stockholm, Sweden

5 Madrid, Spain

Y mean part load

Figure C.15 — Mean part load for different cities in Europe

The very small differences between the different cities in Europe which are noticeable in Figure C.15 are the evidence for using simulation results which are made with weather conditions of the middle of Europe over the whole Europe.

The use of simulation results is also valid for cooling because of the same fundamentals.

The expenditure energy factor e for heating or cooling systems in the sections Emission and Control, Distribution and Generation is depending on the mean part load of the energy demand, because the dynamic influence is in general a function of the mean part load.

C.6 Influence of the different user profiles on the BAC factors

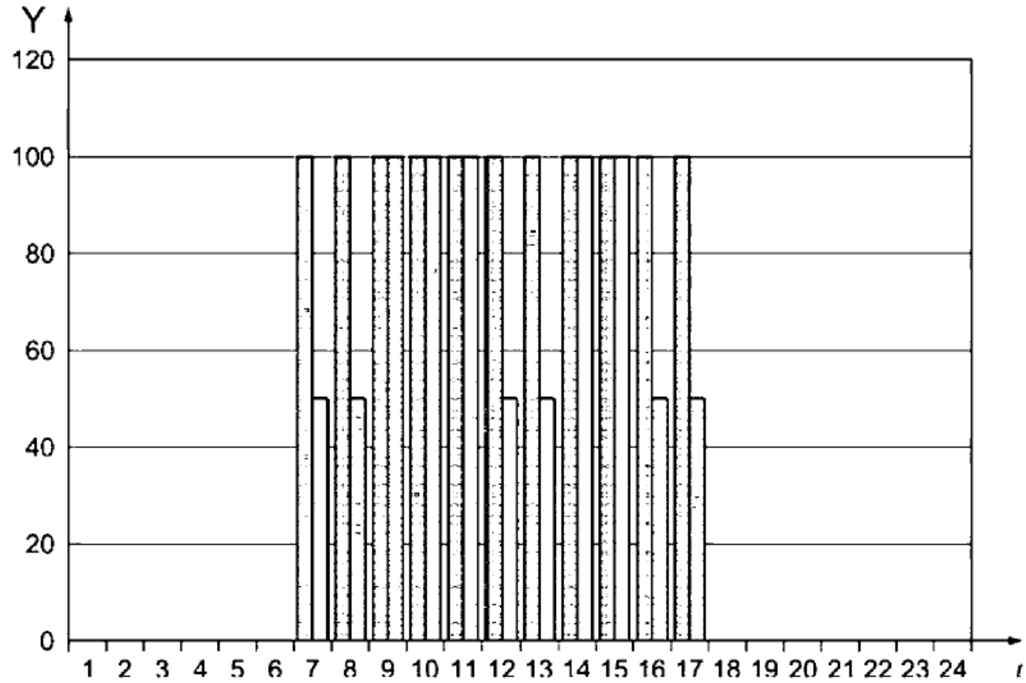
The BAC factors in this standard are calculated with the user profiles which are listed in C.2.

For different user profiles (Figure C.16) a correction factor k_{cor} can be calculated.

For the standard profile A (in Figure C.16 Office-Standard) a constant value $k_{us,A}$ can be calculated.

For the different user profile B (in Figure C.16 Office – new) a constant value $k_{us,B}$ can be calculated in the same way.

The correction factor sets the constant value for a new profile in relation to the constant value of the standard profile.



Key

Y normalized user profile

t time

Figure C.16 — Different user profiles

The constant factor is to be calculated as:

$$k_{\mathrm{us},k} = \frac{\sum_{i=t_{\mathrm{us,sta}}}^{i=t_{\mathrm{us,end}}} a_i}{t_{\mathrm{us,day}}} t_{\mathrm{us,sta}} \tag{C.2}$$

Where

$t_{\mathrm{us,sta}}$	start of use;
$t_{\mathrm{us,end}}$	end of use;
$t_{\mathrm{us,day}}$	daily use;
a_{i}	part of occupancy/gains in %.

Then the correction factor is to be calculated as:

$$k_{\mathrm{cor}} = \frac{k_{\mathrm{us,A}}}{k_{\mathrm{us,B}}} \tag{C.3}$$

Annex D
(informative)

Examples of how to use the BAC function list of EN ISO 16484-3 to describe functions from this European Standard

D.1 General

BAC functions for project specification are described in EN ISO 16484-3; the documentation of complete plant functionality is documented by the BAC function list (BAC-FL) described in EN ISO 16484-3. The BAC-FL can also be used for the purposes of TBM functions. This Annex C shows the relation between EN ISO 16484-3 and this European Standard. Some few of the BAC or TBM functions considered in this European Standard correspond directly to functions defined in EN ISO 16484-3, i.e. to a column of the BAC function list. Examples are given in D.2. For many BAC or TBM functions however it is necessary to specify them by using one or several columns of the BAC function list in combination with a control schematic. See D.3 for examples.

D.2 Direct representation by a function defined in EN ISO 16484-3

D.2.1 Example 1 - Night cooling

Considered BAC and TBM Function in this Standard defined in Table 4:

4	Ventilation and air-conditioning control	
4.8	Free mechanical cooling	
	1	Night cooling: The amount of outside air is set to its maximum during the unoccupied period provided: 1) the room temperature is above the setpoint for the comfort period; 2) the difference between the room temperature and the outside temperature is above a given limit; if free night cooling will be realized by automatically opening windows there is no air flow control.

Representation by using the BAC function list of EN ISO 16484-3:

— This function relates to function 6.7 "Night cooling" in the BAC function list.

D.2.2 Example 2 - h,x- directed control

Considered BAC or TBM Function in this European Standard defined in Table 4:

4	Ventilation and air-conditioning control	
4.8	Free mechanical cooling	
	3	H,x- directed control: The amount of outside air and recirculation air are modulated during all periods of time to minimize the amount of mechanical cooling. Calculation is performed on the basis of temperatures and humidity (enthalpy).

Representation by using the BAC function list of EN ISO 16484-3:

— This function relates to function 6.1 "h,x-directed control" in the BAC function list.

D.3 Representation by a combination of functions defined in EN ISO 16484-3

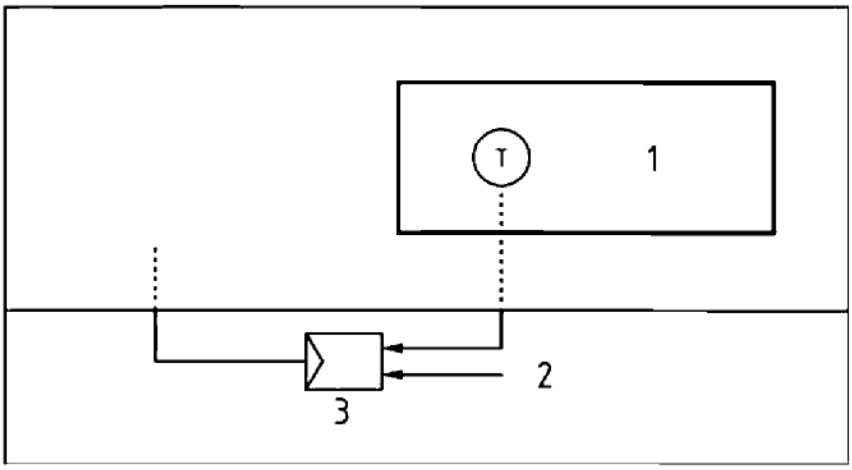
D.3.1 Example 3 - Individual room automatic control

Considered BAC and TBM Function in this Standard defined in Table 4:

Automatic control		
1	Heating control	
1.1	Emission control	
	2	Individual room control: By thermostatic valves or electronic controller.

Representation by using the BAC function list of EN ISO 16484-3:

The function is described by one row of the EN ISO 16484-3 BAC function list and a control schematic, as shown in the following for the case of a PI controller. Analogously it can be represented for the case of a P controller. Any required controller output functions as e.g. proportional output stages for sequences have to be added (see Figure D.1).



Key

1 room

2 setpoint room

3 PI control algorithm

T temperature sensor

Figure D.1 — Control schematic to example 3

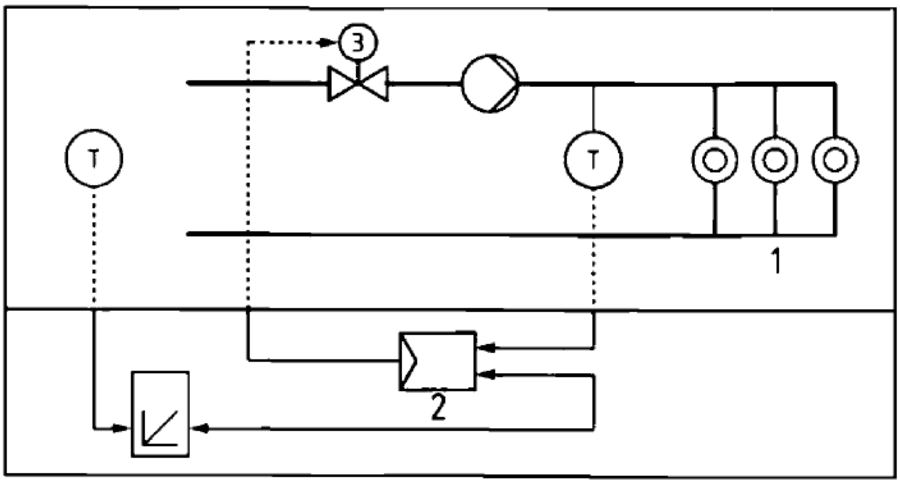
D.3.2 Example 4 - Outside temperature compensated control

Considered BAC and TBM Function in this Standard defined in Table 4.

Automatic control		
1	Heating control	
1.3	Control of distribution network hot water temperature (supply or return)	
	Similar function can be applied to the control of direct electric heating networks	
	1	Outside temperature compensated control: Action lowered the mean flow temperature.

Representation by using EN ISO 16484-3:

The function is described by two rows in the BAC function list of EN ISO 16484-3 and a control schematic, as shown in the following for the case of a valve drive with analogue input. Any required controller output functions as e.g. proportional output stages for sequences have to be added (see Figure D.2).



Key

1 heat emitters

2 PI control algorithm

3 valve

T temperature sensor

Figure D.2 — Control schematic to example 4

Annex E
(informative)

Applying BAC for EMS specified in EN ISO 50001

E.1 General

This annex explains in greater detail how to apply and use BAC (Building automation and Control) including TBM (Technical Building Management) for an EMS (Energy Management System) in buildings.

EMS as specified by EN ISO 50001 is intended to improve energy performance by managing energy use systematically. EN ISO 50001 sets forth the requirements for continuous improvements in regard of more efficient and sustainable energy use for production/process, transportation and buildings (e.g. comfort).

E.2 Guideline for using BACS for EMS

The BACS use encourages different levels and functions of organization by implementing the EMS in buildings and simplifies and significantly improves the continual EMS process in buildings.

Table E.1 outlines BACS options, requirements and functions use to support implementation and processing of EMS in buildings.

Table E.1 — Guideline to apply BACS for EMS

No.	EMS requirements according to EN ISO 50001:2011	BACS for EMS in building
1	4 Energy management system requirements	
1.1	4.1 General requirements	
	The organization shall: a) establish, document, implement, maintain and improve an EnMS in accordance with the requirements of EN ISO 50001; b) define and document the scope and boundaries of its EMS; c) determine how it will meet the requirements of EN ISO 50001 in order to achieve continual improvement of its energy performance and of its EnMS.	The organization shall: Take existing or planned BACS while establishing an EMS. Include existing BACS processes/documentation and esp. monitoring/reporting. Determine the general task to be performed BACS to support the EnMS regarding continual improvement energy performance of Buildings.
2.2	4.2 Management responsibility	
2.2.1	4.2.1 Top management	
	Top management shall demonstrate its commitment to support the EnMS and to continually improve its effectiveness by: a) defining, establishing, implementing and maintaining an energy policy; b) appointing a management representative and approving the formation of an energy management team;	Top management should generally note and consider the following when implementing an energy management system (EMS): BAC impact on energy efficiency of buildings is defined in EN 15232. Application of BACS as the appropriate automatic tool to simplify, maintain and improve the energy management process to

No.	EMS requirements according to EN ISO 50001:2011	BACS for EMS in building
	c) providing the resources needed to establish, implement, maintain and improve the EnMS and the resulting energy performance; NOTE Resources include human resources, specialized skills, technology and financial resources. d) identifying the scope and boundaries to be addressed by the EnMS; e) communicating the importance of energy management to those in the organization; ensuring that energy objectives and targets are established; f) ensuring that EnPIs are appropriate to the organization; g) ensuring that energy objectives and targets are established; h) considering energy performance in long-term planning; i) ensuring that results are measured and reported at determined intervals; j) conducting management reviews.	achieve improved energy performance of and reduce energy consumption in buildings.
2.2.2	4.2.2 Management representative	
	Top management shall appoint a management representative(s) with appropriate skills and competence, who irrespective of other responsibilities, has the responsibility and authority to: a) ensure the EnMS is established, implemented, maintained, and continually improved in accordance with EN ISO 50001; b) identify person(s), authorized by an appropriate level of management, to work with the management representative in support of energy management activities; c) report to top management on energy performance; d) report to top management on the performance of the EnMS; e) ensure that the planning of energy management activities is designed to support the organization's energy policy; f) define and communicate responsibilities and authorities in order to facilitate effective energy management; g) determine criteria and methods needed to ensure that both the operation and control of	A BACS executive shall be appointed who has the responsibilities to:

No.	EMS requirements according to EN ISO 50001:2011	BACS for EMS in building
	the EMS are effective; h) promote awareness of the energy policy and objective at all levels of the organization.	
2.3	4.3 Energy policy	
2.3.1	The energy policy shall state the organization's commitment to achieving energy performance improvement. Top management shall define the energy policy and ensure that it: a) is appropriate to the nature and scale of the organization's energy use and consumption; b) includes a commitment to continual improvement in energy performance; c) includes a commitment to ensure the availability of information and of necessary resources to achieve objectives and targets; d) includes a commitment to comply with applicable legal requirements and other requirements to which the organization subscribes to its related energy use, consumption and efficiency; e) provides the framework setting and reviewing energy objectives and targets; f) supports the purchase of energy-efficient products and services, and design for energy performance improvement; g) is documented and communicated at all levels within the organization; h) is regularly reviewed, and updated as necessary.	As part of an energy policy, top management tasks the organization as a whole to maintain and improve energy performance of buildings (existing buildings, modernized, new construction): Mandatory and specific BAC energy efficiency class (according to EN 15232) for implementation and compliance. Deploy energy-efficient and certified products only as BACS components. Use BACS as a tool for EMS and the documentation and information system supporting the organization. BACS operational processes (e.g. like default heating setpoints) shall support a fast and documented way of implementation measures identified in the on-going EMS activities.
2.4	4.4 Energy Planning	
2.4.1	4.4.1 General	
	The organization shall conduct and document an energy planning process. Energy planning shall be consistent with the energy policy and shall lead to activities that continually improve energy performance. Energy planning shall involve a review of the organization's activities that can affect energy performance. NOTE 1 A concept diagram illustrating energy planning is shown in EN ISO 50001, Figure A.2. NOTE 2 In other regional or national standards, concepts such as identification and review of energy aspects or the concept	The organization should consider the BACS options that identify and review energy aspects for EMS in buildings, such as: Specify and use BACS logs (data) on energy consumption including all parameters that impacting energy and review energy-relevant aspects in buildings. Specify data (available in BACS) to be recorded, stored and delivered, e.g.: Delivered energy (oil, natural gas, electricity etc.). Energy use for heating, air conditioning, lighting, etc.

No.	EMS requirements according to EN ISO 50001:2011	BACS for EMS in building
	of energy profile, are included in the concept of energy review.	Parameters that impact energy use (occupancy, operating hours, climate conditions, building space usage data, user profiles, etc.) Uses of BACS data assignment for 3.3.1 a), b), c), d) and e) shall be determined.
2.4.2	4.4.2 Legal and other requirement	
	The organization shall identify, implement, and have access to the applicable legal requirements and other requirements to which the organization subscribes related to its energy use, consumption and efficiency. The organization shall determine how these requirements apply to its energy use, consumption and efficiency and shall ensure that these legal requirements and other requirements to which subscribes are considered in establishing, implementing and maintaining the EnMS. Legal requirements and other requirements shall be reviewed at defined intervals.	The organization should review whether BACS can be used to support the legal obligations and other requirements with regarding to EMS within buildings e.g.: Compile legally mandated records on energy consumption, room conditions, etc. Determine whether e.g. space usage profiles are within local privacy regulations and act accordingly.
2.4.3	4.4.3 Energy review	
	The organization shall develop, record, and maintain energy review. The methodology and criteria used to develop the energy review shall be documented. To develop energy review, the organization shall: a) analyse energy use and consumption based on measurement and other data, i.e. - identify current energy sources; - evaluate past and present energy use and consumption; b) based on the energy use and consumption, identify the areas of significant energy use, i.e. - identify the facilities, equipment, systems, processes and personnel working for, or on behalf of, the organization that significantly affect energy use and consumption; - identify other relevant variables affecting significant energy uses; - determine the current energy performance of facilities, equipment, systems and processes related to identified significant energy uses; - estimate future energy use and consumption;	BACS resources shall assist is compiling data and determination of consumptions in the desired detail. Depending on the depth of a BACS implementation these data might be around and would need to be tailored towards the measures. BACS can support and determine status of consumption(s) against given budgets.

No.	EMS requirements according to EN ISO 50001:2011	BACS for EMS in building
	c) identify, prioritize record opportunities for improving energy performance. NOTE Opportunities can relate to potential sources of energy, use of renewable energy, or other alternative energy sources, such as waste energy. The energy review shall be updated at defined intervals, as well as in response to major changes in facilities, equipment, systems, or processes.	
2.4.4	4.4.4 Energy baseline	
	The organization shall establish an energy baseline(s) using the information in the initial energy review, considering a data period suitable to the organization's energy use and consumption. Changes in energy performance shall be measured against the energy baseline(s). Adjustments to the baseline(s) shall be made in the case of one of the following: - EnPIs no longer reflect organizational energy use and consumption, or - there have been major changes to the process, operational patterns, or energy systems, or - according to a predetermined method. The energy baseline(s) shall be maintained and recorded.	BACS gathers the necessary data (monitoring function) in order to build baselines. BACS might need to normalize data according to given parameters (e.g. heating degree days). BACS might determine performance indicators that adapt to the actual usage in order to take automatically actual usage of space into account.
2.4.5	4.4.5 Energy performance indicators	
	The organization shall identify EnPIs appropriate for monitoring and measuring energy performance. The methodology for determining and updating the EnPIs shall be recorded and regularly reviewed. EnPIs shall be reviewed and compared to the energy baseline as appropriate.	BACS might determine performance indicators that adapt to the actual usage in order to take automatically actual usage of space into account.
2.4.6	4.4.6 Energy objectives, energy targets and energy management action plans	
	The organization shall establish, implement and maintain documented energy objectives and targets at the relevant functions, levels, processes or facilities within the organization. Time frames shall be established for achievement of the objectives and targets. The objectives and targets shall be consistent with the energy policy. Targets shall be	The organization determines BACS objectives, targets and program that are consistent with the energy policy and the significant energy aspects of buildings, e.g.: Energy saving targets to be achieved by applying BACS. Apply BACS as tool support the EMS in achieving and maintaining its strategic and operative aims.

No.	EMS requirements according to EN ISO 50001:2011	BACS for EMS in building
	consistent with the objectives. When establishing and reviewing objectives and targets, an organization shall take into account legal requirements and other requirements, significant energy uses and opportunities to improve energy performance, as identified in the energy review. It shall also consider its financial, operational and business conditions, technological options and the views of interested parties. The organization shall establish, implement and maintain action plans for achieving its objectives and targets. The action plans shall include: - designation of responsibility; - the means and time frame by which individual targets are to be achieved; - a statement of the method by which an improvement in energy performance shall be verified; - a statement of the method of verifying the results. The action plans shall be documented, and updated at defined intervals.	Apply BACS measuring criteria of the energy targets so that progress towards improved energy efficiency of buildings can be measured. Upgrade and adapt BACS as part of reconstruction, modernization, change in use, etc. On-going upgrade to BACS configuration and sequence programming to reflect organizational changes (e.g. changing operation times, use times, occupancy, room conditions, etc.). Continuously adjust and optimize BACS functions and control sequences to improve energy performance etc. Review building performance on a continuous basis.
3	4.5 Implementation and operation	
3.1	4.5.1 General	
	The organization shall use the action plans and other outputs resulting from the planning process for implementation and operations.	The organization determines functions, tasks, roles, responsibilities, and priorities for using BACS to improve energy performance of buildings as part of EMS, including: Technology, functions, resources and priorities of BACS applications. The resources, roles, authority and responsibility of the personnel at all BACS organizational levels. The BACS applications to support reporting building performance to top management for review, etc.
3.2	4.5.2 Competence, training and awareness	
	The organization shall ensure that any person(s) working for or on its behalf, related to significant energy uses, are competent on the basis of appropriate education, training, skills or experience. The organization shall identify training needs associated with the control of its significant energy uses and the	The organization ensures and verifies appropriate level of training and advanced education of employees responsible for BACS as well as ensuring they remain up-to-date. Specifically, this means personnel are informed on the latest BACS functionality, operation and energy saving options.

No.	EMS requirements according to EN ISO 50001:2011	BACS for EMS in building
	operation of its EnMS. It shall provide training or take other actions to meet these needs. Appropriate records shall be maintained. The organization shall ensure that any person(s) working for or on its behalf are aware of: a) the importance of conformity with the energy policy, procedures and with the requirements of the EMS; b) their roles, responsibilities and authorities in achieving the requirements of the EMS; c) the benefits of improved energy performance; d) the impact, actual or potential, with respect to energy use and consumption, of their activities and how their activities and behaviour contribute to the achievement of energy objectives and targets, and the potential consequences of departure from specified procedures.	It shall provide training or take other actions to meet these needs. Appropriate records shall be maintained. BACS-specific requirements for awareness, knowledge, understanding, skills, e.g.: Energy saving functions and program Operation and maintenance procedures Adjustment and optimization procedures. Continuous performance reviews Etc. The appropriate balance of education, training, experience, etc. to archive and maintain the BACS-specific requirements and its further development concerning awareness, knowledge, understanding and skills. Review of BACS training program to guarantee that the persons responsible for BACS have the necessary competence for its tasks to support EMS and to improve the energy efficiency in buildings.
3.3	4.5.3 Communication	
	The organization shall communicate internally with regard to its energy performance and EMS, such as appropriate to the size of the organization. The organization shall establish and implement a process by which any person working for, or on behalf of, the organization can make comments or suggest improvements to the EMS. The organization shall decide whether to communicate externally about its energy policy, EMS and energy performance, and shall document its decision. If the decision is to communicate externally, the organization shall establish and implement a method for this external communication.	The organization considers BACS options to achieve and maintain EMS communication requirements for buildings. As a consequence, the organization specifies: Whether to communicate the relevant data on energy performance aspects, costs, savings etc. for buildings. Preparation of data (anonymization, standardizing, benchmarking). Rules governing the flow of information of the relevant data at all levels within the internal organization. Rules governing the flow of relevant information to external person, organization, etc. if the decision is made to communicate externally.
3.4	5.4.4 Documentation	
3.4.1	5.4.4.1 Documentation requirements	
	The organization shall establish, implement and maintain information, in paper, electronic or any other medium, to describe the core elements of the EMS and their interaction. The EMS documentation shall include:	The organization considers BACS support options to achieve and maintain the documentation requirements of EMS for buildings. As a consequence, the organization specifies: Development of BACS as the building's

No.	EMS requirements according to EN ISO 50001:2011	BACS for EMS in building
	a) the scope and boundaries of the EMS; b) the energy policy; c) the energy objectives, targets, and action plans; d) the documents, including records, required by this International Standard; e) other documents determined by the organization to be necessary. NOTE The degree of documentation can vary for different organizations for the following reasons: - the scale of the organization and type of activities; - the complexity of the processes and their interactions; - the competence of personnel.	documentation system for EMS. Automated logging, archiving, storage, protection, and proof of all relevant, building operational data. Energy performance data (e.g.: key performance indicators - KPI; energy performance indicators - EPI = kWh/ m2, etc.), Evaluation period, frequency of measurements, plausibility check, reproducibility, replacement value, change management.
3.4.2	5.4.4.2 Control of documents	
	Documents required by this International Standard and the EMS shall be controlled. This includes technical documentation where appropriate. The organization shall establish, implement and maintain procedure(s) to: a) approve documents for adequacy prior to issue; b) periodically review and update documents as necessary; c) ensure that changes and the current revision status of documents are identified; d) ensure that relevant versions of applicable documents are available at points of use; e) ensure that documents remain legible and readily identifiable; f) ensure documents of external origin determined by the organization to be necessary for the planning and operation of the EMS are identified and their distribution controlled; g) prevent the unintended use of obsolete documents, and suitably identify those to be retained for any purpose.	The organization considers and identifies BACS options to support the control of EMS documentation for buildings. As a consequence, the organization determines logging and distribution of all EMS specifications and documented proof for the buildings: Documents are available in electronic form. Status of the document is clearly marked (e.g. current versions, no longer applicable, etc.). Develop the most expedient manner of making documents available to employees with a need to know about.
3.4.3	4.5.5 Operational control	
	The organization shall identify and plan those operations and maintenance activities which are related to its significant energy uses and that are consistent with its energy policy, objectives, targets and action plans, in order	The organization considers supporting BACS options to achieve and maintain operational control requirements of the EMS. As a consequence, the organization specifies

No.	EMS requirements according to EN ISO 50001:2011	BACS for EMS in building
	to ensure that they are carried out under specified conditions, by means of the following: a) establishing and setting criteria for the effective operation and maintenance of significant energy uses, where their absence could lead to a significant deviation from effective energy performance; b) operating and maintaining facilities, processes, systems and equipment, in accordance with operational criteria; c) appropriate communication of the operational controls to personnel working for, or on behalf of, the organization. NOTE When planning for contingency or emergency situations or potential disasters, including procuring equipment, an organization may choose to include energy performance in determining how it will react to these situations.	energy objectives and targets for buildings: Maintenance criteria (e.g. intervals, operating hours etc.) under the BACS maintenance. Building plants, installations, equipment, etc., are continuously adapted and optimized to meet current operational and organizational profiles, needs and demands. A commitment to implement and purchase (new procurement or replacement) only energy efficient BACS equipment and certified products, to the extent available. BACS procedures to record and analyse changes in energy consumption (before/after), modernization, etc. of buildings and/or building installation, plans, equipment etc. BACS communications with regard to building operation, maintenance, etc.
3.4	4.5.6 Design	
	The organization shall consider energy performance improvement opportunities and operational control in the design of new, modified and renovated equipment, systems and processes that can have a significant impact on its energy performance. The result of the energy performance evaluation shall be incorporated where appropriate into the specification, design and procurement activities of the relevant project(s). The result of the design activity shall be recorded.	
3.6	4.5.7 Procurement of energy services, products, equipment and energy	
	When procuring energy services, products and equipment that have, or can have, an impact on significant energy use, the organization shall inform suppliers that procurement is partly evaluated on the basis of energy performance. The organization shall establish and implement the criteria for assessing energy use, consumption and efficiency over the planned or expected operating lifetime when procuring energy using products, equipment	

No.	EMS requirements according to EN ISO 50001:2011	BACS for EMS in building
	and services which are expected to have a significant impact on the organization's energy performance. The organization shall define and document energy purchasing specifications, as applicable, for effective energy use. NOTE See Annex A for more information	
4	4.6 Checking	
4.1	4.6.1 Monitoring, measurement and analysis	
	The organization shall ensure that the key characteristics of its operations that determine energy performance are monitored, measured and analysed at planned intervals. Key characteristics shall include at minimum:	
	a) significant energy uses and other outputs of the energy review;	
	b) the relevant variables related to significant energy use;	
	c) EnPIs;	
	d) the effectiveness of the action plans in achieving objectives and targets;	
	e) evaluation of actual versus expected energy consumption.	
	The results from monitoring and measurement of the key characteristics shall be recorded. An energy measurement plan, appropriate to the size and complexity of the organization and its monitoring and measurement equipment, shall be defined and implemented.	
	NOTE Measurement can range from only utility meters for small organizations up to complete monitoring and measurement systems connected to a software application capable of consolidating data and deliver automatic analysis. It is up to the organization to determine the means and methods of measurement.	
	The organization shall define and periodically review its measurement needs. The organization shall ensure that the equipment used in monitoring and measurement of key characteristics provides data which are accurate and repeatable. Records of	The organization considers suitable, multiplex BACS options to achieve and maintain the measurement and monitoring requirements of the EMS within buildings and specifies: An appropriate energy metering plan for

No.	EMS requirements according to EN ISO 50001:2011	BACS for EMS in building
	calibration and other parameters shall be made.	buildings based on BACS to include an energy data repository for storing all types of energy data. It should include data entered at equal intervals (e.g. measured values for every 15 min, 30 min, or 60 min, etc.) and meter readings and also energy-related factors (operating times, occupancy, etc.). BACS measuring principles including calibration to ensure accuracy, high availability and reproducibility of the energy data and records. BACS activities (more or less online and automated) for measurement and monitoring, e.g.: On-going logging and monitoring of the significant energy use and affected energy factors. Summary of significant energy consumption in form of key figures. Compare actual and expected energy consumption, etc. Intervene when deviations from expected energy consumption occur. Log all significant deviations from expected energy consumption along with the reasons (if determined) as well as associated measures. BACS methods to standardize and anonymize data (for example, energy performance indicators etc.) and for benchmarking purposes (externally and internally).
4.2	4.6.2 Evaluation of legal and other requirements	
	At planned intervals, the organization shall evaluate compliance with legal requirements and other requirements to which it subscribes related to its energy use and consumption. Records of the results of the evaluations of compliance shall be maintained.	The organization reviews whether BACS is capable of supporting compliance evaluation requirements of EMS for building, e.g.: The organization monitors EMS compliance with legal obligations and other requirements. Maintain relevant BACS records to document compliance, to which the organization subscribes, relating to significant energy consumption.
4.3	4.6.3 Internal audit of the EnMS	
	The organization shall ensure that the EnMS: - conforms planned arrangements for energy management including the requirements of this International Standard;	The organization reviews how BACS can support internal audit requirements of EMS for buildings, e.g.: BACS provides effective and efficient energy management program, processes and

No.	EMS requirements according to EN ISO 50001:2011	BACS for EMS in building
	- conforms with the energy objectives and targets established; - is effectively implemented and maintained, and improves energy performance. An audit plan and schedule shall be developed taking into consideration the status and importance of the processes and areas to be audited as well as the results of previous audits. The selection of auditors and conduct of audits shall ensure objectivity and impartiality of the audit process. Records of the audit results shall be maintained and reported to top management.	systems: opportunities to continual improve the capability of processes and systems; data provisioning to apply effective and efficient statistical techniques; a suitable information technology platform to support audit activities.
4.4	4.6.4 Nonconformities, correction, corrective action and preventive action	
	The organization shall address actual and potential nonconformities by making corrections, and by taking corrective action and preventive action, including the following: a) reviewing nonconformities or potential nonconformities; b) determining the causes of nonconformities or potential nonconformities; c) evaluating the need for action to ensure that nonconformities do not occur or recur; d) determining and implementing the appropriate action needed; e) maintaining records of corrective actions and preventive actions; f) reviewing the effectiveness of the corrective action or preventive action taken. Corrective actions and preventive actions shall be appropriate to the magnitude of the actual or potential problems and the energy performance consequences encountered. The organization shall ensure that any necessary changes are made to the EnMS	The organization considers BACS options to achieve and maintain the nonconformity, corrective action and preventive requirements of the EMS for buildings and specifies: Automate BACS applications: monitor, analyse and signal non-conformance to energy saving targets, etc.; identify the cause of the non-conformance; Send appropriate action to correct the non-conformance; initiate action required to prevent recurrence of non-conformance; BACS applications that support: changing documented procedures as needed to ensure that they are consistent with new initiatives or actions; identifying responsible party for recording non-conformance and how it is recorded; ensuring that corrective and preventive action procedures are initiated; storing the relevant data in accordance with legal and/or documented time frames.
4.5	4.6.5 Control of records	
	The organization shall establish and maintain records, as necessary, to demonstrate conformity to the requirements of its EMS and of this International Standard, and the energy performance results achieved. The organization shall define and implement controls for the identification, retrieval and	The organization considers BACS options to achieve and maintain the control of records requirements of EMS for buildings and specifies: BACS electronic records of significant energy consumption, energy performance indicators; effectiveness of energy saving measures,

No.	EMS requirements according to EN ISO 50001:2011	BACS for EMS in building
	retention of records. Records shall be and shall remain legible, identifiable and traceable to the relevant activity.	before and after comparisons, etc. BACS electronic records of important messages (e.g. fault, operational status, maintenance, limit violation, etc.) of equipment with an energy impact; installation, plan, etc. BACS maintenance program with scheduled inspections and servicing of equipment with an energy impact; installation, plan etc. BACS requirements that ensure that the records are legible, identifiable, traceable and readily retrievable. The organization reviews how BAC can support internal audit requirements of EMS for buildings, e.g.: BACS provides effective and efficient energy management program, processes and systems: opportunities to continual improve the capability of processes and systems; data provisioning to apply effective and efficient statistical techniques; a suitable information technology platform to support audit activities.
5	4.7 Management review	
5.1	4.7.1 General	
	At planned intervals, top management review the organization's EnMS to ensure its continuing suitability, adequacy and effectiveness. Records of management review shall be maintained	The organization reviews how BACS can support top management review of the EMS for buildings.
5.2	4.7.2 Input to management review	
	Inputs to the management review shall include: a) follow-up actions from earlier management reviews b) review of the energy policy; c) review of energy performance and related EnPIs; d) results of the evaluation of compliance with legal requirements and changes in legal and other requirements to which the organization subscribes; e) the extent to which the energy objectives and targets have been met;	For inputs to management review: BACS provides inputs to review the EMS part for buildings as it relates to system abilities, compliance with energy policy and the achievement of energy targets. BACS provides an assistant to review overall energy performance of the building and other energy-related factors. Etc.

No.	EMS requirements according to EN ISO 50001:2011	BACS for EMS in building
	f) EMS audit results; g) the status of corrective actions and preventive actions; h) projected energy performance for the following period; i) recommendations for improvement	
5.3	4.7.3 Output from management review	
	Outputs from the management review shall include any decisions or actions related to: a) changes in the energy performance of the organization; b) changes to the energy policy; c) changes to the EnPIs; d) changes to objectives, targets or other elements of the EMS, consistent with the organization's commitment to continual improvement; and allocation of resources.	Activities resulting on outputs from management review: Adjusting and enhancing of BACS and its organization on the building-related results of the management review.

Annex F
(informative)

Maintain BAC energy efficiency

F.1General

This annex describes the minimum required activities to maintain and to improve the objectives of the designed energy efficiency class of an installed BAC functions.

Activities:

a) maintain and improve the impact of BAC on the energy efficiency in buildings

b) upgrading the current BAC efficiency class to a higher class

F.2Activity 1 - Maintain and improve the BAC efficiency class

F.2.1 General

The experience - based on evaluation of running BAC installations shows that most of the original commissioned features are still working but efficiency effect occur in the areas:

— changing of operational concepts;

— different building users than originally planned;

— manual changes while operating building;

— drifting of equipment (e.g. through maintenance).

F.2.2 Monitoring

Energy use and operational parameters shall frequently (e.g. every year) be evaluated and compared with previous period values taking use changes into account.

F.2.3 Operation

BAC operators and managers of them shall frequently (e.g. every year) be offered training or brush up course on how to operate and configure the installed systems.

F.2.4 Energy Efficiency

Energy production, distribution and emission equipment shall frequently (e.g. yearly) be evaluated in regard to operations and energy use. The evaluations shall invoke changes in the operations (in particular setpoints and schedules) and tuning of the system.

F.2.5 Modernizations, Upgrades and new Technologies

Upgrade capabilities and modernizations in order to maximize efficiency, operational methods and potential new technologies shall frequently (e.g. yearly) be considered in order to maintain/improve energy efficiency.

F.3Activity 2 – Upgrading of the BAC efficiency class

F.3.1 General

Four different BAC efficiency classes (A, B, C, D) of the BAC and TBM functions are defined in 5.5 either for non–residential or residential building. The Functions are described and summarized in 5.4, Table 4. Their assignment to the BAC efficiency classes are listed in 5.6, Table 5.

Activity 2 describes the following procedures:

— identify the current BAC efficiency class of an installed BACS (e.g. D, C, B, A);

— upgrading the current BAC efficiency class to a higher class (e.g. from D- > C, C- > B, B- > A).

F.3.2 Procedure for meeting an BAC efficiency class

Procedure to identify the current BAC efficiency class:

a) functions relevant to installed BACS are checked of "+ "in column 1

b) the processing function has to be selected for each relevant function. It is marked by an "X" in column 1.

c) draw a vertical line on the right-hand side of the lowest classification column (shaded part) of the selected processing functions. Afterwards, the line shows on the right side the installed BAC efficiency class.

Procedure to upgrade the current BAC efficiency class to a higher class and to determine their requirements.

d) functions relevant to installed BACS are checked of "+ "in column 1

e) draw a vertical line on the right-hand side of the classification columns (shaded part) of the processing functions. The line has to reach all shaded parts.

f) the processing function has to be selected for each relevant function. It is marked by an "X" in column 1.

EXAMPLE Determine the requirements of the BAC efficiency class "B" for a Single-room store.

The non-residential building contains an open one-room store that is air-conditioned using a central air handling unit. Heating and cooling occurs on the airside using heat transfer water/air.

Procedure:

g) determine the relevant functions to Single-room and marked it by "+ " in column 1

h) draw a line on the right side of the column for the BAC efficiency class "B in Table 1

i) select for each relevant function the processing functions concerned to class "B and marked it by a "X"

The result is shown in Table F.1.

Table F.1 — Requirements of the BAC efficiency class "B" for a Single-room store

				Definition of classes							
				Residential				Non residential			
				D	C	B	A	D	C	B	A
	4	Ventilation and air conditioning control									
+	4.1	Air flow control at the room level									
		0	No control	x				x			
		2	Time control	x	x	x		x	x		
X		3	Occupancy detection	x	x	x	x	x	x	x	
		4	Demand control	x	x	x	x	x	x	x	x
+	4.2	Air flow or pressure control at the air handler level									
		0	No automatic control	x				x			
		1	On off time control	x	x			x	x		
X		2	Multi-stage control	x	x	x		x	x	x	
		3	Automatic flow or pressure control with or without pressure reset	x	x	x	x	x	x	x	x
+	4.3	Heat recovery exhaust air side icing protection control									
		0	Without defrost control	x				x			
X		1	With defrost control	x	x	x	x	x	x	x	x
+	4.4	Heat recovery control (prevention of overheating)									
		0	Without overheating control	x				x			
X		1	With overheating control	x	x	x	x	x	x	x	x
+	4.5	Free mechanical cooling									
		0	No automatic control	x				x			
		1	Night cooling	x	x			x	x		
X		2	Free cooling	x	x	x	x	x	x	x	x
		3	H,x- directed control	x	x	x	x	x	x	x	x
+	4.6	Supply air Temperature control									
		0	No automatic control	x				x			
		1	Constant setpoint	x	x			x	x		
X		2	Variable setpoint with outside temperature compensation	x	x	x		x	x	x	
		3	Variable setpoint with load dependant compensation	x	x	x	x	x	x	x	x
	4.7	Humidity control									
		0	No automatic control	x				x			
		1	Dewpoint control: supply air or room air	x				x			
		2	Direct humidity control: supply air	x	x	x		x	x	x	
		3	Direct humidity control: room air	x	x	x	x	x	x	x	x

Annex G
(informative)

Control accuracy

Values of the control accuracy are given in the following Table G.1:

Table G.1 — Control accuracy

	Standard	Control accuracy ΔT (K)	
		Heating	**Cooling**
Direct electric emitter with built in controller	EN 60675	0,9	
Thermostatic radiator valve	EN 215	0,45 × (hysteresis+ water temperature effect)	
Individual zone control equipment	EN 15500–1	CA_H defined in the standard and certified	CA_C defined in the standard and certified
Other controller if emission can be totally stopped	No standard	1,8	1,8
Other controllers if emission cannot be totally stopped	No standard	2	2

NOTE EN 15316–2 defines also a method using efficiency factor in 7.1.

Setpoints for heating and cooling should be configured so that there is always a minimum zero energy zone between heating and cooling.

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