NEW EN ISO 52120 BACS STANDARD

FOR BUILDING EFFICIENCY

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Introduction

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Heating and cooling our buildings accounts for about 30-50% of the final energy consumption in the EU, with over 70% being generated from fossil fuels (source: eurostat). The optimization of heating, ventilation and air conditioning (HVAC) systems in buildings requires more than simply improving the efficiency of the equipment (e.g. heat pumps, boilers, chillers). It is also vital to look at how heating and cooling is distributed from the central generator towards end use.

"Active control of energy usage", provided through building automation and control solutions, is an essential pillar for efficient buildings. While often overlooked, this is a key element to ensure that energy efficiency measures on the envelope and energy generation deliver in practice what they promise in theory.

The active control of energy usage ensures an optimal distribution and consumption of energy in the building and leads to a more efficient use of the generated energy. In addition, the reduced energy demand due to renovation measures like insulation and windows with negligible leakage is causing a need for active ventilation controls to ensure that the indoor environmental comfort remains consistent before and after the renovation measures are applied. Active controls are needed to ensure this is the case.

With the increased share of renewables including Heat Pumps in the energy system and the integration of distributed energy resources at end-use level such as solar panels, the roll-out of advanced building automation and controls is critical to manage and optimize energy usage from a demand side perspective.

To boost energy performance of buildings, the EU has established a legislative framework that includes the Energy Performance of Buildings Directive 2010/31/EU.

In parallel the Commission has established a set of standards and accompanying technical reports to support the Energy Performance of Building Directive called the energy performance of buildings standards (EPB standards). These are managed by the European Committee for Standardisation (CEN).

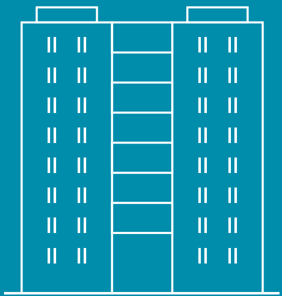
The set of EPB standards play a key role to support the Energy Performance of Buildings Directive (EPBD) of the European Union.

In this document we focus on the new EN ISO 52120 Standard which is the strategic part of the Energy Performance of Buildings (EPB) standards. The aim is to guide professionals, building owners and legislators through the structure and logic of the standard, underlining main updates and its relevant aspects in relation to heating and cooling controls. We also discuss how the standard can be used in the adoption of the EPBD by member states.

BAC and TBM

BAC

Building Automation and Control (BAC) provide effective control functions for any building energy system, for example heating and ventilation, lighting etc... and lead to operational and energy efficiency improvement. Integrated intelligent functions and routines can be configured upon actual use of the building/rooms to avoid unnecessary energy use and emissions.



TBM

Technical Building Management (TBM) functions as a part of building management provides information about operation, maintenance, services, and management of buildings. It supports corrective and preventive actions to improve the energy performance of a building.

Note: in practice often described as Building Management System (BMS), Building Automation System (BAS) or Building Energy Management System (BEMS).

ISO 52120

The new EN ISO 52120-1:2022 "Energy performance of buildings - Contribution of building automation, controls and building management - Part 1: General framework and procedures" standard substitutes the EN 15232-1:2017 "Energy performance of buildings - Impact of Building Automation, Controls and Building Management – Part 1: Module M4,5, 6, 7, 8, 9, 10".

All new communication and technical documents have to refer to the EN ISO 52120-1:2022.

EN 15232-1:2017 has been a fundamental standard in assessing the contribution of BACS to the energy performance of buildings, used in building regulations and guidelines at European and national levels. This standard has been the outset for the EN ISO 52120.

The new European standard EN ISO 52120-1 informs and supports:

Building owners and design engineers, in defining the functions to be implemented for a given new building or a renovated existing building.

Public authorities, in defining minimum requirements for BACS and TBM functions for new as well as for renovated buildings, as defined in the relevant standard.

Public authorities, in defining inspection procedures of technical systems as well as inspectors applying these procedures to check if the level of BACS and TBM functions implemented are appropriate.

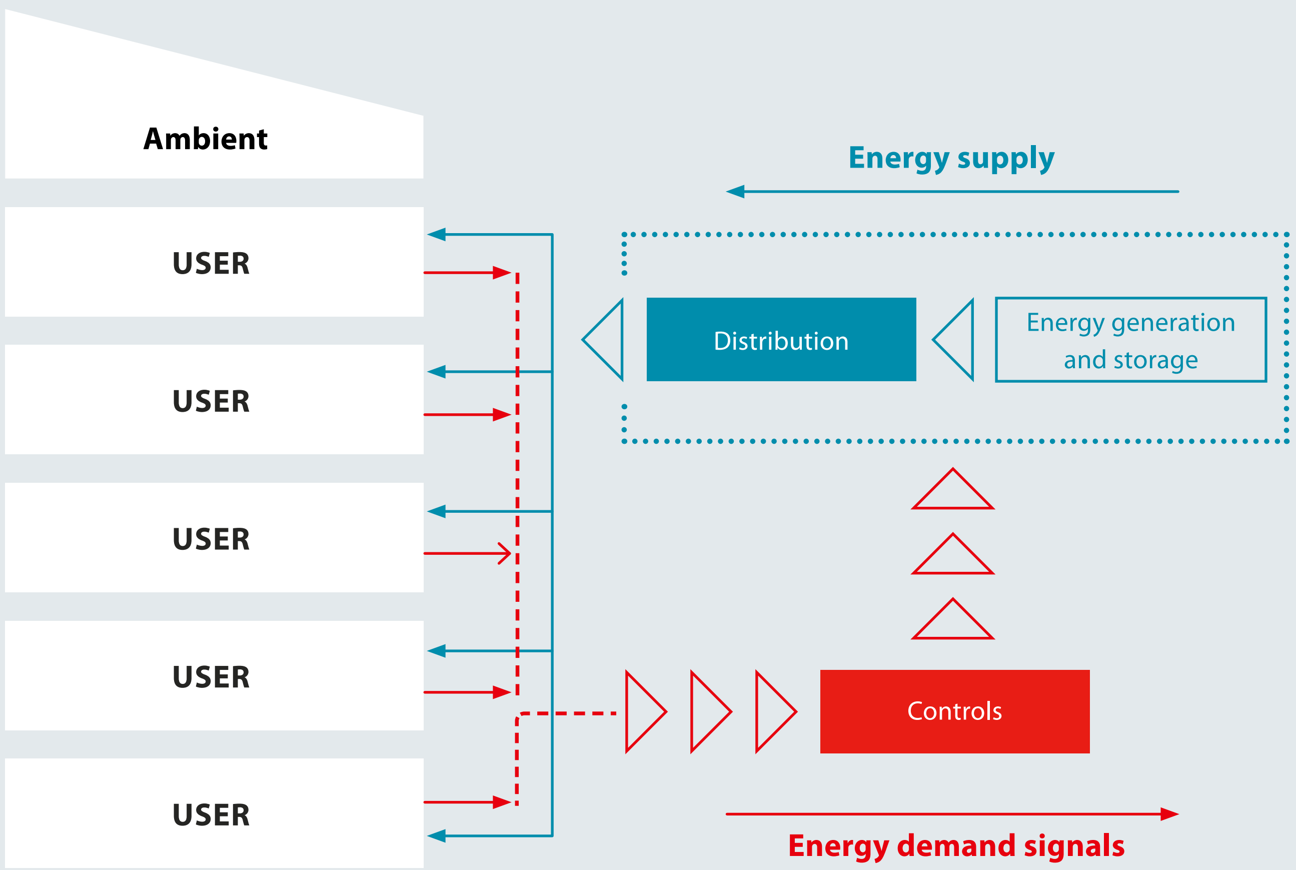
Public authorities, in defining calculation methods which consider the impact of BACS and TBM functions on the energy performance of buildings as well as software developers implementing these calculation methods and designers using them.

Building managers and auditors, in checking the impact of all BACS and TBM functions when assessing the energy performance of a building - manufacturers and system integrators, in providing the optimal products and solutions for highly efficient buildings.

The document specifies:

- a structured list of controls, building automation and technical building management functions which contribute to the energy performance of buildings; functions have been categorized and structured.
- 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 buildings of different complexities.
- a simplified method to get a first estimation of the effect of these functions on typical building types and use profiles.
- detailed methods to assess the effect of these functions on a given building.

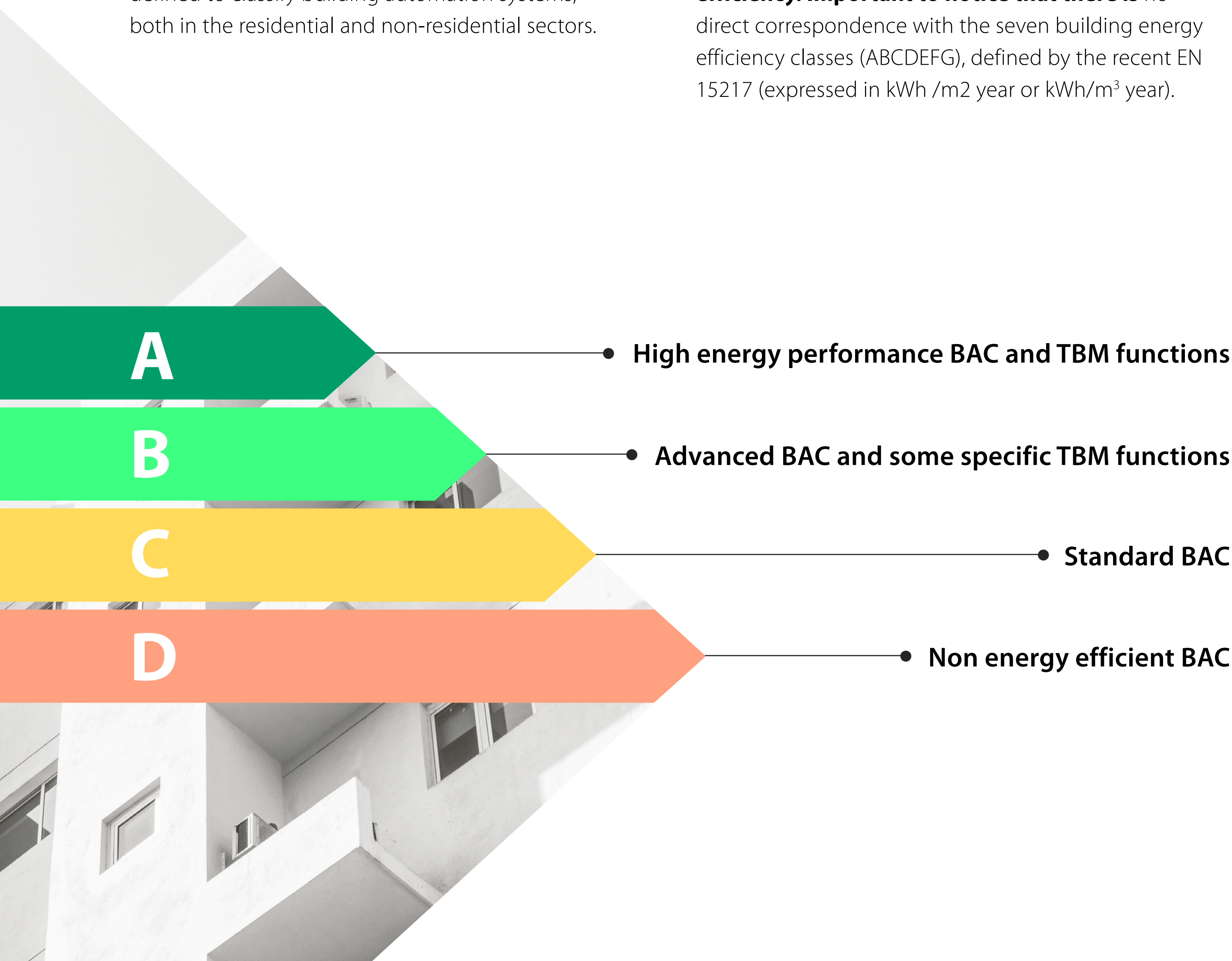
The standard is based on "Energy on Demand" approach. This means that all energy flows (from generation to emissions) must be minimized at the very lowest possible level to achieve the specific need of each user in the building.



> Figure 1

Four different "BACS" (Building Automation and Control Systems) energy efficiency classes were defined to classify building automation systems, both in the residential and non-residential sectors.

These four classes from D to A to represent automation systems with increasing energy efficiency. Important to notice that there is no direct correspondence with the seven building energy efficiency classes (ABCDEFG), defined by the recent EN 15217 (expressed in kWh /m2 year or kWh/m^3 year).



Complete Version of the Standard can be found at: *ISO 52120-1:2021 - Energy performance of buildings — Contribution of building automation, controls and building management — Part 1: General framework and procedures*

Class A "HIGH ENERGY PERFORMANCE":
corresponds to "high energy performance" BAC and TBM (Technical Home and Building Management) systems, i.e. with levels of precision and completeness of the automatic control such as to guarantee high energy performance to the generation plant. "Room control devices must be able to manage HVAC systems taking into account various factors (for example, preset values based on occupancy detection, air quality, etc.) and include integrated additional functions for multidisciplinary reports between HVAC and various building services (e.g., electricity, lighting, solar shading, etc.)".

Class B "ADVANCED":
includes plants equipped with an advanced automation and control system (BACS) and specific building technical building management functions (TBM) for centralized and coordinated management of the individual plants in the building. "Room control devices must be able to communicate with the building automation system".

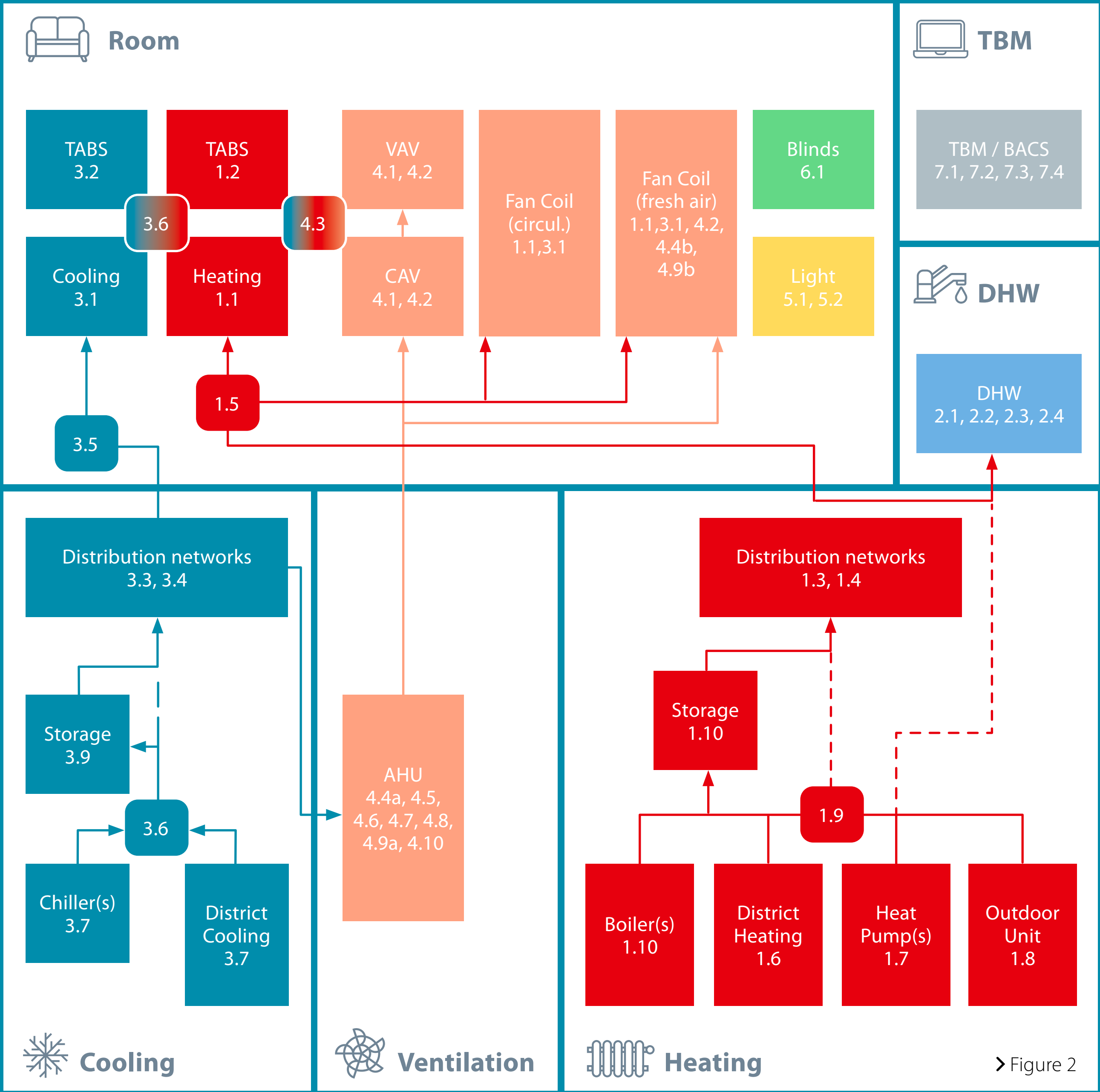
Class C "STANDARD" (reference):
corresponds to solutions equipped with "traditional" building automation and control systems (BACS), possibly equipped with communication BUSes, in any case at minimum performance levels.

Class D "NON ENERGY EFFICIENT":
includes traditional and non-energy-efficient technical systems automation and control.

The standard efficiency classes are based on specifications (description of features for each different efficiency score) which must be seen as minimum requirements to qualify for the classification.

Figure 2, to the right, summarizes how the standard splits functionalities and corresponding paragraph/table in the standard (overview from eu.bac.) and can be used to navigate in the complete document.

Complete Version of the Standard can be found at: ISO 52120-1:2021 - Energy performance of buildings — Contribution of building automation, controls and building management — Part 1: General framework and procedures


Room
TABS 3.2
TABS 1.2
VAV 4.1, 4.2
Fan Coil (circul.) 1.1,3.1
Fan Coil (fresh air) 1.1,3.1, 4.2, 4.4b, 4.9b
Blinds 6.1
3.6
4.3
Cooling 3.1
Heating 1.1
CAV 4.1, 4.2
Light 5.1, 5.2
1.5
3.5
TBM
TBM / BACS 7.1, 7.2, 7.3, 7.4
DHW
DHW 2.1, 2.2, 2.3, 2.4
Distribution networks 3.3, 3.4
Storage 3.9
3.6
Chiller(s) 3.7
District Cooling 3.7
AHU 4.4a, 4.5, 4.6, 4.7, 4.8, 4.9a, 4.10
Distribution networks 1.3, 1.4
Storage 1.10
1.9
Boiler(s) 1.10
District Heating 1.6
Heat Pump(s) 1.7
Outdoor Unit 1.8
Cooling
Ventilation
Heating
Figure 2

As mentioned, each of the functionalities described by the standard has 2 layers of scoring:

Description of the functionality and 4 levels (1 to 4) of its implementation. Example below:

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. Function is to be integrated in a system.	
	2	Individual room control: by thermostatic valves or electronic controller.	
	3	Individual modulating room control with communication: between controllers and BACS (e.g. scheduler, room temperature setpoint).	
	4	Individual modulating 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).	

Table 1

Assignment of the functional levels to BAC efficiency classes for residential and commercial buildings respectively. Note that category D represents the lowest Energy Performance (EP) while A the highest.

See below an example with the split in between residential and non-residential buildings for Heating control classification:

			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								
	1	Central automatic control								
	2	Individual room control								
	3	Individual modulating room control with communication				*				*
	4	Individual modulating room control with communication and occupancy detection (not applied to slow reacting heating emission systems, e.g. floor heating)								

* In case of slow reacting heat and cool emission systems, for example, floor heating, wall heating, etc., functions 1.1.3 and 3.1.3 are allocated to BAC class A.

> Table 2

EN ISO 52120 adds two new, additions (features) to the functionalities:

Modulating room control is introduced as a requirement for the higher efficiency levels of both Heating (1.1) and Cooling Emission control (3.1).

See below Cooling control classification as in the standard:

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 the central automatic control acting either on the distribution or on the generation.	
	2	Individual room control: by thermostatic valves or electronic controller.	
	3	Individual **modulating** room control with communication: between controllers and BACS (e.g. scheduler, room temperature setpoint).	
	4	Individual **modulating** 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).	

Table 3

			Definition of classes							
			Residential				Non residential			
			D	C	B	A	D	C	B	A
Automatic control										
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								
	1	Central automatic control								
	2	Individual room control								
	3	Individual **modulating** room control with communication				*				*
	4	Individual **modulating** room control with communication and occupancy detection (not applied to slow reacting cooling emission systems, e.g. floor cooling)								

* In case of slow reacting heat and cool emission systems, for example, floor heating, wall heating, etc., functions 1.1.3 and 3.1.3 are allocated to BAC class A.

> Table 4

The inclusion of hydronic balancing as one of the key BAC enablers for the energy efficiency of buildings, again for both heating (1.4a) and cooling (3.4a):

Cooling control			
3.4a	Hydronic balancing cooling distribution (including contribution to the balancing on the emission side)	CLG_DISTR _CTRL _HYDR	M4–6
		Hydronic balancing is applied to a group of cooling emitters (cooling panel, fan-coil unit or indoor unit) greater than 10.	
	0	No balancing	
	1	**Balanced** statically per emitter, without group balance.	
	2	**Balanced** statically per emitter, and a static group balance (e.g. with balancing valve).	
	3	**Balanced** statically per emitter and **dynamic** group balance (e.g. with differential pressure controller).	
	4	**Balanced dynamically** per emitter (e.g. differential pressure control).	

Table 5

Hydronics can be part of HVAC directly, (e.g. when terminal units such as radiant panels, fan coils, chilled beams, radiator or floor heating are placed in rooms), or indirectly when the hydronic distribution is feeding AHUs (air handling units). Second case is represented in the standard overview (eu.bac) (Figure 2), where hydronic controls are a crucial component for energy performance of such units. This paper does not directly focus on air distribution, however when cooling or heating energy is provided to air handling units (AHU) by means of hydronics distribution network, the same principles for balancing and control requirements apply.

The updated version of the standard reflects the importance of both modulation and dynamic hydronic solutions for the energy efficiency of buildings.

			Definition of classes							
			Residential				Non residential			
			D	C	B	A	D	C	B	A
Automatic control										
3	Cooling control									
3.4a	Hydronic balancing cooling distribution (including contribution to the balancing to the emission side)									
	Hydronic balancing is applied to a group of cooling emitters (cooling panel, fan-coil unit or indoor unit) greater than 10, in addition to static balancing at individual cooling emitters.									
	0	No balancing								
	1	**Balanced** statically per emitter, without group balance								
	2	**Balanced** statically per emitter, and a static group balance (e.g. with balancing valve)								
	3	**Balanced** statically per emitter and **dynamic** group balance								
	4	**Balanced dynamically** per emitter								

> Table 6

Benefits of modulation

Comfort is not only defined by the temperature because other factors, like humidity and air speed, influence the well-being of occupants too. Similarly, temperature stability has an impact on the comfort perception of the people living in the building. If temperatures fluctuate significantly, the inhabitants complaint rates also rise significantly.

Additionally, cooling setpoints can be increased and heating setpoints can be decreased without impacting the sense of well-being once temperature control is stable, something that can only be achieved with good modulation.

Besides the above mentioned benefits, modulation also improves the system's efficiency. Modulation does not have violent demand swings like On/Off has. Adjustments occur gradually and that ensures the generator (e.g., boiler or chiller) has enough time to adjust to the right level.


24.5
COMFORT
HOT
COLD

Benefits of hydronic balancing

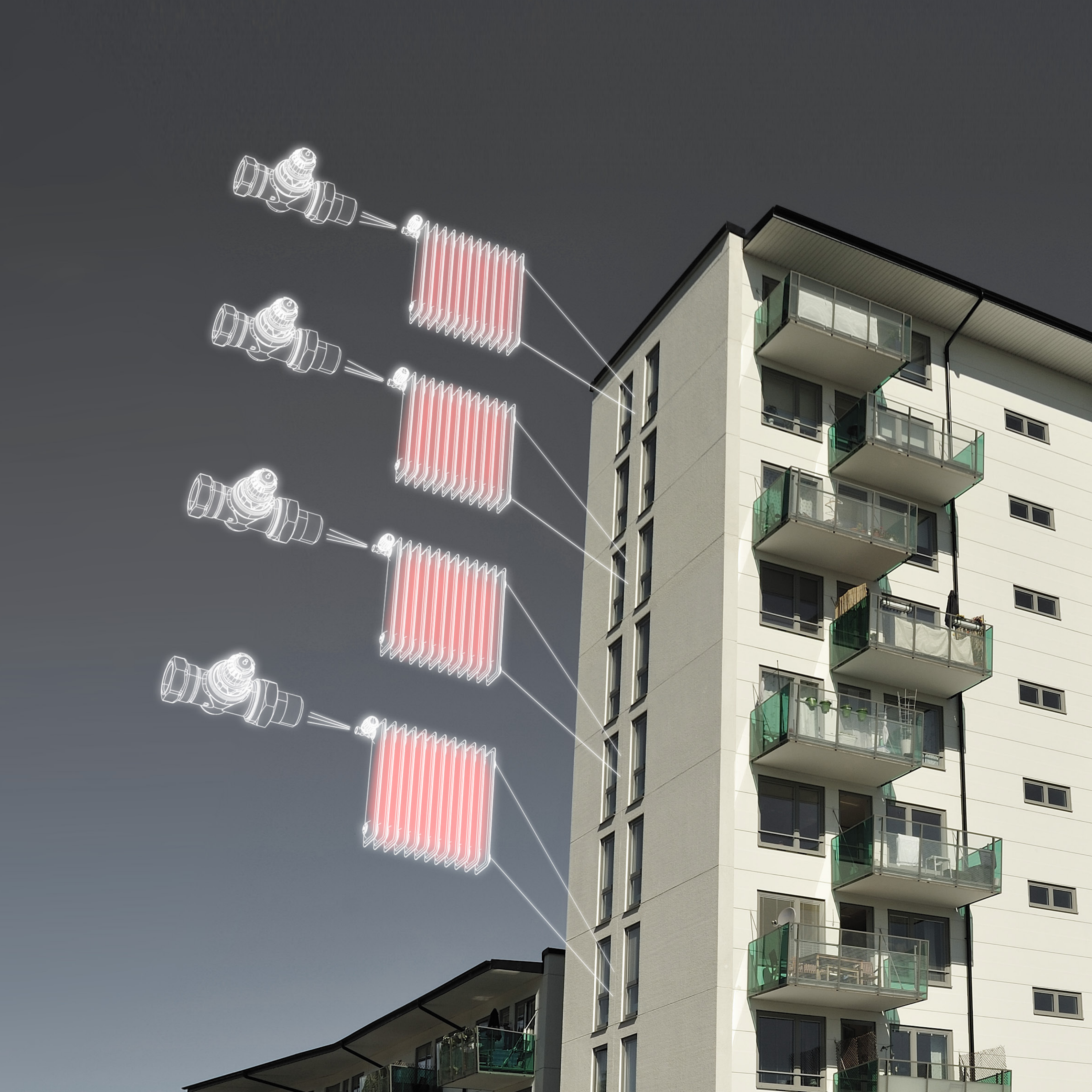
Hydronic systems operate through the distribution of heated or chilled water in the buildings. "Balancing the system" means to ensure that energy is distributed within the system to satisfy the building's heating or cooling demand as effectively and efficiently as possible. Non- or poorly balanced systems do not provide the appropriate flow for dynamic heating or cooling demands, which in turn leads to insufficient comfort and increased energy consumption.

In a heating system a lack of hydronic balancing results in an oversupply of hot water in the system to the emitters located closest to the heat generator, and undersupply to those furthest away. Oversupply means that not all of the heat can be emitted into the space, resulting in high return temperatures to the generator (e.g. a boiler or heat pump), which will then operate with decreased efficiency. It will also increase heat losses in distribution pipes and the power consumption of circulating pumps. In unbalanced systems comfort will also be noticeably affected, e.g. by fluctuating room temperatures and/or noise.

Attempts to resolve complaints often involve increasing water temperatures, pump head settings, or installing a larger circulation pump. The problem with cold radiators might seem to disappear, but the overall performance and the system hydronics further deteriorate, because heat transfer and return temperatures are affected by too high flows. Such approaches usually lead to substantially increased energy use.

Hydronic balancing ensures that the right amount of energy is supplied to all emitters/rooms in a building, avoiding oversupply. This will reduce heat losses and pump power consumption as well as increase the efficiency of the heat generator. There will be an increasing importance for hydronic balancing with low carbon heating systems, **particularly heat pumps** where this will improve the Seasonal Coefficient Of Performance (SCOP).

Despite the fact that it is a capital-light investment with a **fast pay-back time**, balancing is an aspect that today is usually considered a cost-increase and not a priority in renovation. In the new-built markets it is not uncommon to find poorly commissioned systems even if balancing valves are installed. EU legislation, including the Energy Performance of Buildings Directive (EPBD) and Ecodesign, has put forward important provisions to optimize technical building systems but these have not yet fully addressed market failures and therefore the potential of hydronic balancing remains largely unrealized.



Revision of the EPBD in 2022-2023

In Europe alone, more than 220 million existing buildings – or 75% of the building stock – are energy-inefficient (source: European Commission report), with many relying on fossil fuels for heating and cooling.

Buildings are therefore the single largest energy consumer in Europe. Heating, cooling and domestic hot water account for 80% of the energy that we, citizens, consume.

On December 15, 2021 the European Commission published its proposal for the revision of the EPBD:

The revision of the Energy Performance of Buildings Directive (EPBD) upgrades the existing regulatory framework to reflect higher ambitions and more pressing needs in climate and social action while providing Member States with the flexibility needed to take into account the differences in climate, culture and building tradition, building typologies, policy and legal frameworks.

EU Member States are encouraged to consider applicable standards, in particular from the list of EPB standards. Although the new EPBD does not force the Member States to apply the set of EPB standards , the obligation to describe the national calculation methodology following the national annexes of the overarching standards will push the Member States to explain where and why they deviate from these standards. This will lead to an increased recognition and promotion of the set of EPB standards across the Member States and will have a positive impact on the implementation of the Directive.

eu.bac, the association of European manufacturers in the home/building automation sector, is actively pushing for the adaptation of standards in national implementations of the EPDB. Their recommendation is that BACS in renovated and new buildings should be Level A or B compliant.

Why choosing a class A BAC

When renovating a building different technical measures can be applied for staged renovation. There will always be a dilemma on which to prioritize, i.e. to insulate the envelope, change the heat source or invest in the technical building system.

There is no "one fits all" approach but investing in BACS is always a good choice with extremely low Capex compared to other measures and with extremely high ROI and fast pay-back time. As eu.bac. reports most BACS investments pay for themselves in less than 2 years, enabling economic savings that can be directed to further energy efficiency measures.

Furthermore an "intelligent" BACS equipped building is by default low temperature ready, meaning that it will perfectly work with improved insulation or with a heat pump or with district heating.

According to the EN15232-1 standard, a class A BAC offers significant advantages over class C (reference class) allowing savings of approximately 30% of thermal energy and 13% of electricity.

The installation of a Building & Automation Control System simplifies energy management, saves time, but above all keeps consumption under control thanks to the monitoring and intelligent regulation of the equipment.

Summary and main updates from the Standard

- **This is not a brand new standard, but an improved one**. The title of the standard has been changed, previously EN 15232-1:2017
- The description of the control functions within Table 4 in EN 15232 are now in Table 5 in EN ISO 52120
- New hydronic balancing functions for heating and cooling distribution have been added as the functions 1.4a and 3.4a respectively
- Changes of classes for some functions under 1.10, 4.1, 4.4, 5.1 and 5.2
- Table 7 contains the up-to-date referenced EPB standards that shall be taken into account for the control functions defined in Table 5
- The Annex B: "Minimum BAC function type requirements" is normative now and no more only informative
- Annex E: Applying BAC for EnMS specified in ISO 50001 has substantial changes due to the update of the ISO 50001 published in 2018

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