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ANNEX 10

ANNEX

to the

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Approval of the content of the draft Commission Notice providing guidance on new or substantially modified provisions of the recast Energy Performance of Buildings Directive (EU) 2024/1275

Technical building systems, indoor environmental quality and inspections (Articles 13, 23 and 24)

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to the

Commission Notice providing guidance on new or substantially modified provisions of the recast Energy Performance of Buildings Directive (EU)2024/1275

Guidance on Technical building systems, indoor environmental quality and inspections (Articles 13, 23 and 24)

1. INTRODUCTION

The recast Energy Performance of Buildings Directive (the 'recast EPBD')[1] includes new provisions on the requirements for technical building systems, some of which are addressed in this document.

This document provides guidance on how to interpret and transpose the recast EPBD, particularly those provisions that concern technical building systems, indoor environmental quality and inspections. The recast EPBD extends the scope and requirements regarding the regular inspection of technical building systems and groups the provisions together under one individual article. In addition, a new inspection scheme – or alternative measures – is introduced in Article 23(8). That scheme is aimed at certifying that the construction and renovation works delivered meet the designed energy performance and are compliant with the minimum energy performance requirements laid down in the building codes or equivalent regulations. This document will set out certain minimum elements of interpretation.

A definition of 'indoor environmental quality' (IEQ) is introduced in Article 2(66), and multiple references are made throughout the text to reflect that new concept, including within the scope of the legal text. This document provides practical information and technical background as well as elements of interpretation of various provisions regarding IEQ to support Member States in transposing the definition, addressing IEQ issues in new and existing buildings, and establishing requirements to install measuring and control devices to monitor and regulate indoor air quality in line with Article 13(5).

2. TECHNICAL BUILDING SYSTEMS

2.1. Extension of the definition of 'technical building system'

The obligations arising from Article 13 apply to technical building systems as defined in Article 2(6). According to this definition, the term 'technical building system' means technical equipment of a building or building unit for space heating, space cooling, ventilation, domestic hot water, built-in lighting, building automation and control, on-site renewable energy generation and energy storage, or a combination thereof, including those systems using energy from renewable sources. The recast EPBD updates the definition of 'technical building system' by altering the wording for the system for 'on-site electricity generation' in order to extend its scope (now 'on-site renewable energy generation') and by extending it to include 'energy storage'[2].

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[1] Directive (EU) 2024/1275.

[2] Recital 36 of the recast EPBD mentions that the electrification of buildings, such as through the deployment of heat pumps, solar installations, batteries and recharging infrastructure, changes the risks with regard to the fire safety of buildings, which Member States need to address. To this

2.1.1. *On-site renewable energy generation*

'On-site renewable energy generation' generally refers to the production of energy from renewable sources such as ambient air, solar, wind, hydro, biomass, and geothermal directly at the place where the energy is consumed, as opposed to being produced off-site and transported via the electricity grid or by other means. Under the previous EPBD, the term 'on-site electricity generation systems' was used, referring to systems which are designed to produce electricity, are installed in or within the confined boundaries of the premises where the building is located, and which are to some degree integrated into the building and its electrical installation. Those systems include, in particular, photovoltaic (PV) panels (e.g. roof-mounted PV panels), micro combined heat and power (CHP) installations based on renewables (e.g. bioenergy, solar) and small wind turbines[3].

The term 'on-site renewable energy generation' used in the recast EPBD is widened to also include thermal generation systems, the main target being solar thermal[4].

In this context, combustion boilers based on renewable fuels and biomass heating systems are considered to be heating systems and therefore are considered to be technical building systems. They both fall under the general provisions for technical building systems and the specific provisions for heating systems.

Heat pumps, aquifer thermal storage systems (ATES) and geothermal systems are considered to be heating systems (and, where relevant, also cooling systems) and system requirements should be set under these. On-site renewable generation systems, also in combination with other technical building systems (e.g. energy storage, heating and cooling systems), are relevant in terms of a building's capacity to react to external signals and adapt its energy generation (see also section 2.7 of this Guidance).

2.1.2. *Energy storage*

Energy storage, particularly 'behind the meter', can help consumers, from households to industries, maximise self-consumption of self-produced renewable energy and adapt their energy consumption to price signals from the grid, making it possible for those consumers to reduce their energy bills[5]. Energy storage can also be used to provide flexibility to the grid. Energy storage involves various technologies, and can be sorted in five categories: mechanical, electromechanical, electrical, chemical and thermal[6].

With regard to energy storage[7] the main targets are electrical storage systems, such as on-site building batteries and bi-directional recharging infrastructure for electrical vehicles[8], and thermal storage systems, such as solar thermal energy storage, energy storage tanks for heating and cooling systems and ATES.

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effect, stand-alone guidance on fire safety related to the electrification and renovation of buildings will be provided.

3 Commission Recommendations on building modernisation (7 June 2019).

4 Note that the capacity and benefits of on-site renewable energy generation will be evaluated separately in EPC (Annex I, Annex V) and Smart Readiness (Annex IV) of the recast EPBD.

5 European Commission. Energy Storage - Underpinning a Decarbonised and Secure EU Energy System. Commission Staff Working Document SWD(2023) 57 final, 14 Mar. 2023.

6 Directorate-General for Energy. Study on energy storage – Contribution to the security of the electricity supply in Europe (2020). https://energy.ec.europa.eu/publications/study-energy-storage_en.

7 Annex I(5) to the recast EPBD specifically states that the positive influence of electrical (e) and thermal (f) storage systems should be considered in the calculation of the energy performance of buildings.

8 Mentioned in Recital 49 and 52, 'bi-directional recharging' is defined in Article 2(38) and means bi-directional recharging as defined in Article 2(11) of Regulation (EU) 2023/1804.

System requirements for solar thermal storage systems for everyday use should not be considered alone, but in combination with the system requirements for solar thermal systems. System requirements for energy storage tanks, in combination with heat pumps and ATES, are set under the requirements for the heating or cooling system as a whole.

If relevant to ensure capacity to react to external signals (discussed in section 2.7) and, more generally, to demand-side flexibility and seasonal storage, Member States should update these system requirements for energy storage systems[9, 10], (see also Table 1).

Domestic hot water tanks may to some extent be considered as energy storage. Buildings thermal mass and thermally activated building structures (TABS)[11] are in this context not considered as energy storage but may be considered under section 2.7, for their relevance towards the capacity of a building to react to external signals.

Article 13(6) requires Member States to promote energy storage for renewable energy in buildings, which means that they will need to put in place measures to support it (e.g. through financing measures, provision of training and advice to professionals and inspectors, including through one-stop-shops)[12].

2.2. Setting of system requirements

For newly introduced technical building systems, which were not covered by the EPBD before the recast, Member States will have to define and lay down system requirements at national level and ensure that those requirements cover all of the aspects referred to in Article 13(1) of the recast EPBD.

Table 1 indicates the meaning of each of these aspects, giving examples (for illustration purposes only) for the expanded and new types of systems that have been added to the list of technical building systems in the recast EPBD. System requirements are set when technical building systems are installed, replaced or upgraded.

New elements were introduced in Article 13(1) to ensure that, when setting system requirements, Member States give sufficient consideration to energy-saving technologies.

Recital 16 mentions energy-saving technologies with very short payback periods, e.g. thermostatic control valves or heat recovery from exhaust air or wastewater. Energy performance requirements for technical building systems should apply to whole systems, as installed in buildings, and not to the performance of stand-alone components, falling under the scope of product-specific regulations.

Other examples of energy-saving technologies that may be considered can be at technical system level e.g. control systems together with sufficient monitoring devices, appropriate ability to control heating, cooling and ventilation systems, and suitable zoning.

New elements introduced also include hydronic balancing, described in Chapter 2.3.

9 Note that the capacity and benefits of energy storage will be evaluated separately in EPC (Annex I, Annex V) and Smart Readiness (Annex IV) of the recast EPBD.

10 Relevant parameters for energy storage could be storage capacity (e.g. kWh), charge/discharge power rating (e.g. kW), depth of discharge, losses during storage, durability (e.g. number of possible charges), system efficiency, response time, or material specific properties. For thermal storage, for example, the temperature range can be a relevant parameter.

11 TABS is an embedded water-based surface heating and cooling system, where the pipe is embedded in the central concrete core of a building's construction.

12 For examples of ways to increase the uptake of energy storage, see the work cited in footnote 5.

When setting requirements, Member States must also take account of design conditions and typical or average operating conditions, thereby ensuring that the system can perform efficiently and effectively under all representative conditions. Examples of this would be requirements when designing variable air volume ventilation systems and cooling systems, ensuring that valves in heating and cooling distribution systems are dimensioned for lower flow conditions, and that BACSs are designed and optimised for the full range of operating scenarios, including sufficient monitoring devices and benchmarking.

Reference to energy saving technologies that can optimize the performance of technical building systems under typical or average operating conditions is also made in relation to the inspections, in Article 23(4).

Table 1 – Different system requirements areas

Type of requirement	Refers to	Example	
		On-site renewable energy generation	Energy storage
‘overall energy performance’	The performance of the system as a whole (not to be confused with the performance at product or component level and the performance of the whole building)	System performance factor of a photovoltaic (PV) system or a solar thermal system (e.g. according to standard EN 15316-4-3)	System performance depending on functionality, i.e. peak shaving (security of supply) and back-up power (ability to operate critical systems)
‘appropriate dimensioning’	The appropriateness of the system size or capacity given the needs and characteristics of the building under expected use conditions	Determine the optimal size of the solar system based on energy cost reduction, available mounting area, control and other constraints that could apply. For thermal solar additionally storage capabilities.	Determine optimal size of the electric or thermal energy storage based on capacity, duty cycle, recovery time, service life, and cost optimization.
‘proper installation’	The way the system should be installed in the building in order to operate properly	Installation by a trained and/or certified installer.	Installation by a trained and/or certified installer (e.g. IEC 62933-2-1 for electrical and e.g. EN 12977-1 and 12977-5 for solar water heater storage).
‘appropriate adjustment’	Testing and fine-tuning actions on the system, once installed, under real usage conditions	Sequence of tests to be performed after installation to check that the system operates in accordance with its specifications. System is hydronically balanced.	Sequence of tests to be performed after installation to check that the system operates in accordance with its specifications (e.g. IEC 62933-2-1 for electrical storage and EN 12977-3 for solar water heater storage). System is hydronically balanced.
‘appropriate control’	Desired or required control capabilities of systems	(Where applicable) control of electrical or thermal feed (e.g. to grid, self-consumption or storage). Capacity to react to external signals and adapt its energy generation.	Optimize for peak-shaving, cost, or both. Capacity to react to external signals and adapt its energy storage.

2.3. Hydronic balancing

The recast EPBD refers to hydronic balancing in: Article 13(1), in relation to the requirements for technical building systems installed in new and existing buildings; in Article 13(3), in relation to existing buildings when heat generators or cooling generators are replaced; in Article 13(11)(b), in relation to control functionality requirements in residential buildings that are new or undergoing major renovation; and in Article 23(4), detailing the requirements of inspections.

2.3.1. *Requirements for hydronic balancing for Technical Building Systems*

The requirements for technical building systems cover hydronic systems (i.e. systems making use of water, steam or a water solution – such as glycol with water – as a heat-transfer medium) for space heating, space cooling and domestic hot water. Balancing requirements are equally relevant for airborne ventilation systems, but in this context, it would only be the associated hydronic parts, such as heating and cooling coils, zone heating or cooling surfaces, etc. Recital 12 states that system balancing is one of the factors that play an increasingly significant role in the energy performance of buildings. Hydronic balancing ensures that the flow[13] in a building's hydronic heating or cooling network is distributed correctly, so that enough heating or cooling energy is supplied to all emitters and spaces in a building. A non-balanced system may result in inadequate functionality, insufficient comfort and increased energy use.

For systems with small pressure differences, such as a single-family house, static balancing is more typically used. Dynamic balancing is typically used in systems with larger pressure differences and varying loads, for example in a large office building of a significant horizontal spread and with more storeys, where the differential pressure between the first and last vertical shaft is significant[14].

Article 13(1) provides that Member States must, where appropriate (i.e. in hydronic systems), set system requirements in respect of the hydronic balancing of the relevant technical building system when it is installed in new or existing buildings, in new buildings, in existing buildings when heat generators or cooling generators are replaced, and in new residential buildings and residential buildings undergoing major renovations.

As regards hydronic balancing, system requirements should achieve at least Level 2 or higher in Table 2. Higher-level requirements for larger buildings are recommended, where appropriate. For single-family houses (SFH), the hydronic balancing requirements would be those achieving at least Level 1 or higher in Table 2.

Table 2 – Example of requirements for hydronic balancing of technical building systems. Requirements are based on EN ISO 52120, Table 5, M3-6 and M4-6

Level	**Type of requirement - Space heating and space cooling**
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 control)
4	Balanced dynamically per emitter (e.g. differential pressure controllers)

The appropriate design for hydronic balancing will generally require correct calculation of heat loss, correct dimensioning of emitters, adequate sizing of valves, correct system build-up, correct flows, temperatures, pressure losses and distribution, a sufficient possibility for measurement and control of flow and pressure in the system, and that the differential pressure between emitters is not too large. The appropriate verification of

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13 Hydronic systems also include steam systems for space heating.

14 Static balancing usually involves setting the flow rates and adjusting the valves in the system during verification of design conditions. Dynamic balancing is based on automatic pressure independent valves and controls to adjust the flow dynamically in response to changes in system demand and part loads. In practice many systems are a combination of static and dynamic balancing. Care should generally be taken to ensure unintentional hydronic pressure oscillation between dynamic components and pumps.

hydronic balancing for construction and renovation works delivered will generally require correct design specifications, flow and temperature testing, flushing, venting and complete documentation of the tests.

2.3.2. Requirements for hydronic balancing in Inspections

Article 23(4) states that inspections must include an assessment of hydronic balancing systems. As the verification of hydronic balancing systems usually requires the correct design documentation, the appropriate test conditions, multiple tests and readings of pressure, flow and temperature and verification with design conditions, it may be too costly to include this work within an inspection. An assessment of hydronic balancing systems could therefore include verification of whether hydronic balancing has been performed recently and there is sufficient documentation of it, combined with spot checks of temperatures, pressures and flows in the distribution system. In practice, hydronic balancing is often complex to monitor.

2.4. Requirements for low-temperature heating systems

The recast EPBD refers to low-temperature heating systems and/or more efficient temperature settings in Article 5(1) on setting of minimum energy performance requirements, Article 13(2) on technical building systems, Article 19(8) on energy performance certificates and Article 23(4) on inspections, as shown in Table 3.

Low-temperature heating systems are generally required to ensure sufficient efficiency of heat pumps, low-temperature district heating, renewable energy systems and other systems where a low temperature is required, and to reduce distribution losses. However, in many conventional systems there is also a potential to lower the system temperature.

Low-temperature heat emitters will have surface temperatures that are closer to room temperatures than conventional systems and will therefore often require larger emitter surface areas in order to provide the same heat output, i.e. larger radiators or convectors, or the use of floor-heating.

Table 3 – Provisions on low-temperature heating systems

Article reference	Requirements in Articles
Article 5(1) Setting of minimum energy performance requirements	Member States may set the requirements for building elements at a level that would facilitate the effective installation of low temperature heating systems in renovated buildings, when setting minimum energy performance requirements. Generally, when setting requirements, Member States may differentiate between new and existing buildings and between different categories of building.
Article 13(2) Technical building systems	Member States may set specific system requirements for technical building systems in order to facilitate the effective installation and operation of low temperature heating systems in new or renovated buildings.
Article 19(8) Energy performance certificates	The recommendations in the EPCs shall include an assessment of whether the heating systems, ventilation systems, air-conditioning systems and domestic hot-water systems can be adapted to operate at more efficient temperature settings, such as low temperature emitters for water based heating systems, including the required design of thermal power output and temperature and flow requirements.
Article 23(4) Inspections	Where relevant, inspections shall assess the feasibility of the system to operate under different and more efficient temperature settings, such as at low temperature for water-based heating systems, including via the design of thermal power output and temperature and flow requirements, while ensuring the safe operation of the system. Additionally, where no changes have been made to the system or to the requirements of the building following an inspection, Member States may choose not to require the assessment of main component sizing or the assessment of operation under different temperatures to be repeated.

Low-temperature heating systems generally require an adequately insulated building with sufficiently low heat losses, and sufficiently large heat emitters. New residential buildings that apply floor and wall heating type emitters can have a system design temperature of 35 °C, due to low heat loss and large heating surfaces. By insulating a building or upgrading its windows, the heat loss will be lower, and the existing radiators can operate at lower temperatures. However, in many existing buildings there is already a potential to decrease the supply temperature to a certain degree.

In order to characterise the temperature settings of an existing heating system, the following parameters should be applied:

1. System design temperature[15],

2. Seasonal average system temperature, supply and return temperature[16].

Table 4 – Examples of space heating design temperatures with heat pumps or district heating systems. Requirements will typically be higher for domestic hot water systems, which may require additional heating capacity

System	Main relevant characteristics
Heat pump	Space heating design temperatures preferably below 40 °C (and not above 50 °C), and low temperature differences < 5°C between supply and return temperature, requiring larger water flow rates.
District heating system	Space heating design temperatures at 60 °C and requirement of low return temperatures of typically not more than 40°C, requiring high temperatures differences of 20-30 °C. This will often require lower water flow rates[17].

Other relevant parameters that Member States may set to facilitate the effective installation and operation of low-temperature heating systems may concern emitter types and sizes, the pipe distribution system of the building, and the characteristics and requirements of the generator. As a system converted to lower temperatures with the same emitter sizes may be slower to reheat, this should be given special consideration. Indoor comfort considerations should also be taken into account: e.g. there may be a higher draught risk from a poorly insulated window when the emitter below operates at lower temperatures, and the risk of higher relative humidity levels in areas that previously operated at higher temperatures should also be considered.

It may generally be considered technically and economically feasible to design for low-temperature regimes (see Table 5) in new buildings. When renovating existing buildings, it is usually technically and economically more feasible to design for medium temperature regimes. For heat emitters with large areas, such as floor heating, it is considered technically and economically feasible to design for low-temperature heating systems. Lower temperature regimes can be achieved depending on the characteristics of the building, the heat generator (e.g. a heat pump) and the heat emitters (e.g. floor heating).

15 This value for a heating system in an existing building or building unit upgraded in terms of thermal insulation, can be estimated by assessing the heat load (after the upgrade) versus the installed emitters capacity.

16 These parameters can be calculated based on the first parameter, using additional information on the minimum capacity of the generator, the climate zone and the flow in the distribution system.

17 Note that in newer, well-insulated buildings with low heat losses, the heat loss in a given emitter can often be so low that the designated valve may not be able to operate properly, leading to imbalances in the system. This will therefore often require lowering of the supply temperature to obtain sufficiently high flow rates and to obtain a system that can be hydronically balanced.

The guidance on energy performance certificates and independent control systems in [Annex 3 to this Commission Notice on Energy performance certificates (Articles 19-21, Annexes V) and independent control systems (Annex VI)] also addresses low-temperature heating systems at section 4.4. Revha Guidebook No 7 provides further examples of these systems[18].

Table 5 – Temperature regimes for low-temperature heating systems

Medium-temperature regime	Term to be used for a heating system that achieves a system design temperature of ≤ 55 °C. This should make it possible to achieve a seasonal average system temperature of ≤ 50 °C. This regime allows for the operation of boilers in condensing mode (those that allow it) and for heat pumps to operate at fairly efficient levels.
Low-temperature regime	Term to be used for a heating system that achieves a system design temperature of ≤ 45 °C. This should make it possible to achieve a seasonal average system temperature of ≤ 42°C. This regime allows for the operation of boilers in condensing mode (those that allow for it) and for heat pumps to operate at far more efficient levels.

2.5. Building automation and control systems for non-residential buildings

Directive 2010/31/EU as amended by Directive (EU) 2018/844 (the '2018 amended EPBD')[19], Articles 14(4) and 15(4) referred to 2025 as the year by which non-residential buildings, with an effective rated output for heating systems, air-conditioning systems, systems for combined space heating and ventilation, or systems for combined air conditioning and ventilation of over 290 kW[20], must be equipped with building automation and control systems (BACS) meeting the conditions laid down in those Articles. The requirements ensuring installation were required to be transposed by the 10 March 2020. The provisions should therefore already have been transposed.

In the recast EPBD, these provisions have now been grouped under Article 13(9) and (10), and the limit date for BACS installation is now more clearly indicated as 31 December 2024. The transposition of the existing BACS functionalities, detailed in the recast EPBD in Article 13(10)(a) to (c), will not be revisited. In addition, a lower threshold of 70 kW for the installation of BACS is introduced as of 31 December 2029. Note that the threshold for BACS is calculated in a different way than the threshold for inspections, as it is based on the effective rated output for heating systems, air-conditioning systems, systems for combined space heating and ventilation, or systems for combined air conditioning and ventilation. As in the amended EPBD of 2018, BACS requirements must be complied with if either the heating or cooling generator rated outputs (separately) reach the threshold identified.

Member States must ensure that BACS installed in non-residential buildings in line with Article 13(9) and (10) have the listed capabilities at least for the following technical building systems: heating systems, air-conditioning systems, combined heating and ventilation systems, combined air-conditioning and ventilation systems.

18 Babiak, J. (ed), Olesen, B.W., Petras, D., Low temperature heating and high temperature cooling – Embedded Water based surface heating and cooling systems, Rehva Guidebook No 7.

19 Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings as amended by Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018.

20 Systems that serve non-EPB uses (e.g. providing hot water for industrial processes or refrigeration for fridges and storage rooms) should not be considered in the calculation of the effective rated output. For a system that serves both an EPB and a non-EPB use (e.g. a boiler of a hotel providing heating, domestic hot water and hot water for industrial washing machines), the power threshold may be identified based on the assessment of the part of the system that is serving EPB-uses.

The BACS capabilities required under Article 13(10)(a) to (c) could correspond to B-class BACS under standard EN 15120[21]. If individual components of the system are replaced, the requirements should be fulfilled for these. Member States are encouraged to provide professionals with the appropriate technical guidelines to help them assess the BACS capabilities, identify potential gaps, and provide recommendations on how to fill those gaps effectively. This assessment may be done according to the EN 52120.

The new functionality of indoor environmental quality (IEQ) monitoring, introduced in Article 13(10)(d) of the recast EPBD, will be described in detail in section 3.2 of this document and will become mandatory as of the transposition date (29 May 2026). These new BACS capabilities should at least conform to Class B of EN 15120. This means that non-residential buildings that, according to Article 13(9)(a), must be equipped, where technically and economically feasible, with the capabilities in Article 13(10)(a) to (c) by 31 December 2024, will also need to be equipped, where technically and economically feasible, with IEQ monitoring by 29 May 2026. IEQ monitoring means continuous measuring of parameters in spaces designed for human occupancy and, e.g., it can be implemented with integrated sensors in HVAC systems or via centralised BACSs.

A sub-system may be considered sufficient to meet one or more of the requirements of Article 13(10)(a) to (d), if the individual BACS components – also called function blocks or programmable control units – allow for data exchange and interoperability. For example, the capability of monitoring IEQ can be ensured by components of the ventilation system that in turn will need to be interoperable with the main BACS.

When installing a BACS, that system must enable communication between interconnected technical building systems and other appliances within the building and it must be able to be operated together with other types of technical building system, even of different proprietary technologies, devices and manufacturers. This also applies where individual components of the system are being replaced.

Two distinct ways of addressing the economic feasibility of BACS requirements can be found in the relevant legislation in France[22] and in Germany[23].

2.6. Monitoring and control functionalities in residential buildings

The installation of electronic monitoring and effective control functionalities in residential buildings can lead to significant energy savings, improve the management of the indoor environment and be beneficial to building owners and users. This is particularly the case in large buildings, where access to system controls and system information is limited for most users.

According to Article 13(11), Member States must establish requirements to ensure that, where technically, economically and functionally feasible, residential buildings are

[21] Replacing EN 15232. Class B was also mentioned in the Commission Recommendations on building modernisation (7 June 2019). For further information refer to EN ISO 52120-1 chapters 5.4, 5.5 and 5.6 including Tables 5 and 6. Some individual requirements for Class B in Table 6 may not be technically or economically feasible for a specific project, and may therefore be omitted, if documented.

[22] In the Décret No 2023-259 du 7 avril 2023 relatif aux systèmes d'automatisation et de contrôle des bâtiments tertiaires, an automation and control system must be installed in all non-residential buildings above 70 kW unless the owner produces a study establishing that its installation is not feasible with a return on investment time of less than ten years (https://www.legifrance.gouv.fr/).

[23] In the Gebäudeenergiegesetz GEG 2024, §71a, the conditionality of technical and economic feasibility is not included in non-residential buildings above 290 kW (https://www.gesetze-im-internet.de/geg/BJNR172810020.html#BJNR172810020BJNG002001128).

equipped with electronic monitoring and control functionalities. This measure was previously voluntary, so Member States could decide whether or not to establish those requirements for residential buildings.

Article 13(11)(a) concerns the provision of continuous electronic monitoring. Systems that do this measure energy consumption and use it to calculate system performance, which should be made available to the system owner or manager. If system performance falls significantly or if there is a service need, the system notifies the system owner or manager. The system should operate continuously, as opposed to periodically (e.g. every three months). Article 13(11)(b) concerns the provision of effective control functionalities to ensure optimum generation, distribution, storage and use of energy and, where applicable, hydronic balance. These control functionalities should take into consideration the scenario of a multi-apartment building with a single heating system, where individual users are only able to control the system within the boundaries of their building unit.

Member States that have transposed the corresponding provisions in the 2018 amended EPBD (Articles 14(5)(a) and (b), 15(5)(a) and (b)) will need to ensure that, where relevant, hydronic balancing (see section 2.3) is included among the effective control functionalities in their transposition measures and that the functionality c), capacity to react to external signals and adjust the energy consumption, described in further detail in section 2.7, is introduced. Article 13(11) does not include details on thresholds for effective rated output and covers all residential buildings regardless of their size.

It is recommended that Member States take into account the differences in system and building type when setting requirements. In addition, Member States are encouraged to provide professionals with the appropriate technical guidelines.

Standard EN ISO 52120 introduces a list of capabilities for residential buildings[24]. To transpose the provisions under Article 13(11)(a) and (b), Member States could require buildings to meet Class B for part 7. Technical home and building management requirements. For Single-Family Houses undergoing major renovations, Member States could require to meet Class B or C for different segments of part 7. Technical Home and building management requirements, as shown in Table 6. Not all requirements are relevant in all cases: e.g. the requirements in point 7.4 (local energy production and renewable energies) are only relevant if local generation of renewable energy is present after the major renovation or construction of the building. For Article 13(11)(c), in addition to point 7.7 of Table 6, the requirements are discussed in section 2.7. Rehva Guidebook 29[25] provides additional definitions and advice for technical monitoring.

Article 13(11) also introduces the possibility for Member States to exclude single-family houses undergoing major renovations from these monitoring and control functionalities, where the costs of installation exceed the benefits. This paragraph provides for a specific exclusion for specific sub-categories of single-family houses where the cost-benefit assessment is negative. Member States that decide to make use of this exclusion should demonstrate to the Commission how they have transposed this provision and determined that the cost of installing those functionalities exceeds the benefits (lower energy

[24] For further information refer to EN ISO 52120-1 chapters 5.4, 5.5 and 5.6 including Tables 5 and 6. Some single requirements for single-family houses in Table 6 may not be technically or economically feasible for a specific project, and may then be omitted, if documented.

[25] Plesser, S., Teisen, O., and Ryan C., Rehva Guidebook 29 (2019). Quality Management for buildings, Improving Building Performance through Technical Monitoring and Commissioning. Available at: https://www.rehva.eu/hvac-guidebook-repository/rehva-guidebook-29.

consumption, savings due to exemption from costs of inspections, etc.), also considering setting less advanced requirements for single-family houses undergoing major renovation, as shown in Table 6.

Table 6 – Example of part 7. Technical Home and building management minimum requirements for monitoring and control functionalities installed in new residential buildings or residential buildings undergoing major renovations

Building type	Single-family houses undergoing major renovations	New residential buildings, new single-family houses and multi-apartment buildings undergoing major renovations
Minimum level	Class B / Class C	Class B
7.1 Setpoint management 13(11b)	Class C: Manual setting room by room individually	Adaptation from distributed/ decentralized plant rooms only.
7.2 Runtime management 13(11b)	Class C: Manual setting (plant enabling)	Individual setting following a pre-defined time schedule including fixed preconditioning phases.
7.3 Detecting faults of technical building systems and providing support to the diagnosis of these faults 13(11a)	Class C: No central indication of detected faults and alarms.	With central indication of detected faults and alarms ([a])
7.4 Reporting information regarding energy consumption, indoor conditions 13(11a,b)	Class B: Trending functions and consumption determination	Trending functions and consumption determination
7.5 Local energy production and renewable energies 13(11b,c)	Class C: Uncontrolled generation depending on the fluctuating availability of renewable energy sources (RES) and or run time of combined heat and power (CHP); overproduction will be fed into the grid.	Coordination of local RES and CHP with regard to local energy demand profile including energy storage management; optimisation of own consumption.
7.6 Waste recovery and heat shifting 13(11b)	Class C: Managed use of waste heat or heat shifting (including charging/ discharging thermal energy storage)	Managed use of waste heat or heat shifting (including charging/ discharging thermal energy storage)
7.7 Smart Grid Integration 13(11c)	Class B: Building energy systems are managed and operated depending on grid load; demand side management is used for load shifting.	Building energy systems are managed and operated depending on grid load; demand side management is used for load shifting.

[a)] Different central building units each with the functionality of central indication of detected faults and alarms will be considered to fulfil this requirement.

2.7. Capacity to react to external signals

Article 13(11)(c) requires Member States to lay down requirements to ensure that, where technically, economically and functionally feasible, new residential buildings and residential buildings undergoing major renovation are equipped with a ‘capacity to react to external signals and adjust the energy consumption’, as of 29 May 2026.

Article 11(1) requires a zero-emission building (ZEB)[26] to offer, when technically and economically feasible, a capacity to react to external signals and adapt its energy use, generation, or storage[27].

[26] From 1 January 2028, all new buildings owned by public bodies; from 1 January 2030, all new buildings.

[27] The terms ‘adapt its energy use’ in Article 11(1) and ‘adjust the energy consumption’ in Article 13(11c) should be considered to mean the same.

The rationale of this provision is explained in Recital 23 stating that ZEBs can contribute to demand-side flexibility, e.g. through demand management, electrical storage, thermal storage and distributed renewable generation to support a more reliable, sustainable and efficient energy system. The capacity to react to external signals concerns, in particular, the technical building systems falling within the scope of the recast EPBD but may further include other equipment in buildings, such as appliances.

Furthermore, Annex V to the recast EPBD detailing the template for energy performance certificates (EPCs) introduces in point d) among the mandatory indicators to be displayed in an EPC 'a yes/no indication whether the building has a capacity to react to external signals and adjust the energy consumption'.

Table 7 – Relevant timelines and obligations

<table>
<tr><th></th><th></th><th>Buildings undergoing major renovation as defined in Article 2(20)</th><th>Buildings undergoing deep renovation as defined in Article 2(22)</th><th>New buildings</th></tr>
<tr><td></td><td></td><td>Article 13(11)(c)</td><td>Article 13(11)(c)
Article 11(1)</td><td>Article 13(11)(c)
Article 11(1)</td></tr>
<tr><td rowspan="2">Residential</td><td>As of transposition date</td><td rowspan="2">Equipped with a capacity to react to external signals and adjust the energy consumption [a)]</td><td colspan="2">Equipped with a capacity to react to external signals and adjust the energy consumption [a)]</td></tr>
<tr><td>As of 2030
(as of 2028, for new buildings owned by public bodies)</td><td colspan="2">Equipped with a capacity to react to external signals and adapt its energy use, generation, or storage [b)]</td></tr>
<tr><td rowspan="2">Non-residential</td><td>As of transposition date</td><td rowspan="2">-</td><td colspan="2">-</td></tr>
<tr><td>As of 2030
(as of 2028, for new buildings owned by public bodies)</td><td colspan="2">Equipped with a capacity to react to external signals and adapt its energy use, generation, or storage [b)]</td></tr>
</table>

[a)] where technically, economically and functionally feasible;
[b)] where technically and economically feasible

A building subject to this obligation should generally be equipped with a **smart metering system**[28] and have the ability to react to signals from the grid. Systems or equipment controlling the building operation must have the capabilities to exchange valid data in both directions. This would also ensure that owners, tenants and managers have the ability to install, e.g., technical building systems and energy smart appliances[29] in individual building units or serving the whole building.

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[28] Article 2(23) of Directive (EU) 2019/944 defines 'smart metering system' as an electronic system that is capable of measuring electricity fed into the grid or electricity consumed from the grid, providing more information than a conventional meter, and that is capable of transmitting and receiving data for information, monitoring and control purposes, using a form of electronic communication.

[29] Energy smart appliances (ESA) are products that provide energy flexibility being capable of automatically (by means of machine-to-machine communication) optimising their consumption patterns (e.g. time or profile) in response to external stimuli, based on user permission. energy smart appliances can include 1) heating, ventilation, and air-conditioning appliances (HVAC), including heat pumps or 2) white goods: washing machines, tumble driers, washer-driers, dishwashers. For these products, certain common demand response services (i.e. 'use cases') are defined in the EU Code of Conduct on the interoperability of Energy Smart Appliances. Cf. Code of Conduct for Energy Smart Appliances | JRC SES (europa.eu).

Some examples of how a building can be equipped with the capacity to react to external signals and adjust the energy consumption, bringing it into line with Article 13(11)(c), are as follows:

– The building has **(digital) demand response and demand management capabilities, at building level or for main equipment** that, for example, at electricity grid peak demand hours, are able to minimize, turn off temporarily or postpone the supply to the main equipment of the building, potentially based on a pre-defined use case (e.g. turning off a heat pump or limiting its power if the temperature is within a certain pre-defined range, also considering an acceptable deviation, and if the thermal performance of the building envelope allows for it). This capability could also be used to delay the start, or temporarily stop, if possible, the supply to other energy smart appliances, e.g. the 'white goods'.

– The building has **demand management capabilities** that make it possible to maximise the use of cheaper electricity from the grid and its **storage in on-site batteries or in thermal storage systems**, to be used when electricity from the grid is more expensive[30], when building energy needs are higher and/or to reduce energy needs (e.g. through pre-heating the building).

– The building is equipped with recharging points for electric vehicles with the capability of **smart or bi-directional charging**[31].

Good thermal performance of the building envelope and building thermal mass could be exploited in conjunction with smart technical building systems.

More specific examples of interpretation are given in Table 8, based on the functionality levels which are part of the smart readiness indicator (SRI) methodology. In line with Article 15, the SRI will initially become mandatory for large non-residential buildings. When an SRI is issued in the future, Member States may link their SRI score in the functionality of adapting to signals from the grid in order to establish requirements in terms of capability to react for ZEBs. Alternatively, before the entry into force of the SRI scheme and for those buildings that will not be covered by it, the examples of smart-ready services[32] included in Table 8 can be a part of a checklist that the EPC assessor could use to verify whether or not the building assessed is able to offer the capacity to react to external signals and adapt its energy use, generation, or storage.

The examples in Table 8 should be seen in connection with sections 2.5 on BACS, 2.1 on on-site renewable energy generation and 2.2 on energy storage, relevant ecodesign requirements[33] and the following Articles and related guidance documents: Article 11(1) on ZEBs, Article 10 on solar energy in buildings, Article 14 on infrastructure for sustainable mobility, Article 20a of the revised Renewable Energy Directive[34].

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30 This works in the case of energy supply contracts based on dynamic pricing.

31 Cf. [Annex 9 to this Commission Notice on Infrastructure for sustainable mobility (Article 14)]; Guidance on Article 20a on sector integration of renewable electricity of Directive (EU) 2018/2001 on the promotion of energy from renewable sources, as amended by Directive (EU) 2023/2413, available at efcd200c-b9ae-4a9c-98ab-73b2fd281fcc_en.

32 As defined in Delegated Regulation (EU) 2020/2155 of 14 October 2020 supplementing Directive (EU) 2010/31/EU of the European Parliament and of the Council by establishing an optional common European Union scheme for rating the smart readiness of buildings.

33 Regulation (EU) 2024/1781 of the European Parliament and of the Council of 13 June 2024 establishing a framework for the setting of ecodesign requirements for sustainable products.

34 Directive (EU) 2018/2001, as amended by Directive (EU) 2023/2413.

Table 8 – Examples with interpretation of requirements for a capacity to react to external signals and adjust energy consumption, generation, and storage, based on SRI Functionality Levels

Domain	Smart-ready Service	Minimum required SRI Functionality Level (FL)
Monitoring and control	Single platform allowing for automated control and coordination between TBS + optimisation of energy flow based on occupancy, weather and grid signals	FL3: Single platform that allows automated control and coordination between TBS + optimisation of energy flow based on occupancy, weather and grid signals
Monitoring and control	Run time management of HVAC systems	FL3: Heating and cooling plant on/off control based on predictive control or grid signals
Heating	Flexibility and grid interaction	FL3: Heating system capable of flexible control via grid signals (e.g. demand-side management, DSM)
Heating	Thermal energy storage (TES) for building heating (excluding TABS)	FL3: Heat storage capable of flexible control through grid signals (e.g. DSM)
Cooling	Flexibility and grid interaction	FL3: Cooling system capable of flexible control through grid signals (e.g. DSM)
Cooling	Control of Thermal Energy Storage (TES) operation	FL3: Cold storage capable of flexible control through grid signals (e.g. DSM)
Domestic hot water (DHW)[35]	Control of DHW storage charging (with direct electric heating or integrated electric heat pump)	FL3: Control of DHW storage charging (with direct electric heating or integrated electric heat pump)
Domestic hot water	Control of DHW storage charging (using hot water generation)	FL3: DHW production system capable of automatic charging control based on external signals (e.g. from district heating grid)
Electricity	Optimizing self-consumption of locally generated electricity	FL2: Automated management of local electricity consumption based on current renewable energy availability
Electricity	Control of combined heat and power plant (CHP)	FL1: CHP runtime control influenced by the fluctuating availability of RES; overproduction will be fed into the grid
Electricity	Storage of (locally generated) electricity	FL2: On site storage of energy (e.g. electric battery or thermal storage) with controller based on grid signals
Electricity	Support of (micro)grid operation modes	FL1: Automated management of (building-level) electricity consumption based on grid signals
Electricity	EV charging grid balancing	FL2: 2-way controlled charging (e.g. including desired departure time and grid signals for optimization)

2.8. Automatic lighting controls

Article 13(12) requires Member States to lay down requirements to ensure that, where technically and economically feasible, large non-residential buildings are equipped with automatic lighting controls. The automatic lighting controls must be suitably zoned and capable of occupancy detection.

The non-residential buildings falling under this provision are the same buildings that fall under the provisions on BACS set out in Article 13(9). The limit dates are 31 December 2027 for an effective rated output over 290 kW, and 31 December 2029 for an effective rated output over 70 kW. Requirements are established for ‘built-in lighting’ systems[36]. Today, lighting systems are increasingly equipped with energy-efficient light sources. However, lighting still accounts for a significant portion of the electricity consumption in

35 Legionella risk should be considered if control of domestic hot water storage charging is applied.

36 The wording ‘built-in lighting’ emphasises that it covers only lighting equipment that is installed in order to implement lighting specifications defined at design time, and to fulfil related requirements. From Commission Recommendations on building modernisation (7 June 2019).

buildings, especially non-residential, due to its normally extended operation time, compared to usage time/working hours. Operation time can be reduced cost-effectively if automatic lighting control is installed, and the lighting system is regulated according to activity and occupancy patterns in the different areas of the building.

The design of the automatic lighting controls must ensure that sensors correctly detect occupancy in the different zones in order to reduce electricity consumption without compromising the area's functionality, safety and productivity. It is important that the type and number of sensors are chosen and placed according to the activity, the physical geometry of the area and the layout of furniture to ensure adequate sensor coverage of the entire area. The lighting control interface should be easily accessible so that delay times for the individual zones can easily be set and adjusted to the zone's functionality and daily occupancy patterns.

The lighting control can be set up as one or more stand-alone systems or as an integrated part of a centralised control system for the building. In small rooms with few light fixtures, it might be feasible to use light fixtures with integrated occupancy sensors to save on installation costs, but the consumption of such sensors (including stand-by consumption) needs to be carefully considered in relation to the actual savings they provide. In a centralised control system, the occupancy sensors, lighting fixtures, switches, etc., are connected via a network (bus or wireless) and can be monitored and programmed centrally. An advantage of a centralised lighting control system is that the occupancy sensors can also be used for the control of the building's indoor conditions. Since the occupancy detection data can be used in the control of the indoor climate as well, integration as part of the building management system will benefit and optimise the overall technical building system.

The consumption and working hours of the lighting system can be continuously monitored, and the data collected can be used for the operation and maintenance of the lighting system. The automatic lighting control must ensure that the required maintained illuminance levels are met. Implementing verification and commissioning procedures to ensure proper installation and operation is recommended.

In line with Article 13(12), the automatic lighting control should generally comply with the requirements shown in Table 9.

Table 9 – Example of requirements for automatic lighting control

Type of requirement	**Description**
Occupancy detection	The occupancy detection should be designed to fulfil the requirements of Table 5, ref. No 5.1, level 2 in EN ISO 52120-1.
Zoning	Several rooms can be grouped into zones or, alternatively, one large room can be divided into zones according to the occupancy pattern; the automatic lighting control is assigned to each zone. Zones should be defined to ensure that the operation time of the lighting system serving them corresponds as far as possible to their use, so that the operation time is limited as much as possible[37]. Zoning should generally be aligned with zoning in building automation control systems and other technical building systems, where relevant.
Daylight control (optional)	Further energy savings can be achieved by adding automatic daylight control in areas with sufficient daylight. In these types of areas, a daylight sensor could be installed or integrated in the occupancy sensors to monitor the daylight level and adjust the light accordingly.

[37] Typical zones in a non-residential building may include office spaces, meeting rooms, classrooms, corridors and circulation areas, stairs, general areas such as toilet, dressing and shower areas, cloakrooms, resting rooms, canteens and break areas, storerooms, etc.

Whichever lighting control system is used (on the level of a single fixture, one or more stand-alone systems, central systems, etc.), various of their components (sensors, control boxes, zone and main switchboards, etc.) usually draw additional power to operate. The corresponding annual consumption (during the time that the light sources are on as well as when they are off) must be properly taken into consideration when evaluating the overall system performance and the energetic and economic feasibility.

Establishing and operating the automatic lighting control can therefore be costly and must therefore be compared with the expected energy savings over the lifespan of the system. In calculating the technical and economic feasibility, the expected annual savings on electricity should be compared with the investment in the automatic lighting control system. The calculation should also take the expected annual electricity consumption, including stand-by consumption of the lighting control, into account. Calculations can be made in line with standards EN 15193-1 and EN 15193-2 and the expenditure factors[38], defined in those standards, can also be used.

In new non-residential buildings, automatic lighting control can generally be considered technically and economically feasible.

For existing non-residential buildings, if a system has an expenditure factor of 6 or above, it should be considered technically and economically feasible to implement automatic lighting control. If the expenditure factor is above 2, it is recommended that a calculation be made to determine whether it is technically and economically feasible.

When evaluating technical and economic feasibility, daylight control should always be considered as an option, as it typically has a positive cost-benefit ratio.

3. INDOOR ENVIRONMENTAL QUALITY

Article 2(66) introduces a definition of indoor environmental quality (IEQ), which means ‘the result of an assessment of the conditions inside a building that influence the health and well-being of its occupants, based upon parameters such as those relating to the: temperature, humidity, ventilation rate and presence of contaminants’. On that basis, in transposing the relevant provisions on IEQ, Member States will have to address the minimum scope for IEQ targeting the domains of **thermal comfort** and **indoor air quality (IAQ)**[39]. However, Member States could go further and include in their definition also other aspects affecting the health and well-being of occupants, such as lighting and acoustics.

The concept of **optimal indoor environmental quality** is introduced in the recast EPBD. This concept must be taken into account when setting minimum energy performance requirements, in order to avoid possible negative effects, such as inadequate ventilation (Article 5(1)), and it must be addressed in relation to new buildings (Article 7(6)). Member States must address, also in relation to buildings undergoing major renovation, the issues of indoor environmental quality (Article 8(3)). In this case ‘optimal’ is not mentioned, leaving scope for Member States to set higher ambition in the IEQ requirements for new buildings than for existing ones. These provisions concern IEQ in the design phase, resulting in the obligation to set requirements for IAQ and thermal comfort in national and regional regulations for new buildings and major renovations, if they have not yet been set. Renovation can also be the optimal trigger

38 Indicator of the energy efficiency of a given lighting system compared to a reference system.
39 Cf. Commission staff working document on supporting indoor air quality. SWD(2024) 147 final.

point to remove possible hazardous materials installed in buildings, including asbestos. This is an issue that has links with building occupants' health but is addressed separately in the recast EPBD (i.e. outside of the IEQ definition). It is also mentioned in Article 8(3) as an issue that must be addressed when a building undergoes major renovation[40].

Article 13 supports high indoor environmental standards during operation, for example calling for the setting of national requirements for the **implementation of adequate indoor environmental quality standards** in buildings in order to maintain a healthy indoor climate (Article 13(4)). These requirements may be referred to in the recommendations in EPCs on improving IEQ (Article 19(5)). If inadequate IEQ standards are found during inspections, their improvement should be recommended. If during the preparation of an EPC inadequate standards are observed, recommendations should be issued. In line with Article 8(3), major renovation will have to address IEQ issues and should strive to improve IEQ in order to achieve the relevant design levels.

Inadequate indoor temperatures, humidity and contaminant affect the wellbeing of occupants as well as their productivity (relevant e.g. in office building or in schools) and can cause health problems. High indoor temperatures can cause heat stress, and high humidity in cold rooms can cause condensation, which increases the risk of mould developing. High concentrations of pollutants[41] indoors are caused by indoor emission sources or outdoor pollution. High levels of carbon dioxide (CO_2), which can occur e.g. in airtight rooms with little ventilation or due to increased number of occupants, serves as an indicator of poor indoor air quality, impacting the health and well-being of occupants (e.g. due to the potentially increased risk of airborne pathogen transmission).

In addition, Article 13(5) requires that non-residential zero-emission buildings (ZEBs) be equipped with measuring and control devices for monitoring and regulating indoor air quality. These will apply, as of 2028, to new non-residential buildings owned by public bodies and, as of 2030, to all new non-residential buildings and to buildings renovated to ZEB-level. This is also the case for non-residential buildings undergoing major renovations, where technically and economically feasible. Member States may require the installation of such devices in residential buildings. Additionally, for non-residential buildings, Article 13(10)(d) introduces the new functionality of IEQ monitoring.

3.1. References for indoor environmental quality requirements

In order to set relevant IEQ requirements, Member States can refer to the parameters introduced in the EN 16798-1 standard, describing the occupant expectation towards IEQ through Categories I to IV. The European framework for sustainable buildings – Level(s) – can also supplement the standard[42]. Another example of IEQ indicators for buildings undergoing renovation is TAIL[43].

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40 Further information on possible target buildings and regions could be obtained, based on the construction year and asbestos ban date. Cf. Maduta, C., Kakoulaki, G., Zangheri, P. and Bavetta, M., Towards energy efficient and asbestos-free dwellings through deep energy renovation, Publications Office of the European Union, Luxembourg, 2022, doi:10.2760/00828; Kakoulaki, G., Maduta, C., Tsionis, G., Zangheri, P. and Bavetta, M., Identification of vulnerable EU regions considering asbestos presence and seismic risk, Publications Office of the European Union, Luxembourg, 2023, doi:10.2760/652785.

41 Chemicals and biological pollutants could be in gaseous, vapour, liquid, or solid states (the latter two emitting from products).

42 https://environment.ec.europa.eu/topics/circular-economy/levels_en.

43 https://aldren.eu/comfort-well-being/.

With regard to addressing the issues of (optimal) indoor environmental quality in new buildings and buildings undergoing major renovations, it is up to each Member State to establish the requirements to be addressed in the design phase, based inter alia on their respective cost-optimal calculations.

For new buildings, where ‘optimal’ IEQ is mentioned, it is recommended that Member States use the Category II specified in EN 16798-1 (medium occupant expectation), whose values ensure the comfort and well-being of occupants and limit adverse health effects.

For existing buildings undergoing major renovation, Member States may set less stringent requirements, based on technical, economic and functional feasibility considerations, which would justify less ambition requirements in renovated buildings (also in line with Article 8(3), simply referring to indoor environmental quality). The cost-optimal methodology enables these elements to be taken into account.

The values in Table 11, mostly based on Category II of EN 16798-1, can constitute a useful reference for Member States.

For the implementation of adequate indoor environmental quality standards in buildings to ensure a healthy indoor climate (i.e. for existing buildings in operation), in line with Article 13(4), Member States may refer to Category III, based on moderate occupant expectation. Requirements may be tightened according to special requirements linked to the use of specific buildings (e.g. occupants with special needs such as children, older people, people with disabilities, etc.).

Member States may set different requirements for residential and non-residential buildings and may also differentiate further for specific building types. Requirements may also concern air filtration or cleaning, where relevant (e.g. to address specific concerns).

Documentation requirements may also differ according to the building type, size or effective rated output of heating, ventilation and air-conditioning systems, and any combination thereof.

Examples of parameters for IEQ and extreme conditions are introduced in section 3.4.

It is important to underline that ensuring indoor air quality is a requirement linked with better living conditions and minimising both short-term and long-term health risks in the building. Depending on the situation it might be linked to an increase in energy consumption, but the alternative is an unhealthy indoor climate. Several solutions for ensuring indoor environmental quality are already cost-efficient (e.g., ventilation and heat recovery minimise thermal losses in winter to ensure adequate indoor air quality), even before considering the positive impacts linked to the improved health and well-being of building occupants.

3.2. Guidelines on measuring and control

Multiple origins of indoor air pollution[44] and distribution in a room makes full IAQ monitoring complicated. Direct measurement of all indoor air pollutants is impossible in practice as it generally requires sampling and subsequent chemical analysis. However,

[44] The six pollutants included in World Health Organisation Air Quality Guidelines (WHO AQG), available at https://www.who.int/publications/i/item/9789240034228, are particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulphur dioxide and carbon monoxide.

affordable sensors for routine IAQ monitoring are available for indoor temperature[45], CO_2, relative humidity (RH), and fine particulate matter ($PM_{2.5}$). These could generally be considered technically and economically feasible for new buildings and for major renovations. CO_2 concentration can be continuously monitored as a proxy for ventilation, which is an important factor for good IAQ. $PM_{2.5}$ monitoring can ensure, where relevant, that outdoor air for ventilation is clean or adequately filtered and that indoor sources, such as cooking (relevant e.g. in commercial kitchens), are properly extracted.

Article 13(5) sets requirements for buildings to be equipped with measuring and control devices for the monitoring and regulation of IAQ[46]. It is recommended that such devices measure carbon dioxide and, where relevant, particulate matter ($PM_{2.5}$). An example of these can be demand-controlled ventilation systems (in principle mechanical, hybrid or natural) which have both control and monitoring functions[47].

Member States may also decide to introduce IAQ monitoring and regulating capabilities for residential buildings and have complete flexibility with regard to the type of equipment to install (e.g. only measuring sensors), the parameters to monitor, the buildings to target (e.g. new and existing, based on dimension, age of construction, etc.). If the requirements of Article 13(5) are extended also to cover residential buildings, it could be useful, for example, to monitor CO_2 levels in living spaces, and relative humidity in 'wet rooms', such as toilets and bathrooms.

It is recommended to specify at which unit or zone level or in which space categories it is relevant to require measuring and control of IAQ, as not all spaces in a building require the same levels of IAQ and not all spaces need IAQ measuring and control. For non-residential buildings, appropriate zoning would typically be per room characterised by long-term occupation (but depending on its dimensions or occupancy). Typical zones in a non-residential building may include office spaces, meeting rooms, classrooms, resting rooms, canteen and break areas, reception areas, etc. In circulation areas such as stairs and corridors, it may be required to ensure adequate conditions, so they do not affect occupied zones negatively. Large rooms or multiple areas served by a single system (e.g. cellular offices served by the same system) may require division into smaller zones according to occupancy pattern. For residential buildings, appropriate zoning could, for example, include a ventilation system servicing each building unit. Common areas with higher occupancy would also be considered an appropriate zone.

Article 13(10)(d) introduces a requirement for indoor environmental quality monitoring for existing non-residential buildings by 29 May 2026. It is recommended that IEQ monitoring in non-residential buildings includes indoor temperature, relative humidity, carbon dioxide, and, where relevant, particulate matter ($PM_{2.5}$). It is common in existing buildings to use the air temperature measurement as a proxy for the number of people in the room and associated ventilation rates (even without CO_2 sensor). In such cases, where monitoring equipment is already present and it is able to interact with the ventilation system to ensure the identified ventilation rates, it may not be technically and economically feasible to upgrade with IEQ monitoring existing buildings in operation until a major renovation is performed for the building.

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[45] It is generally recommended that indoor temperature complements IAQ requirements.

[46] Note that other IEQ parameters such as temperature are not described.

[47] Demand-controlled operation of ventilation systems is not currently addressed in standards, but it is considered in ongoing revision of EN 16798-1:2019, and therefore specific attention in national regulation/guidelines is expected.

3.3. Relevant IEQ parameters and examples of optimal IEQ conditions

Table 10 (page 23) provides examples of relevant IEQ parameters when setting design requirements (e.g. in line with Articles 7(6) and 8(3)), conducting commissioning, performing monitoring (e.g. in line with Article 13(5)), and conducting inspections (in line with Article 23). Dedicated inspections can address specific issues in operation (e.g. short-term monitoring via sensors installed for certain periods to observe or address specific issues), but Table 10 refers to the inspections referred to in Article 23(1).

Table 11 (page 25) provides examples of optimal IEQ reference values and ranges in design outdoor conditions, that Member States may use for new buildings. The values in this table are mostly based on Category II of EN 16798, based on a medium expectation of occupants. Member States may use these values as reference when setting IEQ requirements for design and monitoring in typical outdoor conditions, i.e. periods without extreme events (such as heat waves) which are introduced at section 3.4.

In relation to thermal comfort, the seasons are defined according to EN 16798. The heating and cooling seasons are defined as the part of the year during which heating or cooling is needed, respectively, to keep the indoor temperature within specified levels. The transition season is defined as periods between the heating and cooling season. As season length differs substantially between Member States, the running mean temperature (Trm) is used to provide a uniform distinction between heating, cooling, and transition periods[48]. Buildings with mechanical cooling use active means to provide cooling of supply air. These include fan coil units, chilled ceilings and beams cooled surfaces. Opening of windows during night and daytime or mechanical supply of cold outdoor air is not regarded as mechanical cooling.

Table 11 provides thermal comfort recommended ranges with and without mechanical cooling. Recommended ranges in buildings without mechanical cooling can be used only if occupants have easy access to operable windows and do not have strict clothing policies. Otherwise, the recommended ranges ‘with mechanical cooling’ apply. For non-residential buildings without mechanical cooling, it is recommended that the airing system is automatically controlled and appropriate consideration is taken to draught risk.

3.4. Adaptation to climate change and extreme outdoor conditions

With the rise of global temperatures, measures to reduce indoor temperatures by design (e.g. adjusting the orientation of facades to reduce direct sunlight, using external shading, and using natural ventilation) will become increasingly important. These elements have a significant effect on indoor conditions and therefore on indoor environmental quality.

Articles 7(6) and 8(3) state that, in relation to new buildings and buildings undergoing major renovation, Member States must, among other issues, address that of adaptation to climate change and indoor environmental quality[49].

Member States may address the issues of adaptation to climate change by requiring use of outdoor climate conditions and their future changes according to best available climate

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[48] Natural ventilation rates can be calculated in accordance with EN 16798-7 or with dynamic thermal simulation tools.

[49] The LEVEL(s) framework addresses, under Macro-objective 5, the issues of adaptability and resilience to climate change. Specifically, occupier health and thermal comfort are addressed in Dodd N., Donatello S. & Cordella M., 2021. Level(s) indicator 5.1 Protection of occupier health and thermal comfort user manual: introductory briefing, instructions and guidance, available at https://susproc.jrc.ec.europa.eu/product-bureau/product-groups/412/documents.

projections (e.g. IPCC models for climate change, heating and cooling degree days – HDD and CDD – projections, etc.) when assessing energy performance of buildings and their ability to maintain indoor comfort requirements. A heat stress assessment performed with respect to extreme conditions may also be required as part of the design process. In situations with extreme outdoor conditions, where comfort requirements may be exceeded, Table 12 (page 27) provides additional indicators to evaluate passive survivability that may be considered in the design phase.

Advice for the selection, implementation, commissioning, and operation of passive and active cooling systems with regards to maintaining comfort and energy efficiency are provided by IEA EBC Annex 80[50] and REHVA[51], for example. Numerous passive cooling solutions such as solar shading, ventilative cooling (especially during nighttime) and the thermal mass of the building can be used to reduce and control the building cooling load, while active cooling solutions (e.g. radiant or air-based systems, fans) can be used for cooling when passive systems are insufficient to ensure comfort and health. Electrical fans may be combined with air-conditioning to reduce discomfort, if the upper limit of the operative temperature is exceeded.

In addition, for building locations with outdoor PM2.5, CO, NO_2 concentrations above the recommended WHO levels[52], filtration of outdoor air can be used to reduce pollutant transmission.

A definition of a heatwave can help Member States to address overheating risk in buildings in extreme conditions. Individual Member States may have their own definitions of a heatwave, though most do not have one. One possible definition is the meteorological heatwave definition[53], which has been adopted, e.g., by Spain. Other Member States, such as Austria, Belgium, France, and Germany, use similar definitions. An advanced definition is the physiological heatwave[54], where the heatwave is defined on the basis of heat stress for people under sunshade using heat stress or thermal discomfort metrics. An example for a heatwave definition, combining the meteorological and physiological heatwave definitions and heat index, is a period of three consecutive days with an outdoor running mean temperature above 30 °C, for which the outdoor heat index, combining air temperature and relative humidity, exceeds 32.2 °C.

Table 12 provides indicators for passive survivability against heat waves and extreme outdoor air pollution events. The thermal comfort indicators can be used during design and assessed during inspection, to optimize the building using passive measures (e.g. solar shading, cross-ventilation and filtration). However, if limits are not met during design and inspection, the building or space may not have the passive ability to withstand an extreme event. If a certain level of passive survivability is surpassed, e.g. danger for heatwaves and poor for air pollution, buildings may require active measures (e.g. active cooling, fans and air cleaning) against extreme outdoor conditions. Monitoring can indicate potential reductions in comfort during operation.

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50 International Energy Agency. Resilient Cooling of Buildings Technology Profiles Report (Annex 80). Energy in Buildings and Communities Technology Collaboration Programme, May 2024.

51 Resilient Cooling Design Guidelines, REHVA.

52 World Health Organization, (2021). WHO global air quality guidelines. Particulate matter ($PM_{2.5}$ and PM_{10}), ozone, nitrogen dioxide, sulphur dioxide and carbon monoxide. https://www.who.int/news-room/questions-and-answers/item/who-global-air-quality-guidelines.

53 International Energy Agency. Resilient Cooling of Buildings Key Performance Indicators Report (Annex 80). Energy in Buildings and Communities Technology Collaboration Programme, 2024.

54 Cf. footnote 3.

Table 10 – Examples of relevant parameters for indoor environmental quality

	Indicator	D	C	M([a])	I([a])	Description and references
Thermal Comfort	Operative temperature	X		(X)		Possible alternative to air temperature in the monitoring stage. Uniform temperature of an imaginary black enclosure in which an occupant would exchange the same amount of heat by radiation plus convection as in the actual non-uniform environment. Ranges are provided as a function of building type, season, and dependent on the cooling system (with or without) by the predicted mean vote (PMV) and adaptive comfort models. (EN ISO 7730, EN ISO 7726).
	Air temperature	X	X	X	X	Required in the assessment of other indicators. Air temperature can be used in long-term measurements if corrected for large hot or cold surfaces to determine the operative temperature. Indoor temperatures above 18 °C during the heating season will have significant health benefits. (EN ISO 7730, EN ISO 7726).
	Air velocity	X				It influences general thermal comfort and local thermal discomfort due to draught. Comfortable air velocity generally below 0.2 m/s. In buildings with mechanical cooling artificially increased air velocity under personal control (e.g. fans) can be used to compensate for increased air temperature under summer comfort conditions (operative temperature >25 °C). (EN 16798-1, EN ISO 7726). A comfort area for increased air velocity (<0.8 m/s) without personal control for temperatures above 25.5 °C is defined in ASHRAE 55([b]).
	Relative humidity	X		X		Composition of the air in terms of water vapour in relation to the maximum amount it can hold at a given temperature. It also influences air quality. Very low RH (<20%) can cause irritation of eyes, nose, and throat and increase sensitiveness to infections. Persistent dampness, condensation, and excess moisture (RH > 70%) can cause building damage and microbial growth. It is recommended to limit absolute humidity to 12 g/kg (EN 16798-1, EN ISO 7726).
Indoor air quality	Ventilation rate	X	X		X	To be addressed as part of system inspections pursuant to Article 23. Supply or removed air from space for the purpose of controlling air contaminant levels, humidity, perceived air quality or temperature within the space (EN 16798-1). If critical sources for health are identified, it must be checked that they remain below the health threshold values. Minimum 4 l/s per person is prescribed during occupied hours; 0.15 l/s per m^2 during unoccupied hours. Typically measured from supply and extract terminals.
	Carbon dioxide	X		X		Proxy for ventilation effectiveness in spaces where people are the main source of pollution. Indoor CO_2 concentration should be adjusted according to the outdoor CO_2 concentration. It should not exceed 1350 ppm above outdoor concentration. Typically measured in extract terminals. (EN 16798).
	$PM_{2.5}$	X([c])		X([d])		Particulate matter where particles have an aerodynamic diameter equal to or less than 2.5 µm. It can be generated indoors from combustion appliances or outdoors and has harmful effects on human health. Air filtration is required to control particulate matter from outdoor sources. Indoor particulate matter is controlled by reducing emission sources (e.g. electric instead of gas stoves) and adequate ventilation. Preferably below an annual mean of 10 µg/m^3. Incremental steps are proposed for $PM_{2.5}$ limits (35, 25, 15, 10, 5 µg/m^3) (EN 16798-1, WHO).
	Formaldehyde ([e])	X([f])				Major sources are building materials and consumer products (e.g. furniture, cleaning). It can cause sensory irritation and respiratory health risks. Use of labelled low-emitting building and finishing materials and products can reduce exposure Measured near potential sources such as furniture and flooring (EN 16798-1, WHO).
	Nitrogen dioxide	X([f])				Originating from combustion. Indoor contamination may be possible from attached garages and indoor combustion sources, in which cases sensors and/or measuring requirements would be recommended. It poses health risks related to the respiratory system. Measured near potential sources such as kitchens and garages. A 1 h mean limit of 200 µg/m^3 and annual mean of 40 µg/m^3 are proposed (EN 16798-1, WHO).
	Radon	X([f])				Human carcinogen, originating from decay of radium in soil and rocks. Reference level of 100 Bq/m^3 (or 300 Bq/m^3 based on prevailing country-specific conditions). Measured in the lowest occupied level of the building (EN 16798-1, WHO).
	Carbon monoxide	X([f])				Originating from combustion. Acute exposure-related reduction of exercise tolerance and increase in symptoms of ischaemic heart disease. A 24-hour mean limit of 4 mg/m^3 is proposed with an interim target of 7 mg/m^3 (EN 16798-1, WHO).

	Indicator	D	C	M(a)	I(a)	Description and references
Lighting (g)	Daylight provision	X				Daylight should be a significant source of illumination as it is favoured by building occupants, contributing to physiological well-being. Daylight can reduce energy use for electrical lighting. Shading devices should be provided to reduce visual and thermal discomfort in spaces where activities comparable to reading, writing, or using display devices are carried out. Daylight can be quantified using spatial daylight autonomy (sDA), representing the level of illuminance achieved from daylight across a fraction of a reference plane for a fraction of daylight hours within a space. An annual sunlight exposure (ASE) (h), i.e. percentage of regularly occupied floor area with illuminance higher than 1000 lx, lower than 10% is desired to prevent glare and overheating (EN 17037).
	Glare probability (DGP)	X				Used to assess protection against glare in rooms where activities such as reading, writing, or screen time take place. Glare represents discomfort or a reduction in the ability to see details or objects, caused by an unsuitable distribution or range of luminance, or by extreme contrasts. It can be quantified using daylight glare probability (DGP_e) in rooms with vertical or inclined daylight openings and is evaluated across the regularly occupied floor area. If DGP_e exceeds 0.45 in more than 5% of the occupation time, glare protection should be installed or other interventions (i.e. change in orientation, field of view) should be implemented (EN 17037).
	Illuminance	X	X			Luminous flux incident on a surface per unit area. The areas where an adequate illuminance level should be ensured are task and activity areas, the surrounding and background areas, walls, ceiling, and objects in the space. Required values are dependent on type of task or activity area. For writing, typing, reading and data processing, an illuminance of 500 lx is required (EN 12464–1).
Acoustics (g)	Sound pressure	X	X			Equivalent continuous sound pressure level from mechanical equipment. Sound pressure can be normalised using the reverberation time and standardised to a reference reverberation time. It does not include outdoor noise. Investigated at representative points in the occupied zone (EN 16798, EN 12354-5, EN 16032, EN 10052).
	Sound reverberation time	X	X			Duration required for the space-averaged sound energy density in an enclosure to decrease by 60 dB after the source emission has stopped. It takes into account the sound absorption of the room. Reverberation times over 1 s produce loss in speech discrimination and make speech perception more difficult and straining (i) (EN 12354-5, EN 16032, EN 10052).

D = Design, C = Commissioning, M = Monitoring, I = Inspection

a) In assessing indoor values, consideration of outdoor values for air temperature, humidity, CO_2 and $PM_{2.5}$ as well as of other outdoor pollutant levels such as CO, NO_2 is necessary. Further indicators may be monitored or inspected in order to validate IEQ management performance.

b) Khovalyg, D., et al., 2020. Critical review of standards for indoor thermal environment and air quality. Energy and Buildings, 213, p.109819.

c) For non-residential buildings filters are specified in EN 16798-3.

d) PM2.5 continuous monitoring may only be needed if the outdoor PM2.5 pollution levels are above those set in EN 16798-1 guidelines. If above, particulate matter should be controlled with filters in the ventilation system and infiltration through building envelope should be checked. Indoor pollution levels may also need to be considered (e.g., for residential buildings, in case of local space heaters with indoor emissions).

e) Volatile Organic Compounds (VOC) refer to a variety of chemicals that can originate in a building, e.g. from building materials and furniture. They are not included here as an indicator, as newer requirements are more focused on specific indicators such as formaldehyde, benzene, etc.

f) Where relevant, based on national, regional, or local health protection priorities or on specific identified issues which should be considered in the design and operation of the building. For example, nitrogen dioxide and carbon monoxide would be relevant when designing indoor parking areas, or if the building is located in polluted areas or in case of indoor pollution sources. Where relevant, e.g. in the case of specific issues such as indoor problems caused by combustion devices, measurement could be needed to address these specific pollutants. A map of the indoor Radon concentration is provided by the Joint Research Centre of the European Commission (http://data.europa.eu/89h/jrc-eanr-02_indoor-radon-concentration).

g) Optional element of IEQ definition: it is recommended that it is at least addressed in the design of new buildings.

h) Illuminating engineering society, IES LM-83-12, 2012.

i) World Health Organisation (WHO). Guidelines for community noise, 1999.

Table 11 – Example of optimal indoor environment limits for new buildings based on a medium expectation of occupants

	Parameter	**Examples of optimal ranges**						**Deviation during occupancy for design outdoor conditions**
Thermal comfort	-	Heating season ([a]) (T_{rm} ([b]) ≤ 10 °C)		Cooling season ([a]) (15 °C $\leq T_{rm} \leq$ 30 °C)		Transition season ([a]) (10 °C $< T_{rm} <$ 15 °C)		
		With mechanical cooling ([c])	Without mechanical cooling	With mechanical cooling	Without mechanical cooling	With mechanical cooling	Without mechanical cooling	
	Operative temperature (T_{op})([d])	$T_{op} \geq 20$ °C	$T_{op} \geq 20$ °C	$T_{op} \leq 26$ °C	$T_{op} \leq 0.33 \times T_{rm} + 21.8$ °C	$20 \leq T_{op} \leq 26$ °C	$20 \leq T_{op} \leq 0.33 \times T_{rm} + 21.8$ °C	Yearly: 6% and 3% Monthly: 25% and 12% Weekly: 50% and 20% Outside Category II and III, respectively (EN 16798)
	Draught rate ([e]) (Air velocity)	DR 20% (ISO 7730)	DR 20% (ISO 7730)	DR 20% (ISO 7730)	Openable window ([f]) $T_o \geq 10$ °C	DR 20% (ISO 7730)	Openable window ([f]) $T_o \geq 10$ °C	n.d.([g])
	Relative humidity	25 - 60% ([h])						Weekly: 50% and 20% Outside Category II and III, respectively (EN 16798)
Air quality	Ventilation rate (q) ([i])	Supply air flow rate, $q = q_p \cdot n + q_b \cdot A$, where A is the area of the space, q_p is 7 l/s per person for *non-adapted* and 2.5 l/s per person for *adapted*, and q_b is 0.7 l/s per m^2 (non-residential) ([k]) and 0.15 l/s per m^2 (residential) ([i]). Extract air flow rates: 15 l/s for bathroom/toilet, 10 l/s for kitchen, and 10 l/s for other wet room. A 75% odour extraction from cooking hoods is considered as optimum for boost air flow rate from kitchen hoods (EN 13141-3)						5%
	Carbon dioxide	$\Delta CO_2 \leq 800$ ppm above outdoor CO_2 concentration, if people are the main source of pollution ([j]) (EN 16798)						5% ([l])
	$PM_{2.5}$ ([m])	Below an annual mean of 10 µg/m^3 and a 24-hour mean of 25 µg/m^3						Dependent on outdoor concentration and human behaviour
	Formaldehyde ([m])	30-minute mean: 100 µg/m^3						
	Nitrogen dioxide ([m])	1 h mean: 200 µg/m^3; Annual mean: 40 µg/m^3						
	Radon ([m])	Reference level of 100 Bq/m^3 (or 300 Bq/m^3 depending on prevailing country-specific conditions)						
	Carbon monoxide ([m])	15-minute mean: 100 mg/m^3; 1 h mean: 35 mg/m^3; 8 h mean: 10 mg/m^3; 24 h mean: 4 mg/m^3						

	Parameter	Examples of optimal ranges	Deviation during occupancy for design outdoor conditions
Lighting	Daylight provision	sDA of 300 (100) lx over 50% (95%) of the reference plane within the space (vertical and inclined daylight openings) for 50% of daylight hours. sDA of 300 lx over 95% of the space fraction (horizontal daylight openings) for 50% of daylight hours.	n.d.
	Glare probability	Daylight glare probability (DGP_e) should not exceed 0.40 in more than 5% of the occupation time of the relevant space	n.d.
	Illuminance	100 to 750 lx required depending on type of task and activity area (e.g. 100 lx in corridor, 500 lx for writing, typing, reading, data processing, and 750 lx for technical drawing). Recommended to increase maintained illuminance based on context modifiers (e.g. low daylight provision, productivity, costly errors, impaired visual capacity) (o)	n.d.
Acoustics	Sound pressure	A-weighted equivalent sound pressure level, $L_{A,eq,nT}$ [db(A)], normalised using reverberation time and standardised to the reference reverberation time. Non-residential (p): Small office ≤35 db(A), Landscape office ≤ 40 db(A), conference room 35 db(A) Residential: Living room ≤ 35 db(A), Bedroom ≤ 30 db(A)	5-10 dB(A)
	Sound reverberation time	0.6 - 1 s (q)	n.d.

a) Heating season, cooling season, transition periods, and operative temperature limits may be defined according to national regulations.

b) Running mean temperature (T_{rm}) can be calculated as $T_{rm} = (T_{ed-1} + 0.8 \cdot T_{ed-2} + 0.6 \cdot T_{ed-3} + 0.5 \cdot T_{ed-4} + 0.4 \cdot T_{ed-5} + 0.3 \cdot T_{ed-6} + 0.2 \cdot T_{ed-7})/3.8$, where $T_{ed\text{-}i}$ is the daily mean outdoor air temperature for the previous i^{th} day. (EN 16798-1, 7-day formula).

c) Cooling of the indoor environment by mechanical means used to provide cooling of supply air. Includes fan coil units, chilled ceilings and beams cooled surfaces. Opening of windows during night and daytime or mechanical supply of cold outdoor air is not regarded as mechanical cooling.

d) Temperature ranges for heating and cooling and transition periods should be used for hourly calculation of cooling and heating energy in building energy performance calculations. Occupant schedule examples can be found in EN 16798 by building type.

e) Draught risk (DR). Mostly due to high air velocities from opening of windows, ventilation and air-conditioning systems, but also due to cold vertical surfaces. Usually this is calculated based on a turbulence intensity (Tu) of 40%.

f) Infiltration or small valves in envelope may be required if outdoor temperature (T_o) is below 10 °C for air quality purposes.

g) Deviation allowed during occupancy not defined (n.d.). Limits can be imposed for design, commissioning, and inspection but not for monitoring.

h) Humidification or dehumidification is usually only needed in special buildings like museums, certain healthcare spaces, process control, paper industry, etc. It is recommended that humidity recovery be used in very cold climates.

i) As occupant density in residential buildings may vary between Member States, a total air flow rate of 0.42 l/s per m^2 (including infiltration) can be used as reference. Use of air flow rates for *adapted* persons is only applicable to residential buildings.

j) Relative CO_2 concentration, i.e. difference between outdoors and maximum indoors concentrations. For an outdoor CO_2 concentration of 450 ppm, the limit becomes 1250 ppm. CO_2 limit may vary depending on the required air flow rate for the perceived air quality.

k) Ventilation rate for diluting building emissions may be adjusted according to the pollution level of the building according to EN 16798-1.

l) Value proposed in this Guidance.

m) Only design and inspection. During design, pollution levels should be estimated based on building site and function. During inspection, measures can be recommended (e.g. filtration, air cleaning) if a specific contaminant is registered.

o) Illuminance can be increased according to the scale '5-7.5-10-15-20-30-50-75-100-150-200-300-500-750-1000-1500-2000-3000-5000-7500-10000' (EN 12464-1).

p) Target values are dependent on additional parameters, for example tonal patterns. Noise criteria for other non-residential building and space types can be found in EN16798.

q) Dependent on room size and target group (e.g. lower reverberation time desirable for speech intelligibility for older people).

Table 12 – Example of extreme outdoor conditions for residential and non-residential buildings

Domain	Parameter	Description	Purpose	Range
Thermal comfort	Standard effective temperature (SET)	Equivalent dry bulb air temperature of an isothermal environment at 50 % relative humidity, and still air, in which an imaginary subject, while wearing clothing standardised for activity concerned, would experience the same heat stress (skin temperature) and thermoregulatory strain (skin wetness) as in the actual test environment (ASHRAE 55). SET of >30 °C results in uncomfortable conditions for occupants ([a]). It can be used as an indicator for passive survivability.	Passive survivability during heatwaves ([b])	Residential: ≤ 5 °C SET-days (120 °C SET-hours) above 30 °C SET. Non-residential: ≤ 10 °C SET-days (240 °C SET-hours) above 30 °C SET. ([c])
	Percentage of occupied hours within a heat index range (PHHI)	The heat index (HI) represents the temperature expectation of the human body when both air temperature and relative humidity are taken into account. Can be normalised by the occupied hours and be used as an indicator for passive survivability. Heat exhaustion likely for a HI > 39.4 °C.		Caution: 26.7 °C ≤ HI ≤ 32.2 °C (fatigue possible with prolonged exposure and/or physical activity) Extreme caution: 32.2 °C < HI ≤ 39.4 °C (heat stroke, heat cramps, or heat exhaustion possible with prolonged exposure and/or physical activity) Danger: 39.4 °C < HI ≤ 51.1 °C (heat cramps or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity) Extreme danger: 51.7 °C ≤ HI (heat stroke highly likely) ([d])
Outdoor Air quality	Air quality index ([e])	European air quality index. Based on relative risks associated with short-term exposure to PM2.5, O_3, NO_2 as defined by WHO, relationship between PM10 and PM2.5 (1:2) and limit values for SO_2 set under the EU Air Quality Directive.	Passive survivability during periods with increased outdoor air pollution ([f])	Good: 0 < PM2.5 < 10 µm/m³. Air quality is good. Enjoy usual activity. Fair: 10 < PM2.5 < 20 µm/m³. Enjoy usual outdoor activity. Moderate: 20 < PM2.5 < 25 µm/m³. Enjoy usual outdoor activity. Poor: 25 < PM2.5 < 50 µm/m³. Reduce intense activity if symptoms such as sore eyes, cough, or sore throat arise. Very poor: 50 < PM2.5 < 75 µm/m³. Reduce intense activity if symptoms such as sore eyes, cough, or sore throat arise. Extremely poor: 75 < PM2.5 < 800 µm/m³. Reduce intense activity if symptoms such as sore eyes, cough, or sore throat arise.

a) Gagge, A., et al., An effective temperature scale based on a simple model of human physiological regulatory response, 1970.
b) Resilience to heat waves can be assessed during design using extreme future weather data.
c) Source: U.S. Green Building Council. *LEED BD+C: Passive Survivability and Back-up Power During Disruptions*. Standard effective temperature (SET) hours are calculated as the sum of the difference between the zone calculated SET and 30 °C, only if the zone SET is greater than 30 °C, for all hours of the extreme hot week.
d) US National Oceanic and Atmospheric Administration.
e) Outdoor air concentration, Air quality index, https://ecmwf-projects.github.io/copernicus-training-cams/proc-aq-index.html#about.
f) During short-term events with an air quality index of poor and above, windows should be closed, mechanical ventilation reduced, and air cleaning (if available) operated.

4. INSPECTIONS

4.1. Introduction and clarification of the scope

The provisions on inspections are grouped under Article 23 in the recast EPBD, whereas they were addressed in two separate articles in the 2018 amended EPBD: Article 14 dealt with the inspections of heating systems and systems for combined space heating and ventilation; Article 15 dealt with the inspections of air-conditioning systems and systems for combined air-conditioning and ventilation.

Article 23(1) expands the scope of systems to be inspected compared to the 2018 amended EPBD. In particular, it requires inspections of systems with an effective rated output over 70 kW but specifies that it is calculated on the basis of the sum of the rated output of the heat generators and cooling generators.

Before, to establish whether a system was over or under the 70 kW threshold, the respective heating and cooling effective rated outputs were treated separately. For example, a combined heating and air-conditioning system with a heating rated output of 50 kW and a cooling rated output of 30 kW would have been below the threshold of 70 kW for both heating and air-conditioning inspections.

In the recast EPBD, the sum of the rated output of the heat and cooling generators taken into account for the purpose of the 70 kW threshold. In the above example, it amounts to 80 kW (50+30), meaning that the system qualifies for the regular inspections under the recast EPBD. If a heat pump is used as the heating and cooling generator in a system that provides both heating and air-conditioning, then the rated outputs for heating and cooling should be added. When a heat pump has the possibility to provide both heating and cooling but only provides one of the two services, only the relevant power output effectively used for heating or cooling should be considered in the sum needed to identify the inspection threshold.

The heating system of a multi-apartment building, with four building units served by four autonomous heat generators each with a power output of 20 kW and with no air-conditioning system, would not qualify for the inspections under Article 23, as in this case the power of the heat generators would not need to be added. In the case of a centralised system (e.g. combining a heat pump and a boiler) serving the heating system of the units of a multi-apartment building, the power output of all generators serving the building must be added.

In practice, combined heating and air-conditioning systems may well exist. This is recognized in the recast EPBD, so there is now scope to treat them together for the purpose of their respective inspection requirements, reporting obligations, periodicity, certification of inspectors, etc. The new provisions support an integrated inspection scheme in these cases, ideally performed by the same inspector in order to avoid double inspections. However, Member States have flexibility and may still opt for separate inspections for the heating and cooling systems.

It is common for a ventilation system to be connected to both the heating and the air-conditioning system. In Member States that have decided to implement inspections for both heating and air-conditioning systems, the ventilation could be subject to a double inspection (once with the heating system and once more with the air-conditioning system). This scenario of double inspections should be avoided in order to limit the burden on buildings and users. The inspection of the ventilation system should only happen once. In the same way, the inspection of stand-alone ventilation systems (now in scope) should as far as possible be integrated with the inspection of heating and/or air-conditioning systems.

Reaching the threshold of 70 kW triggers the inspection of the whole system. This also means that, for example, when that threshold is reached, ventilation systems independent from the heating system, i.e. where the ventilation system is independent from the heating both in terms of heat source and operation, now fall within the scope of the inspections according to Article 23. This is the case, for example, of extract-only systems and supply and extract systems (without pre-heating). Article 23(4), in particular, mentions that where a ventilation system is installed, its sizing and its capabilities to optimise its performance under typical or average operating conditions relevant for the specific and current use of the building must also be assessed[55].

Generally, if the systems are serving the building, they must be included. However, it is possible to exclude from the inspections very small stand-alone systems that have no significant impact on the building's energy performance, such as a stand-alone extraction fan only serving one room or individual bathroom extraction fans or kitchen hoods not connected to a central system.

Article 24 sets out the requirements for the reports on the inspection of heating systems, ventilation systems and air-conditioning systems, to be handed over to the owner or tenant of the building or building unit. Member States should evaluate whether the reporting methodology and templates need to be updated, based on the requirements introduced in Article 23. In addition to these, the inspection report must also indicate any safety issue (which may be, e.g., related to fire or electrical hazards) detected during the inspection. The inspection report must be uploaded into the national database for the energy performance of buildings in line with Article 22. This would also ensure adequate tracking of the inspections (e.g. in terms of number of inspections, type of systems, size, etc.) and could feed into the summarised analyses of the inspection schemes and their results that Member States are required to include as an annex to the national building renovation plan (NBRP) according to Article 23(9). The number of inspections, the type of systems inspected, the expected saving in terms of energy and greenhouse gas (GHG) emissions resulting from the recommended actions, and other relevant information may be included in the summarised analysis. Member States that have opted for the alternative measures (section 4.5) must instead annex to the NBRP a summarised analysis and the results of the alternative measures, which could include, e.g., the expected saving in terms of energy and GHG emissions.

4.2. Setting inspection frequencies

Article 23(3) introduces minimum frequencies of inspections: systems with generators of an effective rated output of more than 70 kW (calculated as explained above) must be inspected at least every five years; systems with generators of an effective rated output of more than 290 kW shall be inspected at least every three years. The new frequency should be counted from the date of the last inspection.

Member States are free to set different inspection frequencies, while respecting the above-mentioned minimum intervals, depending on the type and effective rated output of the system. For example, an inspection frequency shorter than five years could be dedicated to heating systems that involve a high risk of carbon monoxide intoxication (mentioned in Recital 73), depending on the type of heat generator, the type of fuel (coal, oil, biomass, gas) or the location of the heat generator (such as in living spaces or in spaces not properly ventilated). It is up to Member States to establish the inspection schemes: besides what is identified in Article 23(4), last paragraph, some elements that might not need to be reassessed in each

[55] It is common for a ventilation system to be connected to both the heating and the air-conditioning system, specifically in non-residential buildings. The new provisions support an integrated inspection scheme in these cases, ideally performed by the same inspector to avoid double inspections.

inspection may be identified in this process, if justified by the presence of measuring devices providing the relevant information.

4.3. New inspection requirements

Article 23(4) introduces a series of new requirements for the periodical inspections of technical building systems. This means that, where needed, the existing inspection schemes need to be revised to include these new requirements.

The inspection scheme still includes an assessment of efficiency and sizing of the heat and cooling generator or generators and of the main components thereof. In this context, Article 23(4) adds a reference to the use of available energy-saving technologies as well as the requirement to also consider the capabilities of the system to optimise its performance under changing conditions, due to use variation.

Among the elements that need, where appropriate, to be included in the inspections are components of ventilation systems, air and water distribution systems, hydronic balancing of systems (relevant for hydronic heating and cooling systems, see sub-section 2.3.2) and control systems. Member States may include additional building systems as indicated in Annex I of the recast EPBD. If the heating generator also serves the DHW system, it is recommended that the latter also be included in the assessment. If an energy storage system is part of a heating or cooling system, they should be assessed jointly.

In addition, where a ventilation system is installed, its sizing and its capabilities to optimise its performance under typical or average operating conditions relevant for the specific and current use of the building must also be assessed. The inspection should also be able to identify issues in terms of inadequate IEQ, e.g. by assessing the ventilation rate ensured by the equipment, and to provide recommendations.

The inspection schemes should include new elements for ventilation systems, which can be as detailed in EN 16798-17[56] and summarized in Table 13.

Table 13 – New elements for inspection of ventilation systems

System category	Examples of what inspections may cover	Examples of components that may be included
Mechanical exhaust and/or supply systems	Requirements in EN 16798-17 including components indicated in chapter 6.4.2 Mechanical exhaust and/or supply systems.	Ductwork, air handling units or fan, air filters, heat exchangers and heat recovery, externally or internally mounted air transfer device/supply or exhaust in rooms, air intakes and air exhaust openings of the system, controls and settings, recirculated air.
Natural ventilation	Requirements in EN 16798-17 including components indicated in chapter 6.4.3 Natural ventilation. It is advised also to include controls of natural ventilation in the inspection.	Inlets, exhausts, air volumes and air velocity, motors, control, sensors.
Hybrid ventilation	Requirements in EN 16798-17 including components indicated in chapter 6.4.4 Hybrid ventilation; above categories in 6.4.2 and 6.4.3.	A combination of the examples mentioned above in this table.

To address, where necessary, the new requirements of the recast EPBD, Member States are advised to take account of the standards EN15378-1 and 2 for the inspection of heating and DHW systems; EN16798-17 and 18 for the inspection of ventilation and air-conditioning systems. These standards detail the methods, measurements, and content of inspections.

56 It should be noted that EN 16798-17 was produced to meet the requirements of the previous directive. It also covers air conditioning system(s) without mechanical ventilation and air conditioning system(s) with mechanical ventilation. Therefore some, but not all, ventilation systems were covered previously.

The inspection must, where relevant, assess the feasibility of the system to operate under different and more efficient temperature settings, such as low temperature for water-based heating systems, including via the design of thermal power output and temperature and flow requirements, while ensuring the safe operation of the system. The guidance on energy performance certificates and independent control systems in [Annex 3 to this Commission Notice on Energy performance certificates (Articles 19-21, Annexes V) and independent control systems (Annex VI)] provides, at section 4.4, information on low-temperature heating in hydronic systems, together with the recommended assessment steps needed to determine the potential of heating systems to achieve energy-efficient performance within residential buildings (including a calculation tool for assessing the low-temperature feasibility in existing dwellings).

The inspection shall, where relevant, include a basic assessment of the feasibility to reduce on-site use of fossil fuels[57], for example by integrating renewable energy, changing energy source, or replacing or adjusting the existing systems. For example, if the building is located in a district heating area (e.g. based on renewables and waste heat), the basic assessment could result in the recommendation to connect the inspected building to the district heating system (in the context of the report introduced in Article 24). Alternatively, solutions relying on renewable energy could be assessed: for example, installing heat pumps, bio-energy boilers, solar thermal systems, and combinations thereof, or replacing the fossil fuels burnt in the existing equipment with renewable fuels such as biofuels, bioliquids, biomass fuels and renewable fuels of non-biological origin.

4.4. Exemptions from inspections

The exemptions from regular inspections for non-residential buildings equipped with BACS in line with Article 13(10) and for residential buildings with the monitoring and control functionalities detailed in Article 13(11) still apply and must be granted by Member States. As of the transposition date (29 May 2026), for a building to be exempted as provided for in Article 13(10), the additional functionality of IEQ monitoring needs to be ensured. The exemption was introduced in the 2018 amended EPBD to support the deployment of these technologies and functionalities and to release those buildings where they are installed from the periodical costs of inspections. If necessary, leaner dedicated maintenance schemes[58] could help verify the proper installation and functioning of monitoring and control systems and functionalities.

The exemptions laid down in Article 23(5), previously covered by Article 14(2) and 15(2) of the 2018 amended EPBD, continue to apply, provided that the overall impact is equivalent. Those exemptions cover technical building systems:

– that are explicitly covered by an agreed energy performance criterion or a contractual arrangement specifying an agreed level of energy efficiency improvement, such as energy performance contracting, or

– that are operated by a utility or network operator and therefore subject to performance monitoring measures on the system side[59].

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[57] See the guidance on what qualifies as a fossil fuel boiler, as referred to in Article 13(8) ([Annex 11 to this Commission Notice on Fossil fuel boilers]).

[58] For example, France has developed a dedicated periodical inspection scheme for BACS introduced by the aforementioned 'Décret n° 2023-259 du 7 avril 2023'. A subsequent Decree of the Ministers responsible for energy and construction further details the scheme in terms of frequency, technical specifications and methods for the inspection, including the content of the inspection report.

[59] There can be many configurations of these systems: e.g. in the case of a district heating (DH) system serving a building, if the DH operator owns a meter with sufficient capabilities (e.g. measuring

An energy performance contract as defined in Article 2(33) of the Directive (EU) 2023/1791 (recast Energy Efficiency Directive, EED) fulfils these requirements.

The recast EPBD does not indicate how the equivalence of such exemptions should be determined. One possibility could be to ascertain whether the technical building system already undergoes a regular inspection under the contract or agreement, and that it is similar in nature to inspections under Article 23(1). If the technical building system undergoes such an inspection, an exemption from the requirements set out in Article 23(1) could be granted. It is safe to assume that most energy performance contracts or agreements already include some level of regular inspection. However, the full extent of those inspections may not be completely in line with the requirements of the recast EPBD (also given the expansion of the scope and the requirements for inspections).

Among other measures, the recast EED also introduces provisions on energy services. Article 28 requires Member States to ensure that certification or equivalent qualification schemes, including, where necessary, suitable training programmes, are available for energy efficiency-related professions including providers of energy services and that providers of certification or equivalent qualification schemes, including, where necessary, suitable training programmes are accredited in accordance with Regulation (EC) No 765/2008 of the European Parliament and of the Council or approved in line with converging national legislation or standards. Article 29 of the recast EED requires Member States to support the public sector by providing model contracts for energy performance contracting. Under Article 28 of the EED, these model contracts must include at least the items which are listed in Annex XV. For the purposes of the equivalence requirements indicated in Article 23(5) of the recast EPBD, energy performance contracts signed by an accredited/certified company which adequately follows a model such as the one specified in Annex XV to the recast EED could be considered to have an equivalent impact to that of inspections. Member States would therefore need to have a publicly available list of accredited or certified companies together with publicly available model contracts.

For the purposes of record keeping, the status of a system exempted from inspections due to an energy performance contract should be recorded in the inspection database. This should include a reference to the duration of the contract and, thus, the period for which the exemption applies.

4.5. Alternative measures

Article 23(6), replacing Articles 14(3) and 15(3) of the 2018 amended EPBD, confirms that Member States may opt to take alternative measures[60] to the inspections of technical building systems such as financial support or the provision of advice to users concerning the replacement of generators, other modifications to the system and alternative solutions to assess the performance, efficiency and appropriate size of those systems. In such cases,

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temperature difference between supply temperature and return temperature from the building), this can be considered as fulfilling performance monitoring measures on the system side. This means that there is no obligation for an inspection, but the effect must be equivalent: the DH operator monitors the system performance and can detect performance issues and make the necessary adjustments, where a need for them is identified. Additional measures (information for the receivers of the service, installation of control and regulation systems, etc.) may be needed to ensure full equivalence.

60 An overview of the alternative measures implemented in Member States, based on the analysis of the latest equivalence reports notified to the Commission in line with Articles 14(3) and 15(3) of the 2018 Amended EPBD is provided in European Commission: Joint Research Centre, Maduta, C., Tsemekidi-Tzeinaraki, S., Castellazzi, L., D'Agostino, D., Melica, G., Paci, D. and Bertoldi, P., *Updates on the Energy Performance of Buildings Directive implementation in the EU Member States,* Publications Office of the European Union, Luxembourg, 2025, https://data.europa.eu/doi/10.2760/9619902, JRC140950.

Member States are required to ensure that the measures have an overall impact that is equivalent to the impact that would have been achieved had an inspection scheme been in place, as set out in Article 23(1). This means that a baseline of what would be achieved under the measures set out in Article 23(1) should be calculated, in order to ascertain whether the alternative measures will have the same impact. Article 23(6) of the recast EPBD now also specifies that such impact must be **expressed in terms of energy savings and greenhouse gas emissions.**

According to Article 23(6), Member States must report alternative measures to the Commission **before starting to apply them**. The notification of those alternative measures should be accompanied by an equivalence report. The existing reporting obligation of notifying this report also under the national energy and climate plans (NECP) is now removed. However, Member States that have opted for the alternative measures introduced at Article 23(6) must include, every five years, a summarised analysis and the results of the alternative measures as an annex to the national building renovation plan (NBRP)referred to in Article 3 of the recast EPBD. It is recommended that the summarised analysis include an assessment of the need to update or revise the equivalence report or the calculations of impacts in the future. If the assessment finds such a need, a new equivalence report should be submitted in due time.

For Member States that have not opted for alternative measures, a summarised analysis of the inspection schemes and their results must instead be included as an annex to the NBRP.

Although the recast EPBD groups the provisions on inspections under one single Article (Article 23) – while they were previously covered by two separate articles (14 and 15) in the 2018 amended EPBD with heating and air-conditioning systems treated separately – Member States may decide to adopt a ‘hybrid’ approach and to cover, for example, heating systems with regular inspections and air-conditioning systems with alternative measures (e.g. in those countries where the number of air-conditioning systems above 290 kW is very limited). In these cases, the above-mentioned reporting obligations would apply separately, so the summarised analysis of the results of both the inspection schemes and the alternative measures will have to be provided.

4.6. New inspection scheme after construction and renovation works

Article 23(8) requires Member States to put in place inspection schemes or alternative measures such as digital tools and checklists to certify that the delivered construction and renovation works meet the designed energy performance and are compliant with the minimum energy performance requirements laid down in the building codes or equivalent regulations. This provision aims to address quality issues and lack of adequate tracking of existing construction and renovation works as well as ‘as built’ vs ‘as designed’ performance gaps. In principle, this will target major renovations and new constructions, for which procedures such as commissioning and on-site ‘as built’ controls are in place (also for aspects other than energy performance) and for which energy performance certificates (EPCs) are issued according to Article 20(1)(a) of the recast EPBD.

Provided that Member States are free to opt for alternative measures, the inspection introduced in Article 23(8) should be on-site and must be carried out by an independent expert, who must ensure visual inspection, verification and collection of relevant building data (such as technical product documentation) and of any relevant documentation from the testing and functional measurements of building systems. Compliance with the minimum requirements and achievement of the designed energy performance can be verified through the collection and assessment of the EPC. The inspection could be carried out by the same expert who drafts the EPC. The building owner must receive all relevant documentation resulting from the inspection. This also complements and integrates the existing provisions, which are now in Article 13(6), as regards ensuring that, when a technical building system is installed, the overall energy performance of the altered part and, where relevant, of the complete altered system is assessed and that the results of this assessment are documented and passed on to the building owner, so that they remain available and can be used for the verification of compliance with the minimum requirements of technical building systems (laid down in Article 13(1)) and the issue of EPCs.

Alternative measures, such as digital tools and checklists, will need to meet the same quality level as the inspections scheme, and will require documentation from Member States. An example could be 'as built' building information models (BIM) providing the necessary information on installed products, digital product data sheets, and links to additional documentation (e.g. EPCs).

5. TECHNICAL, ECONOMIC AND FUNCTIONAL FEASIBILITY

The notion of 'feasibility' is relevant for several system requirements in Article 13 as well as for several other articles (such as Articles 10, 11, 14, 17). This section introduces the notion in general terms, while specific examples of how to approach technical, economic and functional feasibility for the different provisions of the recast EPBD are provided in the corresponding guidance documents.

Note that if an obligation is subject to 'conditionalities' of technical, economic and functional feasibility this is an exception that should be narrowly interpreted and as such it is for the Member States to detail the specific cases in which meeting the requirements is not feasible from a technical, economic and/or functional perspective. Member States should ensure that these cases are clearly identified, framed and justified[61].

The interpretation of technical, economic and functional feasibility should not be left solely to the judgment of interested parties (e.g. owners or system installers[62]). The conditions under which feasibility is evaluated should be defined and made public at Member State level or, where regional conditions affect only part of a Member State's territory, at regional level, so that there is clarity on when and how they apply. However, in the latter case, regional conditions should be defined in national transposition measures. In all cases, these conditions should be documented (e.g. in technical guidelines) and should apply uniformly on the national, or, where applicable, regional, territory. Finally, the non-application of system requirements should be assessed with clear procedures established and supervised by public authorities.

These procedures may differentiate between different types of buildings, in particular to address specific types for which technical, economic or functional feasibility is an issue. One example is historical or listed buildings, which can have specific constraints that make it more difficult to apply some of the requirements. In this context, note that compliance with these requirements should not, in principle, alter the character or appearance of historical or listed buildings. To avoid any doubt, also note that the requirements are also applicable to all categories of buildings for which the recast EPBD allows Member States to introduce derogations in the application of minimum energy performance requirements (Article 5(3)). However, the specificities of certain buildings can be taken into account when evaluating the

[61] It is recommended that Member States ensure the adequate involvement of stakeholders in defining the conditions for technical, economic and functional feasibility.

[62] Meaning that, in cases where those parties are responsible for assessing feasibility, their interpretation should be supported by guidelines and procedures provided by public authorities. This should also ensure a degree of consistency, supervision and control when applying the guidelines and procedures.

technical, economic and/or functional feasibility of meeting the requirements. In exceptional cases, where the evidence shows that compliance with the requirements is technically, economically or functionally impossible for a specific building, requirements can be disregarded. Such a conclusion can only be reached on a case-by-case basis, and Member States should not introduce systematic exemptions for any category of buildings.

The following table sets out how each type of feasibility can be interpreted and provides examples.

Table 14 – Interpretation of technical, economic and functional feasibility

Type of feasibility ([a])	Meaning	Examples
Technical feasibility	There is technical feasibility when the technical characteristics of the system and the building (or building unit) make it possible to apply the requirements. There is no technical feasibility when it is impossible to apply them from a technical perspective, i.e. when the system's technical characteristics prevent the requirements from being applied.	Technical feasibility would be an issue if a system does not allow for the installation of the devices needed to comply with the requirements, for example if: — for requirements on heat recovery for ventilation systems, the air intake and exhaust are not located in the same areas; — for requirements on the insulation of pipes, portions of pipes are not accessible.
Economic feasibility	Economic feasibility relates to whether: (i) the expected benefits outweigh the costs of the specific required intervention ([b]) taking into account the expected lifetime of the system; (ii) the costs of the specific required intervention (e.g. system upgrade) are proportionate with regard to the usual costs of applying the requirements.	Economic feasibility can, for example, be calculated based on: — a maximum payback period, taking into account the monetary benefits of applying the requirements (which should be correlated with the expected lifetime of the system in question); — a maximum ratio between the usual costs of applying the requirements and the costs of the specific required intervention (e.g. heat generator replacement).
Functional feasibility ([c])	It is functionally not feasible to apply requirements if these would lead to changes that would impair the operation of the system or the usage of the building (or building unit), taking into account the specific constraints (e.g. regulations) that may apply to the system and/or building.	The application of system requirements may not be functionally feasible for example when: — applicable regulations (e.g. on safety) contradict the requirements; — applying the requirements would result in a significant loss of usability of the building or building unit (e.g. substantial loss of space).

a) The two first rows (technical and economic feasibility) apply to Article 10(3), 11(1), 11(7), 13(1) para. 2, 13(3), 13(5), 13(9), 13(11), 13(12), 14(1) para. 3.

b) This means that a cost-benefit assessment would be carried out. This cost-benefit assessment approach is probably the most relevant, as applying the requirements will generally result in the costs being recovered (in particular due to energy cost savings).

c) Applies only to 10(3), 13(1) para. 2, 13(11).