RECOMMENDATIONS

COMMISSION RECOMMENDATION (EU) 2019/1019

of 7 June 2019

on building modernisation

(Text with EEA relevance)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union, and in particular Article 292 thereof,

Whereas:

(1) The Union is committed to developing a sustainable, competitive, secure and decarbonised energy system. The Energy Union and the energy and climate policy framework for 2030 establish ambitious Union commitments to further reduce greenhouse gas emissions by at least a further 40 % by 2030 compared with 1990, to increase the proportion of consumption of renewable energy, and to make energy savings in accordance with Union level ambitions, improving the Union's energy security, competitiveness and sustainability. Directive 2012/27/EU of the European Parliament and of the Council ([1]), as amended by Directive (EU) 2018/2002 ([2]), establishes an energy efficiency headline target of at least 32,5 % savings at Union level by 2030. Directive (EU) 2018/2001 of the European Parliament and of the Council ([3]) sets a binding target of at least 32 % energy from renewable sources at Union level by 2030.

(2) Buildings are central to the Union's energy efficiency policy as they account for nearly 40 % of final energy consumption.

(3) The 2015 Paris Agreement on climate change that followed the 21st Conference of the Parties to the United Nations Framework Convention on Climate Change (COP 21) boosts the Union's efforts to decarbonise its building stock. Given that almost 50 % of the Union's final energy consumption is for heating and cooling, of which 80 % is used in buildings, the Union's achievement of its energy and climate goals is linked to its efforts to renovate building stocks by giving priority to energy efficiency, applying the 'energy efficiency first' principle and considering the deployment of renewables.

(4) The Commission highlighted the importance of energy efficiency and the role of the building sector for the achievement of the Union's energy and climate goals and for the transition to clean energy in its Communication on energy efficiency and its contribution to energy security and the 2030 framework for energy and climate policy ([4]), in its Communication on a Framework Strategy for a Resilient Energy Union with a Forward-looking Climate Change Policy ([5]), and in its Communication on a European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy ([6]). The latter Communication stresses that energy efficiency measures should play a central role in achieving a climate neutral economy by 2050 and reducing energy consumption by as much as half compared to 2005.

([1]) Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC (OJ L 315, 14.11.2012, p. 1).

([2]) Directive (EU) 2018/2002 of the European Parliament and of the Council of 11 December 2018 amending Directive 2012/27/EU on energy efficiency (OJ L 328, 21.12.2018, p. 210).

([3]) Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (OJ L 328, 21.12.2018, p. 82).

([4]) Impact Assessment accompanying the document Communication from the Commission to the European Parliament and the Council Energy Efficiency and its contribution to energy security and the 2030 Framework for climate and energy policy (SWD(2014) 255 final).

([5]) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank '*A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy*' (COM(2015) 80 final).

([6]) Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank '*A Clean Planet for all — a European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy*' (COM(2018) 773 final).

(5) Full implementation and enforcement of existing energy legislation is considered as the first priority in establishing the Energy Union.

(6) Directive 2010/31/EU of the European Parliament and of the Council ([7]) ('EPBD') is the main legislation, together with Directive 2009/125/EC of the European Parliament and of the Council ([8]) and Regulation (EU) 2017/1369 of the European Parliament and of the Council ([9]), addressing energy efficiency in buildings in the context of the 2030 energy efficiency targets. The EPBD has two complementary objectives, namely to accelerate the renovation of existing buildings by 2050 and to support the modernisation of all buildings with smart technologies and a clearer link to clean mobility.

(7) In 2018 the EPBD was amended by Directive (EU) 2018/844 of the European Parliament and of the Council ([10]) in order to accelerate the modernisation of buildings in the Union.

(8) The performance of technical building systems has a significant impact on overall building energy performance and should therefore be optimised. It is important to ensure that improvement of energy performance of buildings follows an integrated approach, taking into account measures both on building envelope and on technical building systems.

(9) National legislation transposing Article 8(1) of the EPBD has to ensure that system requirements are established and enforced for an expanded group of technical buildings systems, and that new requirements are introduced on the installation of self-regulating devices in buildings.

(10) To meet the objectives of energy efficiency policy for buildings, the transparency of energy performance certificates should be improved. National legislation transposing the requirements of Article 8(9) of the EPBD is required to ensure that the overall energy performance of the altered part, or where relevant, of the whole system, is documented for use in building certification and compliance checking when technical building systems, such as for space heating, air-conditioning or water heating, are installed, replaced or upgraded.

(11) Innovation and new technology also make it possible for buildings to support the overall decarbonisation of the economy, including in the transport sector. For example, buildings can support the development of the infrastructure necessary for the smart charging of electric vehicles, which can provide a basis for Member States, if they choose to, to use car batteries as a source of power.

(12) Electric vehicles are an important component of a clean energy transition based on energy efficiency measures, alternative fuels, renewable energy and innovative solutions for the management of energy flexibility. Building codes can be effectively used to introduce targeted requirements to support the deployment of recharging infrastructure in the car parks of residential and non-residential buildings. National legislation transposing the requirements of Article 8(2) to Article 8(8) of the EPBD is required to ensure the deployment of recharging infrastructure for electric vehicles in buildings' car parks.

(13) When applying the requirements of Article 8(2) to Article 8(8) of the EPBD Member States should consider the need for holistic and coherent urban planning; as well as the promotion of alternative, safe and sustainable modes of transport and their supporting infrastructure, for example through dedicated parking infrastructure for electric bicycles and for the vehicles of people with reduced mobility.

(14) Member States should lay down measures to simplify the deployment of recharging infrastructure with a view to addressing barriers that individual owners encounter when trying to install a recharging point on their parking space, such as split incentives and administrative complications.

(15) To digitalise the building sector, thus facilitating the emergence of smart homes and well-connected communities, targeted incentives should be provided to promote smart-ready systems and digital solutions in the built environment.

([7]) Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (OJ L 153, 18.6.2010, p. 13).

([8]) Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products (OJ L 285, 31.10.2009, p. 10).

([9]) Regulation (EU) 2017/1369 of the European Parliament and of the Council of 4 July 2017 setting a framework for energy labelling and repealing Directive 2010/30/EU (OJ L 198, 28.7.2017, p. 1).

([10]) Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency (OJ L 156, 19.6.2018, p. 75).

(16) It is important to raise awareness amongst building owners and occupants of the value of building automation and the electronic monitoring of technical building systems; and give occupants confidence in the actual savings those enhanced functionalities offer.

(17) To ensure the initial and continued performance of heating systems, air-conditioning systems and ventilation systems, inspection schemes should be designed to maximise their results. Articles 14 and 15 of the EPBD expand the scope of technical building systems subject to mandatory regular inspections or alternative measures. In addition, those Articles lay down alternatives to inspections based on automation and control or electronic monitoring and set out new requirements on the installation of building automation and control systems in certain non-residential buildings.

(18) Building automation and electronic monitoring of technical building systems have proven to be an effective replacement for inspections, in particular for large systems. As a result, they hold great potential to provide cost-effective and significant energy savings for both consumers and businesses. The installation of such equipment should be considered as a cost-effective alternative to inspections of large non-residential and multi-apartments buildings of a sufficient size, as it offers an interesting return on investment and enables action to be taken on the information provided, thereby securing energy savings over time. The implementation of the requirements in Article 14(4) and Article 15(4) of the EPBD will ensure that building automation and control systems are installed in non-residential buildings where heating or air-conditioning effective rated output is above a certain threshold, and where this is technically and economically feasible.

(19) To meet the objectives of energy efficiency policy for buildings, the transparency of energy performance calculations should be improved by ensuring that all necessary parameters for both certification and minimum energy performance requirements, are set out and applied consistently across the Union.

(20) Annex I to the EPBD was amended in order to introduce a degree of transparency in the calculation of primary energy factors, to ensure the central role of the building envelope and to address the role of on-site and off-site renewable energy sources

(21) Member States are to bring into force the laws, regulations and administrative provisions transposing Directive (EU) 2018/844 by 10 March 2020.

(22) The full transposition and effective implementation of the amended EPBD is fundamental to support the achievement of 2030 energy efficiency targets and to put the Union on track for the full decarbonisation of national building stocks by 2050.

(23) The EPBD leaves to Member States a large margin of discretion when designing their building codes and implementing technical requirements regarding renovations, building certificates and technical building systems in a way which fits best the national climatic conditions and building stocks. This Recommendation aims at explaining the substance of these technical requirements and the different ways in which the objectives of the Directive can be achieved. It also presents the experience and best practices the Commission has seen amongst Member States.

(24) The Commission is committed to work closely with the Member States in their transposition and effective implementation of the EPBD. To this end the present Recommendation has been prepared to explain in more detail how certain provisions of the EPBD should be read and can be best applied in the context of national transposition. The aim in particular is to ensure a uniform understanding across Member States in the preparation of their transposition measures. This Recommendation does not alter the legal effects of the EPBD and is without prejudice to the binding interpretation of the EPBD as provided by the Court of Justice. This Recommendation deals with subjects in the EPBD which are legally complex, demanding to transpose and have high potential in terms of impact on the energy efficiency of buildings. This Recommendation focuses on the provisions relating to the modernisation of buildings and concerns Articles 2, 8, 14, 15, and Annex I of the EPBD, which include provisions on technical building systems and their inspections, electromobility, and the calculation of energy performance of buildings. Provisions in the EPBD dealing with renovation are addressed in a separate Recommendation.

(25) Therefore this Recommendation should allow Member States to achieve strong impacts in terms of modernisation of their building stock,

HAS ADOPTED THIS RECOMMENDATION:

1. Member States should follow the guidelines provided in the Annex to this Recommendation in transposing the requirements laid down by Directive (EU) 2018/844.

2. This Recommendation is addressed to the Member States.

3. The Recommendation shall be published in the *Official Journal of the European Union*.

Done at Brussels, 7 June 2019.

For the Commission
Miguel ARIAS CAÑETE
Member of the Commission

ANNEX

1. INTRODUCTION

Directive 2010/31/EU ('EPBD') promotes improvement in the energy performance of buildings, including of technical building systems. In particular, the Directive clarifies the systems to which the requirements are to be applied and includes specific provisions to ensure that those systems are designed, dimensioned, installed and adjusted in a way that optimises performance. For those systems that have a particularly significant impact on energy performance, the Directive also requires inspections that regularly monitor system efficiency. It considers electronic monitoring and control as a possible alternative to inspections.

Directive 2012/27/EU ('EED') contained provisions on building renovation and long-term strategies for mobilising investment in the renovation of national building stocks.

The EPBD and the EED have been amended by Directive (EU) 2018/844, which entered into force on 9 July 2018, strengthens the above elements and, increases the types of system whose performance are to be optimised. It also strengthens the role of electronic monitoring, automation and control and includes additional requirements that support the deployment of electric vehicle recharging infrastructure in building car parks.

Expanding the scope of the definition of technical building systems to include more systems and, more generally, the need to reflect the evolution of buildings and the energy system have made it necessary to update the EPBD's framework for calculating the energy performance of buildings. Most notably, this means improving the transparency of energy performance calculations and energy performance certificates, in particular in relation to the calculation of primary energy factors.

The aim of this Recommendation is to help ensure full implementation and enforcement of Union energy legislation. It provides guidance on how to understand and transpose the EPBD, specifically those provisions that concern technical building systems and their inspections, including: requirements on installing self-regulating devices and building automation and control systems (Article 8 and Articles 14 and 15 of the EPBD), electromobility recharging infrastructure (Article 8 of the EPBD), and the calculation of primary energy factors (Annex I to the EPBD).

The guidelines set out in this Annex present the view of the Commission services. It does not alter the effects of the Directive and is without prejudice to the Court of Justice binding interpretation of Articles 2, 8, 14, 15 and Annex I of the EPBD.

2. TECHNICAL BUILDING SYSTEMS AND THEIR INSPECTIONS, INCLUDING REQUIREMENTS ON THE INSTALLATION OF SELF-REGULATING DEVICES AND BUILDING AUTOMATION AND CONTROL SYSTEMS

2.1. **Aim: to ensure optimal performance of technical building systems and support the management of energy and the indoor environment**

The EPBD includes provisions on requirements for technical building systems and on the assessment and documentation of system performance, whose aim is twofold. Firstly, the assessment and documentation of system performance aims to ensure that technical building systems are adequately designed, installed and commissioned in order to optimise their actual performance. Secondly, it aims to ensure that any intervention that can have an impact on the performance of a technical building system is tracked and documented. This is important as such information is valuable to the owner and to facilitate the assessment of the performance of the building as a whole (e.g. in the context of energy performance certification).

The amendment to the EPBD expands the scope of the regular inspection of technical building systems. The aim of these inspections is to evaluate system performance. Inspections should also identify issues or problems, propose solutions or improvement measures, and log the results of the inspection in a report for future reference.

The EPBD includes requirements for the installation of self-regulating devices that are able to regulate indoor temperature in buildings, with the aim of improving the management of energy consumption while limiting costs. It also includes a requirement to install building automation and control systems (BACS) in all (existing

and new) non-residential buildings over a certain effective rated output of heating, ventilation and air-conditioning systems. This is because BACS lead to significant energy savings, improve the management of the indoor environment and, as such, are beneficial to both building owners and users, in particular in large non-residential buildings.

2.2. **Scope of provisions on technical building systems and their inspections, self-regulating devices and BACS**

This sub-section recalls the scope and content of these provisions and highlights the differences introduced by amendments from Directive (EU) 2018/844 where relevant.

2.2.1. *Technical building systems: system requirements, assessment and documentation of overall energy performance (Article 2, Article 8(1) and 8(9) of the EPBD)*

Before amendment: before the amendment, Article 8(1) of the EPBD required Member States to set system requirements in respect of the overall performance, proper installation and appropriate dimensioning, adjustment and control of technical building systems. This obligation applied to technical building systems installed in existing buildings and Member States could also apply it to technical building systems installed in new buildings. In addition, before amendment, Article 2(3) of the EPBD defined a technical building system as 'technical equipment for the heating, cooling, ventilation, hot water, lighting or for a combination thereof, of a building or building unit'.

After amendment: with regard to technical building systems, Article 8 of the EPBD was replaced, with the following to be noted:

(a) the provisions on technical building system requirements in Article 8(1) remain substantially unchanged (with the exception of the systems for which the system requirements had to be applied, listed in subparagraph 2, which has been repealed);

(b) the amendment updates and extends the definition of 'technical building systems' (Article 2(3));

(c) the amendment introduces new provisions on the assessment and documentation of the overall performance of technical building systems (Article 8(9)).

2.2.2. *Technical building systems: inspections (Articles 14 and 15 of the EPBD)*

Before amendment:

Article 14 of the EPBD set inspection requirements for heating systems with a rating over 20 kW. Member States had to determine inspection frequencies based on the type of the system, effective rated output, the costs of inspections and estimated energy savings. Heating systems with an effective rating of over 100 kW had to be inspected at least every 2 years. Member States could also allow for reduced inspection frequency for systems with electronic monitoring and control systems in place. As an alternative to inspections, Article 14(4) allowed Member States to opt to take measures that would ensure that users receive advice concerning the replacement of boilers, other modifications to the heating system and alternative solutions to assess boiler efficiency and appropriate size. The overall impact of this approach had to be equivalent to the expected impact of inspections.

Article 15 of the Directive set inspection requirements for air-conditioning systems with a rating over 12 kW. Member States had to determine inspection frequencies based on the type of the system, effective rated output, the costs of inspections and estimated energy savings. Member States could allow for reduced inspection frequency for systems with electronic monitoring and control systems in place. As an alternative to inspections, Article 15(4) allowed Member States to opt to take measures that would ensure that users receive advice concerning the replacement of air-conditioning systems and other related modifications, including inspections to assess the system's efficiency and appropriate size. The overall impact of this approach had to be equivalent to the expected impact of inspections.

After amendment:

Article 1(7) of Directive (EU) 2018/844 replaces the provisions related to inspections in Article 14 and 15 of the EPBD.

Under Article 14 of the EPBD, heating systems and combined heating and ventilation systems with an effective rating of 70 kW or lower no longer require inspections. Under the same Article, heating systems and combined heating and ventilation systems with an effective rating over 70 kW must still be inspected at regular intervals. The EPBD allows for exemptions for:

(a) systems that are under energy efficiency contractual arrangements (or similar), in accordance with Article 14(2);

(b) systems operated by a utility or a network operator, in accordance with Article 14(2);

(c) systems in non-residential buildings equipped with automated and control systems, in accordance with Article 14(4) and 14(6);

(d) systems in residential buildings with specific monitoring and control functionalities, in accordance with Article 14(5) and 14(6).

Under Article 15 of the EPBD, air-conditioning systems and combined air-conditioning and ventilation systems with an effective rating of 70 kW or lower no longer require inspections. Under the same Article, air-conditioning systems and combined air-conditioning and ventilation systems with an effective rating over 70 kW must still be inspected at regular intervals. The EPBD allows for exemptions for:

(a) systems under energy efficiency contractual arrangements (or similar), in accordance with Article 15(2);

(b) systems operated by a utility or a network operator, in accordance with Article 15(2);

(c) systems in non-residential buildings equipped with automated and control systems, in accordance with Article 15(4) and 15(6);

(d) systems in residential buildings with specific monitoring and control functionalities, in accordance with Article 15(5) and 15(6).

2.2.3. *Requirements related to the installation of self-regulating devices (Article 8(1) of the EPBD)*

Before amendment: Not applicable (these provisions were introduced with the amendment)

After amendment: Article 1 of Directive (EU) 2018/844 introduces new requirements related to the installation of self-regulating devices and building automation and control systems in buildings that meet specific conditions. More precisely, under the third subparagraph of Article 8(1) of the EPBD, Member States must require the installation of self-regulating devices in all new buildings and in existing buildings when heat generators are replaced, where technically and economically feasible.

2.2.4. *Requirements related to the installation of building automation and control systems (Article 14(4) and 15(4) of the EPBD)*

Before amendment: Not applicable (these provisions were introduced with the amendment)

After amendment: Under Article 14(4) and Article 15(4) of the EPBD, Member States must require the installation of building automation and control systems in all non-residential buildings in which the effective rated output of heating, air-conditioning, combined heating and ventilation and combined air-conditioning and ventilation is more than 290 kW. In accordance with Article 14(4) and 15(4) of the EPBD, this must be done by 31 December 2025 where technically and economically feasible (see section 2.3.4 for more guidance on the feasibility of meeting requirements).

2.3. **Understanding provisions on technical building systems and their inspections, self-regulating devices and BACS**

2.3.1. *Technical building systems requirements and assessment and documentation of overall energy performance of technical building systems (Article 2, Article 8(1) and 8(9) of the EPBD)*

2.3.1.1. Extension of the definition of a 'technical building system' (Article 2(3) of the EPBD)

The obligations arising from Article 8(1) and 8(9) of the EPBD apply to technical building systems as defined in Article 2(3). According to this definition, the term 'technical building system' means 'technical equipment for space heating, space cooling, ventilation, domestic hot water, built-in lighting, building automation and control, on-site electricity generation or a combination thereof, including those systems using energy from renewable sources, of a building or building unit.'

A 'technical building system' was already defined in the EPBD before the last amendment. The EPBD updates this definition by: using a different wording for some systems, in order to clarify their scope; and extending it to include additional systems ('technical equipment for building automation and control' and 'technical equipment for on-site electricity generation').

The following table summarises the changes made to the definition under the EPBD:

Table 1

Changes to the definition of a 'technical building system' introduced under the EPBD

Before the amendment	With the amendment	Type of change
heating	space heating	clarification of scope
cooling	space cooling	clarification of scope
ventilation	ventilation	no change
hot water	domestic hot water	clarification of scope
lighting	built-in lighting	clarification of scope ([1])
n/a	building automation and control	new technical building system
n/a	on-site electricity generation	new technical building system

([1]) The Directive was already on built-in lighting before the amendment (built-in lighting installations were taken into consideration in the methodology used to calculate the energy performance of buildings). This is also consistent with considering built-in lighting as part of the energy uses which have an impact on the energy performance of buildings (see Annex I of the EPBD).

The concept of 'on-site electricity generation' under the EPBD should be subject to interpretation in the light of Article 15 of the Electricity Directive ([1]) on common rules for the internal market in electricity that regulates the status, rights and obligations of electricity customers that also own generation units, and of the notion of 'active customers' within the meaning of the same Directive.

2.3.1.2. New technical building systems in the EPBD (Article 2(3) and 2(3a) of the EPBD)

Technical equipment for building automation and control and technical equipment for on-site electricity generation have been added to the definition of technical building systems.

(a) 'Building automation and control systems' are defined in Article 2(3a) of the EPBD: '"building automation and control system" means a system comprising all products, software and engineering services that can support energy-efficient, economical and safe operation of technical building systems through automatic controls and by facilitating the manual management of those technical building systems';

(b) 'On-site electricity generation systems' refers to systems that are designed to produce electricity, that are installed in or within confined boundaries of the premises where the building is located and that have some level of integration with the building and its electrical installation ([2]). Such systems include, in particular, photovoltaic panels (e.g. roof-mounted photovoltaics panels), micro combined heat and power (CHP) installations and small wind turbines.

([1]) The Directive of the European Parliament and of the Council on common rules for the internal market in electricity (recast) was approved by the European Parliament at first reading on 26 March 2019, following a provisional agreement reached in interinstitutional negotiations. Adoption by the Council is foreseen for May 2019 and publication in the Official Journal will follow.

([2]) Member States will need to decide how to transpose the notion of 'on-site' in cases where the system is not in or on the building. Whether the electricity generation system shares a connection to the electricity grid or not could help distinguish between on- and off-site systems.

2.3.1.3. Useful definitions: 'heating system' and 'air-conditioning system' (Article 2(15a) and 2(15) of the EPBD)

In addition to the definition of a technical building system, Article 2 of the EPBD includes definitions of a heating system and air-conditioning system ([3]):

(a) '"Heating system" means a combination of the components required to provide a form of indoor air treatment, by which the temperature is increased ([4])'.

(b) '"Air-conditioning system" means a combination of the components required to provide a form of indoor air treatment, by which temperature is controlled or can be lowered ([5])'.

2.3.1.4. When do the obligations apply? (Article 8(1) and 8(9) of the EPBD)

The technical building system provisions under Article 8(1) and 8(9) of the EPBD apply when a technical building system is installed, replaced or upgraded.

Note that the conditions that need to be met for these obligations to apply relate only to the technical building systems themselves and not to the type of building or building unit under consideration. The definition of a technical building system makes it clear that a technical building system is equipment in a building or building unit, meaning that provisions that apply to technical building systems are applicable in the buildings or building units concerned, regardless of building type or characteristics.

However, the provision on setting system requirements is obligatory only with regard to technical building systems in existing buildings. It is up to Member States whether they choose to extend the obligation to technical building systems in new buildings.

2.3.1.5. Meaning of terms (Article 8(1) and 8(9) of the EPBD)

The new provisions on the documentation of system performance (Article 8(9) of the EPBD) use some of the same concepts as the provisions on setting system requirements: 'overall energy performance', 'installation', 'replacement' and 'upgrading'. The meaning of these terms remains the same in the new provisions. These terms should therefore be transposed at national level in the same way as in the provisions on setting system requirements.

The provisions on the documentation of system performance also use the term 'altered part', which refers to the specific part (i.e. component) of a system that is affected when the system is upgraded. This is only relevant in the context of a system upgrade, not when a system is installed or replaced.

2.3.2. *Inspection of heating, air-conditioning, combined heating and ventilation and combined air-conditioning and ventilation systems (Article 14 and 15 of the EPBD)*

2.3.2.1. Evolution of provisions on inspections under the EPBD (Article 14 and 15 of the EPBD)

In summary, the main changes in inspection requirements introduced under the EPBD are: (1) the different thresholds for inspections; (2) introduction of inspections of ventilation systems for combined heating (air-conditioning) and ventilation systems; (3) a greater focus on normal operating conditions; and (4) a greater role for building automation and control systems (BACS) and electronic monitoring and control systems.

As an alternative to inspections, Articles 14(3) and 15(3) of the EPBD include the possibility for Member States to opt to take alternative measures that would ensure that users receive advice. The EPBD's provisions on alternative measures are similar to those set out in the EPBD before the last amendment.

([3]) The definition of 'air-conditioning system' was already provided before the amendment and has not been modified in the EPBD. The definition of 'heating system' is new in the EPBD.

([4]) The EPBD refers both to 'heating system' and to 'system for space heating' — these two terms are equivalent within the meaning of the Directive.

([5]) The EPBD refers both to 'air-conditioning system' and 'system for space cooling' — these two terms are equivalent within the meaning of the Directive.

However, Member States that choose to apply alternative measures must ensure that their impact is equivalent to the impact that inspections carried out under Article 14(1) and Article 15(1) of the EPBD would have had (this includes elements such as the new thresholds, combined heating and ventilation systems, exemptions, etc.).

The provisions in Article 15 of the EPBD are almost identical to those in Article 14. The only difference is that Article 14 applies to heating systems while Article 15 applies to air-conditioning systems. Member States should therefore apply the recommendations provided for the inspection of heating systems in Article 14 to the inspection of air-conditioning systems in Article 15 (or their alternative measures if applicable). It follows that references to heating systems also apply to air-conditioning systems, and references to heat generators or boilers also apply to cooling generators or chillers. In order to avoid redundancies, the following sections mainly address the inspection of heating systems under Article 14; separate references to air-conditioning systems under Article 15 are only made where necessary.

2.3.2.2. Effective rated output (Article 2(17), 14 and 15 of the EPBD)

The definition of 'effective rated output' is given in Article 2(17) of the EPBD.

For heating and air-conditioning, the effective rated output means the maximum output (in kW) during operation, as specified by the system manufacturer ([6]):

(a) rated heat output for a heating system;

(b) rated cooling output for an air-conditioning system.

Where applicable, the threshold for the effective rated output applies to each system individually (heating, air-conditioning, combined heating and air-conditioning and ventilation).

Where combined systems are in place, the effective rated output should reflect the capacity of the combination of systems, as clarified in sections 2.3.2.3 and 2.3.2.4.

Usually, a system will comprise more than one unit that operate jointly. In this case, the effective rated output corresponds to the sum of the effective rated outputs of the individual units.

2.3.2.3. Heating and combined heating and ventilation systems (Article 14 of the EPBD)

The last amendment to the EPBD expands the scope of inspection to also include the ventilation part of combined heating and ventilation systems.

For those Member States which already have inspection regimes in place, the scope of the heating system itself should have already been defined in the context of transposition. In accordance with Article 14(1) of the EPBD, it must include all accessible parts, such as the heat generator, control system and circulation pumps.

The EPBD also requires the inspection of the ventilation in combined heating and ventilation systems. Since this is a new requirement, Member States should define the types of systems that will now be considered as combined heating and ventilation systems.

The notion of combined heating and ventilation systems should be understood as including the following categories:

(a) Type 1: ventilation systems connected to the heating system. These are systems where the ventilation system is composed of one or more air handling units (AHUs) delivering treated air to the heated space(s) and where these AHUs are connected to one or more heat generators in order to use its heat to treat the air. Examples of this type of system: boiler + AHU + terminal units (fan coils/fan convectors/radiators) or boiler + variable air volume system;

([6]) Such information is part of the product information required under the different Ecodesign regulations for heating and cooling products.

(b) Type 2: ventilation systems coordinated with the heating system. These are systems where there are one or several air handling units delivering treated air to the heated space(s). The ventilation system is connected to an independent heat source (e.g. dedicated boiler or heat pump) or uses an internal heat source (e.g. electrical resistance). Space is heated mostly by a system that uses a different heat source. Even though the heating and ventilation systems do not share heat sources, they operate in an integrated and coordinated way (e.g. in terms of schedules, flow temperatures or flow rates). Examples of this type of system: rooftop units (variable refrigerant volume or variable refrigerant flow) + AHUs;

(c) Type 3: ventilation systems independent from the heating system. These are systems where the ventilation system is completely independent from the heating both in terms of heat source and operation. Examples of this type of system: extract-only systems, supply and extract systems (without pre-heating).

Type 1 systems should be considered as combined heating and ventilation systems. This means that the requirements of the EPBD apply (recital 35 of Directive (EU) 2018/844 helps establish this). Regardless of the share of heat used by the ventilation system, both the heating and the ventilation system are fully involved in the delivery of the heat within the building. This type of system requires careful integration between ventilation and heating to adequately provide for the indoor environment in the most efficient way, particularly under typical or average operating conditions. Inspections carried out on such systems are a good opportunity to identify ways to save energy at a reduced cost (low hanging fruit).

Type 2 systems should also be considered as combined heating and ventilation systems. This is mainly because of the need to adequately integrate the operation of the heating and ventilation systems. Similarly to Type 1 systems, an inspection is a good opportunity to identify ways to save energy at a reduced implementation cost.

Type 3 systems should not be considered as combined heating and ventilation systems. The heating system and the ventilation system should be dealt with as individual and separate systems for the purposes of the EPBD.

In general, Type 1 and Type 2 systems are more common in non-residential buildings (such as offices, shopping centres, etc.), whereas Type 3 systems are more common in residential buildings.

The effective rated output of a combined heating and ventilation system should be the sum of the effective rated output of the different heat generators installed in the system ([7]).

The calculation of the effective rating of a system depends on the type of system. In Type 1 and Type 3 systems, the size of the heat generator is the determining factor. In Type 2 systems, the size of the heat generator should be added to the size of the separate heat generator in the ventilation system (e.g. electric heaters, solar thermal panels, etc.). This is because the heating capacity of both elements is used to compensate for the heat losses in the treated space.

The EPBD does not specify to what extent the inspection applies to the air management and treatment aspects of the system (such as ductwork, dampers or air filters). However, it would be good practice that the independent expert still includes them in the inspection, at least to a certain degree, based on the accessibility of the system and the energy-saving opportunities available. In practice, in a combined heating and ventilation system, the different parts of the system may be located together or in close proximity. Since the inspector is physically visiting the building, the added workload and cost are limited, while the opportunities to save energy are good.

2.3.2.4. Combined heating and air-conditioning and ventilation systems (Article 14 and 15 of the EPBD)

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 to limit the burden on building and users.

([7]) For example: boiler, heat pump, electric resistance, solar thermal panels, etc. This should be taken into consideration when establishing whether a system falls above or below the 70 kW threshold for inspections.

Combined heating and air-conditioning and ventilation systems should preferably be inspected in a single visit by an expert qualified to inspect both. Failing that, it is recommended that the ventilation system is inspected by an expert qualified to carry out inspections of air-conditioning systems.

In Member States that have decided to implement inspections for one type of system and alternative measures for another, the risk of double inspection does not exist. However, the inspection should ensure that the heating or cooling cycle in the ventilation system do not fight each other.

To establish whether a system is over or under the 70 kW threshold, the respective heating and cooling effective rated outputs should be considered 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 be below the threshold for both heating and air-conditioning inspections. A combined system with a heating rated output of 80 kW and a cooling rated output of 30 kW would be over the threshold for heating inspections, and below the threshold for air-conditioning inspections.

The reason for this separate treatment is that the EPBD treats heating and air-conditioning systems separately (Article 14 and Article 15, respectively). There are no provisions in the EPBD that treat such systems together. Consequently, even though in practice such combined systems may well exist, according to Article 14 and 15 of the EPBD, they nonetheless must be treated separately, with their respective inspection requirements, reporting obligations, periodicity, certification of inspectors, etc.

2.3.2.5. Heat pumps and rooftop units (Article 2(18), 14 and 15 of the EPBD)

Article 2(18) of the EPBD defines heat pumps as 'a machine, a device or installation that transfers heat from natural surroundings such as air, water or ground to buildings or industrial applications by reversing the natural flow of heat such that it flows from a lower to a higher temperature. For reversible heat pumps, it may also move heat from the building to the natural surroundings'. Heat pumps are therefore capable of acting as generators for both heating and air-conditioning systems, although in some applications they may provide only one or the other function. Because of this capacity to provide both heating and cooling, heat pumps could fall under both Article 14 and Article 15.

If a heat pump is used as the heat generator in a system that provides only heating, then the system should fall under Article 14. For example, this would be the situation of a heat pump generating heat for heating and domestic hot water.

If a heat pump is used as the heating or cooling generator in a system that provides both heating and air conditioning, then the system should fall under Article 15.

Rooftop units are a special category of heat pump and are commonly used in relatively large non-residential buildings. They work as heat pumps and have the added capability of providing heating and cooling simultaneously. They should always be considered as falling under Article 15.

2.3.2.6. Performance under typical or average operating conditions (Recital 36, Article 14(1) and 15(1) of the EPBD)

Before the amendment, recital 26 of the EPBD stated that 'regular maintenance and inspection of heating and air-conditioning systems by qualified personnel contributes to maintaining their correct adjustment in accordance with the product specification and in that way ensures optimal performance from an environmental, safety and energy point of view' and Article 14(1) stated that the inspection must include an assessment of the boiler size compared with the requirements of the building.

With the amendment, the EPBD refers not only to the boiler, but to the system as a whole and in particular the heat generator. Therefore, there is a greater emphasis on normal operating conditions. Recital 36 of Directive (EU) 2018/844 indicates that it is preferable for inspections to focus on real-life use conditions, with varying operating conditions that may require only a part of the nominal output capacity. This is because only a small fraction of the energy consumption in a heating system takes place under conditions approaching design conditions. Instead, the greatest proportion of energy is consumed when the system is running under 'part load' (i.e. when the system does not operate at full capacity). Therefore, the objective should be to ensure that the system can perform efficiently and effectively under all conditions.

Under Article 14(1) of the EPBD, the inspection of heating systems includes, where relevant, an assessment of the system's capability to optimise its performance under typical or average operating conditions. Member States must update their legislation to ensure that this performance assessment is included, where relevant, in the scope of inspections.

The operation of a heating system depends on many factors, including: outdoor conditions, building characteristics, building use and system characteristics. It is complex and possibly impractical to define typical or average operating conditions for all possible combinations.

Systems rarely operate at full capacity, operating instead at what is known as part load. It is possible to provide some rough guidelines on typical or average operating conditions based on the percentage of system output over a given period. For example, as a rule of thumb, it could be said that typical or average conditions result in a system operating between 20 % and 40 % of its design output over a period of time (e.g. a day). However, this gives an incomplete picture. Even in a typical or average day, the most efficient settings for a system may differ substantially throughout the day. As a result, it is not recommended that typical or average operating conditions are defined as a function of system load in national legislation.

It is also possible to provide some general guidelines for defining typical or average operating conditions based on outdoor temperature and specify how these differ from design conditions. For example, if design conditions were set at – 10 °C, one could define typical or average operating conditions as a function of a less demanding outdoor temperature (e.g. between 5 and 10 °C) or based on the temperature difference between inside and outside (e.g. a 60 % temperature difference between inside and outside in the design conditions). However, the same system may behave completely differently depending on the building in which it is installed, how it is used, and the weather at a specific moment. As a result, it is not recommended that typical or average operating conditions are defined or tabulated as a function of outdoor conditions (e.g. standard day) in national legislation. The same can be said for building characteristics or building usage (e.g. 80 % occupancy).

The technical details on how to carry out the assessment can be set out in the training or documentation provided to inspectors.

The need to account for the operation of systems under typical or average conditions is well understood by technical bodies and associations. There are a number of published manuals and guidelines that address performance of systems under part load (as opposed to full load or design load). It is recommended that Member States follow or use these guidelines when developing their training material ([8]).

2.3.2.7. Electronic monitoring and effective control functionalities in residential buildings (Article 14(5) and 15(5) of the EPBD)

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 for large buildings, where access to system controls and system information is limited for most users.

([8]) E.g. the guide to carrying out inspections of air-conditioning systems developed by the Commission-funded iSERV project ('Inspection methodology — Air conditioning maintenance tasks — Identifying energy services' http://www.iservcmb.info/sites/default/files/results/Physical-Inspections/Public-report-Methodology-for-HVAC-System-Inspections.pdf) or the technical paper on improving the performance of heat pumps in working conditions from the REHVA association ('Capacity control of heat pumps' https://www.rehva.eu/publications-and-resources/rehva-journal/2012/052012/capacity-control-of-heat-pumps-full-version.html).

Article 14(5) of the EPBD on electronic monitoring and control functionalities covers only residential buildings. According to this Article, it is up to Member States to decide whether they will opt to establish requirements to ensure that residential buildings are equipped with such functionalities, introducing them into their national transposition measures.

Article 14(5)(a) of the EPBD concerns the provision of continuous electronic monitoring. Systems that do this measure their own 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 on a continuous basis, as opposed to a periodical basis (for example every 3 months).

Article 14(5)(b) of the EPBD concerns the provision of effective control functionalities to ensure optimum energy generation, distribution, storage and use. These control functionalities should take into consideration the scenario of a multi-apartment building with a single heating system, where the individual users would only be able to control the system within the boundaries of their building unit.

Article 14(5) of the EPBD concerns the optional introduction of both functionalities in residential buildings.

Unlike Article 14(1) and Article 14(4) of the EPBD, which provide for specific thresholds that trigger the mandatory obligations to be reflected in national transposition measures, Article 14(5) has an optional character ('may') and therefore does not include details on thresholds for effective rated output and implicitly covers all residential buildings regardless of their size. It is recommended that Member States take into consideration the differences in system and building type when setting out requirements.

2.3.2.8. Exemption from inspections (Article 14(2), 14(4), 14(5), 15(2), 15(4), and 15(5) of the EPBD)

Before the amendment, the Directive allowed the possibility for Member States to reduce the frequency of inspections or lighten them as appropriate where electronic monitoring and control systems were in place.

The amendment to the EPBD introduces exemptions if:

(a) the technical building system is covered by an energy performance contract (or similar) or is operated by a utility or a network operator (exemption laid down in Article 14(2)); or

(b) the heating system has specific control and monitoring features as defined in Article 14(4) and (5) (exemption laid down in Article 14(6)).

(a) Technical building systems covered by energy performance contracts (or similar) (Article 14(2) and 15(2) of the EPBD)

Article 14(2) of the EPBD excludes from inspections those technical building systems that are explicitly covered by an agreed energy performance criterion or a contractual arrangement specifying an agreed level of energy performance improvement. An energy performance contract as defined in Article 2(27) of the EED fulfils these requirements.

Buildings operated by a utility or network operator that are therefore subject to performance monitoring on the system side are also exempt.

The exemptions specified in Article 14(2) of the EPBD only apply if the overall impact of the approach is equivalent to the impact resulting from the application of inspections under Article 14(1) of the EPBD.

The EPBD does not indicate how this equivalence should be established. One possibility could be to determine whether the technical building system is already undergoing a regular inspection as part of the contract or agreement, and that this is similar in nature to inspections under Article 14(1). If the technical building system undergoes such inspection, an exemption from the requirements set out in Article 14(1) could be established.

It is safe to assume that most energy performance contracts or agreements already include some level of regular inspection. However, the full extent of such inspections may not be completely in line with the requirements of the EPBD. Under normal circumstances, it would not be feasible for Member States to individually check each energy service contract to determine whether they are equivalent or not. In addition, since such contracts may be signed by two private companies, the terms and conditions may differ widely between contracts. As a result, Member States may decide to streamline and normalise such contracts.

Article 2(27) of the EED defines energy performance contracting as 'a contractual arrangement between the beneficiary and the provider of an energy efficiency improvement measure, verified and monitored during the whole term of the contract, where investments (work, supply or service) in that measure are paid for in relation to a contractually agreed level of energy efficiency improvement or other agreed energy performance criterion, such as financial savings.'

Amongst other measures, the EED also introduces provisions on energy services. Article 16 of the EED requires Member States to, where necessary, develop certification and/or accreditation schemes.

Article 18 of the EED requires Member States to support the public sector by providing model contracts for energy performance contracting. Under Article 18 of the EED, these model contracts must include at least the items which are listed in Annex XIII.

For the purposes of the equivalence requirements indicated in Article 14(2) of the EPBD, energy performance contracts signed by an accredited/certified company which adequately follows a model such as the one specified by Annex XIII to the 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 exempt 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, therefore, the period for which the exemption applies.

In Member States where model contracts and a list of accredited or certified companies are not publicly available, authorities will need to check contracts individually to verify whether there is equivalence or not. The contracting parties could facilitate this by adding an annex to their contract, clearly and unequivocally indicating at least the following points listed in Annex XIII to the EED:

(a) guaranteed savings to be achieved by implementing the measures of the contract;

(b) duration and milestones of the contract terms and period of notice;

(c) reference date to establish achieved savings;

(d) obligation to fully implement the measures in the contract and documentation of all changes made during the project;

(e) clear and transparent provisions on measuring and verifying the guaranteed savings achieved, quality checks and guarantees (ideally with reference to national or EU standards).

Member States may find it useful to refer to existing standards ([9]), guidelines ([10]) and contract models ([11]).

(b) BACS, continuous electronic monitoring and effective control functionalities (Article 14(4), 14(5), 15(4) and 15(5) of the EPBD)

Article 14(6) of the EPBD exempts from the inspections provided for in Article 14(1) those buildings that comply with the requirements of Article 14(4) and Article 14(5).

Under Article 14(4) of the EPBD, non-residential buildings with heating or combined heating and ventilation systems with an effective rated output of over 290 kW are required to have BACS installed by 2025, wherever technically and economically feasible ([12]).

([9]) e.g. Italian standard UNI CEI 11352, which includes general requirements, checklists for verifying the organisation's requirements and the contents of the service offer, and a checklist and specific references to Annex XIII of the EED, or Spanish standard UNE 216701 'Clasificación de proveedores de servicios energéticos', for the classification of providers of energy services.

([10]) e.g. the Guide for the drafting of documents of administrative and technical clauses for energy performance contracting with guaranteed savings subject to harmonised regulation (service contracts). It is a guide for tendering procedures related to energy performance contracts (available at http://icaen.gencat.cat/web/.content/10_ICAEN/18_actuacio_internacional/Enllacos/Arxius/20180717_EPC_Public_Tendering_GUIDE.pdf).

([11]) e.g. the Spanish 'Modelo de contrato de rendimiento energético con inversión adaptado a la le 9/2017 y a la guía de tratamiento estadístico de Eurostat', and in Slovenia, the 'Oris Vzorca Pogodbe' (available at http://www.energetika-portal.si/podrocja/energetika/energetska-prenova-javnih-stavb/projektna-pisarna/).

([12]) See Sections 2.2.4, 2.3.3.1 and 2.3.3.3(b).

Non-residential buildings with systems that have an effective rated output between 70 kW and 290 kW are not affected by the requirement to have BACS installed, although Member States may decide to lower the threshold and require heating systems with smaller systems to also have BACS installed. Buildings that fall under the new requirement and have BACS installed should also be exempt from inspections.

Individual building owners may decide to install a BACS that is in compliance with the substantive requirements set out in Article 14(4) of the EPBD. In such cases, Member States may decide to exempt those buildings even if their systems do not reach the 290 kW threshold. If Member States decide to do this, they should however include it in their transposition measures for the EPBD.

Article 14(5) of the EPBD introduces the possibility for Member States to ensure that residential buildings are equipped with continuous electronic monitoring and effective control functionalities. In a similar scenario to BACS, some of these elements may already be present in the market in some form or other. However, they might not completely fulfil the requirements of Article 14(5) of the EPBD. Therefore, the definition of these systems and how they are introduced in national legislation should clearly address the differences.

As indicated in recital 39 of Directive (EU) 2018/844, Member States may choose to continue applying the inspection regimes which are already in place. Nevertheless, the exemptions applicable under Article 14(2) and Article 14(6) should still be considered.

2.3.2.9. Alternative measures

Article 14(3) of the EPBD sets out the provisions and obligations for Member States to opt to take alternative measures concerning heating systems or combined heating and cooling systems. In such cases, 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 14(1). This means that a baseline of what would be achieved under the measures set out in Article 14(1) should be calculated, in order to know whether the alternative measures will have the same impact.

There are four scenarios that reflect the different situations that Member States may encounter when applying alternative measures.

(a) Scenario 1: Member States already applied alternative measures before the amendment and decide to continue to apply these measures

The amendment to the EPBD does not substantially change the provisions on alternative measures to inspections. However, they are affected by the amendments to the provisions in the other paragraphs of Article 14. Those provisions have different effects on Article 14(3) of the EPBD, as described in the subsequent paragraphs.

The introduction of the new threshold (70 kW) in the EPBD means that Member States that opt to apply alternative measures must apply these measures in relation to the systems that are covered by the new increased threshold. This could result in a reduction in the number of systems to be covered by the alternative measures and, consequently, might result in a reduction in the energy savings achieved.

In contrast, the new requirement to inspect the ventilation part of combined heating and ventilation systems should increase the impact in terms of energy savings per inspection. Member States should consider this when setting the baseline that they should achieve with their alternative measures.

The provisions on exemptions specified in Article 14(2) of the EPBD (exemptions of systems covered by energy performance criteria) and Article 14(6) (exemptions of systems with BACS) could also result in a reduction in the number of inspections.

Under Article 14(5) of the EPBD, Member States may set out requirements related to electronic monitoring and enhanced control functionalities in residential buildings. Under Article 14(6) of the EPBD, buildings covered by systems providing those functionalities would be exempt from inspections. As a result, Member States that apply alternative measures would have to exclude this group of buildings if they decide to apply such requirements.

The range of measures that Member States may take in order to apply Article 14(3) of the EPBD has not changed with the amendment.

In view of the above, Member States that decide to continue applying alternative measures under the EPBD are under an obligation to ensure that these 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 the Article 14(1). This requires that the baseline of what would be achieved under an inspection regime set up under Article 14(1) be re-calculated in light of the Article 14(1), as well as in view of the above-mentioned amendments and requirements in the EPBD. Such a re-calculation will enable the Member State concerned to know whether the alternative measures that it has in place have the same impact as an inspection would or if they fall short, and to modify the measures accordingly in order to ensure equivalent impact.

Member States should include the results of this process in the report documenting equivalence that must be submitted, in accordance to Article 14(3), to the Commission *before* the alternative measures are applied by the Member State.

(b) Scenario 2: Following transposition, Member States that already applied alternative measures decide to change the nature of their alternative measures

This scenario reflects a situation where, following the initial transposition of Article 14(3) into national law, a Member State decides to change the scope and/or nature of the equivalent alternative measures that it has put in place. For example: a Member State applying measures A, B and C decides to change them and start applying measures C, E and D.

As explained under Scenario 1 above, Article 14(3) of the EPBD states that requires Member States to notify the Commission of their intention to take alternative measures *before* the alternative measures are applied. In order to do so, according to Article 14(3), a Member State must submit to the Commission an additional report that shows that the impact of the amended alternative measures is equivalent to the impact of the inspection schemes referred to in Article 14(1). The Commission will then evaluate this additional report to ensure that the Member State in question continues to achieve an equivalent level of savings.

(c) Scenario 3: Changes to the building stock affect the scope of Article 14(1) and consequently have an impact on the scope of the alternative measures

As the building stock changes and evolves, the scope of an inspection scheme as set out under Article 14(1) will change accordingly. For example, as more and more Nearly Zero-Energy Buildings (NZEBs) enter the market, it is likely that the proportion of buildings with systems over 70 kW will decrease. In addition, buildings with BACS installed (see Chapter 2.8) will be exempt from inspections. Over time, these two elements could have a significant impact on the scope of inspection schemes and therefore on any equivalent alternative measures that Member States already have in place.

Member States may for example identify such changes through a standalone study or through ongoing evaluation of the alternative measures scheme. They may also notice such changes as part of the integrated national energy and climate progress report which, according to Article 17 of Regulation (EU) 2018/1999 of the European Parliament and of the Council ([13]) ('Regulation (EU) 2018/1999'), must be submitted every 2 years.

If the changes in national building stock are such that the scope or intensity of alternative measures is no longer equivalent to those of an inspection regime, then the Member State in question should adapt the alternative measures. Member States can do this either by amending the existing measures or introducing new ones.

Article 14(3) of the EPBD requires Member States to notify the Commission of their intention to take alternative measures *before* they apply the alternative measures. Changes in the building stock might require a Member State to amend its equivalent measures; in such cases, according to Article 14(3) of the EPBD, the Member State in question must notify the Commission of any changes *before* the amended alternative measures are applied.

([13]) Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council (OJ L 328, 21.12.2018, p. 1).

According to Article 14(3) of the EPBD, Member States must notify the Commission by submitting a report that shows that the impact of the amended alternative measures is equivalent to the impact of the inspection schemes referred to in Article 14(1). The Commission will then evaluate this additional report to ensure that the Member State in question continues to achieve an equivalent level of savings.

(d) Scenario 4: Member States opt to take alternative measures for the first time

This scenario concerns a situation where a Member State that had so far used inspection schemes decides to switch to alternative measures for the first time.

Article 14(3) of the EPBD requires Member States to notify the Commission of their intention to use this option *before* they apply the alternative measures. In order to do so, according to Article 14(3) of the EPBD, Member States must submit to the Commission a report which shows that the impact of the alternative measures is equivalent to the impact of the inspection schemes referred to in Article 14(1). The Commission will then evaluate the report to ensure that the Member State in question will in fact achieve an equivalent level of savings.

(e) Submission of reports

According to Article 14(3) of the EPBD, a Member State must submit an equivalence report to the Commission before they apply any alternative measures. The Commission will evaluate the report and take appropriate action vis-à-vis the Member State.

Under Article 14(3) of the EPBD, Member States must also submit any equivalence report as part of their integrated national energy and climate plans (NECPs). Under Article 17 of Regulation (EU) 2018/1999, each Member State is to submit this at the next appropriate step of the reporting cycle ([14]). If the timing of the reporting cycle fits in with the timing of introducing the new or amended alternative measures, the Member State can simply submit the equivalence report as an annex to the NECP.

If the timing does not fit in the way described above, the Member State must in any case, under Article 14(3) of the EPBD, submit their report to the Commission before the measures are put in place. Member States can submit their report directly to DG ENER, although they must, under Article 17 of Regulation (EU) 2018/1999, also submit it during the next NECP cycle.

2.3.3. *Requirements related to the installation of self-regulating devices and BACS (Article 8(1), 14(4) and 15(4) of the EPBD)*

2.3.3.1. Building automation and control systems (BACS) (Article 2(3a), 14(4) and 15(4) of the EPBD)

Building automation and control systems (BACS) are a widely known and used concept whose meaning can vary significantly. Before addressing BACS requirements, it is important to underline what this term refers to in the specific scope of Articles 14 and 15 of the EPBD.

First of all, a BACS is a system that complies with the definition given in Article 2(3a) of the EPBD, which reads as follows ([15]):

'3a. "building automation and control system" means a system comprising all products, software and engineering services that can support energy efficient, economical and safe operation of technical building systems through automatic controls and by facilitating the manual management of those technical building systems;'

([14]) Member States are required to submit their first final NECP by the end of 2019. The NECP will then be updated in 2023 (draft) and 2024 (final update). From March 2023 and then every 2 years, Member States must also submit a progress report on their NECP.

([15]) This definition is close to the one given in standard EN 15232.

In addition, a BACS within the scope of Articles 14 and 15 of the EPBD are required to have all of the capabilities listed in Articles 14(4) and 15(4) of the EPBD, which read as follows:

(a) 'continuously monitor, log, analyse and allow for adjusting energy use;

(b) benchmark the building's energy efficiency, detect losses in efficiency of technical building systems, and inform the person responsible for the facilities or technical building management about opportunities for energy efficiency improvement; and

(c) allow communication with connected technical building systems and other appliances inside the building, and be interoperable with technical building systems across different types of proprietary technologies, devices and manufacturers.'

Building automation and control systems that are installed in non-residential buildings under the obligations of Articles 14(4) and 15(4) of the EPBD must *both* comply with the definition of Article 2(3a) of that Directive and include the capabilities listed above. Those capabilities should be ensured at least for the technical building systems that fall under the scope of Articles 14 and 15 of the EPBD: heating systems, air-conditioning systems, combined heating and ventilation systems, combined air-conditioning and ventilation systems.

Although automation and control systems have been common for some categories of buildings (e.g. non-residential), most buildings do not have such advanced capabilities and the ones that must comply with the above obligations will therefore require upgrades, which can be a significant undertaking.

It is therefore of particular importance that the interested parties (e.g. facility managers of buildings that must comply with the obligations) are made aware of the fact that the scope of the requirements goes beyond what such systems usually cover.

2.3.3.2. Self-regulating devices (Article 8(1) of the EPBD)

The EPBD refers to 'self-regulating device' without giving any specific definition of what it is. However, Article 8(1) of the EPBD clarifies that such a device must allow for the *separate regulation* of the temperature in *each room* (or, where justified, in a designated zone) of the building unit. The devices installed as a result of the implementation of these provisions should therefore:

(a) allow for the automatic adaptation of heating output depending on the indoor temperature (and optionally additional parameters ([16]));

(b) allow for the regulation of heating output in each room (or zone), in accordance with the heating settings of the considered room (or zone).

This means in particular that:

(a) any solution based on the manual regulation of heating output would not fulfil the requirements, even if the adjustment can be performed at room (or zone) level;

(b) any solution that allows for the automatic regulation of temperature but not at room (or zone) level, e.g. automatic regulation at dwelling-level, would not fulfil the requirements.

It is important to note that, regardless of the number or types of system(s) installed, what matters is that the systems make it possible for users to adjust temperature settings and ensure that these settings are respected ([17]).

([16]) In this context, 'automatic' means that the device allows for the automatic regulation of heating output when ambient temperature evolves based on pre-defined settings. Adjustment of the settings themselves, however, is generally manual and performed by users (e.g. manual adjustment of temperature settings with a thermostatic radiator valve).

([17]) For instance, where a building or building unit is equipped with more than one heating system, the requirement could apply to only one of the systems, provided that the expected capability is ensured.

The following table gives some indicative examples of devices that fulfil the requirement for different types of systems ([18]):

Table 2

Examples of self-regulating devices

Device	Type of system	Regulation capability
Thermostatic radiator valve	Hydronic heating system and radiators	Regulation of hot water flow in emitters according to temperature setting
Room thermostat	Hydronic heating system and surface heating (e.g. floor heating)	Regulation of hot water flow in the surface heating thanks to the room's mixing valve
Fan coil unit thermostat	Hydronic heating/cooling system	Control of hot/cool water- and air-flow based on temperature setting
Individual thermostat	Standalone heaters or air-conditioners	Control of heat output depending on temperature setting

(a) Heating, air conditioning, or both?

The second and third subparagraphs of Article 8(1) of the EPBD refer to technical building systems in the broad sense, i.e. as in the definition given in Article 2 of the EPBD. As regards the specific provisions on self-regulating devices (subparagraph 3), the text does not specify which type of system is concerned but does refer to regulation of temperature, which applies both to heating and systems for space cooling.

Therefore, not only heating systems but also air-conditioning systems and systems for space cooling should meet the requirements related to self-regulating devices.

In particular, the reference to 'heated zone' in the text should not be interpreted as implicitly restricting the requirements to only heating systems.

However, the focus of these provisions is effectively on heating, as the vast majority of air-conditioning/cooling systems are already equipped with room- or zone- level monitoring and control.

In addition, when heat generators are replaced in existing buildings, the requirement to install self-regulating devices should apply only to heating systems ([19]).

Also, the third subparagraph of Article 8(1) of the EPBD does not require the installation of self-regulating devices in cases where cooling generators are replaced in existing buildings. However, Member States may consider establishing such an additional requirement ([20]), as it would be consistent with the general objective of these provisions: to ensure adequate regulation capability and avoid wasting energy.

The following table summarises the different cases that may arise.

([18]) Self-regulating devices can be electronic or not (e.g. a thermostatic radiator valve); what matters is the self-regulation capability, not the technology itself.

([19]) This means in particular that when heat generators are replaced in an existing building that is equipped with a system for space cooling that has no self-regulation at room- or zone-level, the requirement to install self-regulating devices at room- or zone-level would not extend to the system for space cooling.

([20]) Most space cooling systems will have the self-regulation capability anyway but this is not a requirement under Ecodesign regulations.

Table 3

Cases that should trigger the requirement to install self-regulating devices

New or existing building	Type of intervention	Should requirement to install self-regulating devices apply?
New	Installation of heating system	Yes
New	Installation of space cooling system	Yes
Existing	Replacement of heat generators	Yes, only for heating system
Existing	Replacement of cool generators	Up to Member State

(b) Room- or zone-level?

The principal requirement is the possibility to regulate temperature at room-level. The installation of self-regulating devices at zone-level, however, has to be justified.

A 'room' is to be understood as a part or division of a building enclosed by walls, floor and ceiling.

A 'heated zone' is to be understood as a zone of a building or building unit, located on a single floor, with homogeneous thermal parameters and corresponding temperature regulation needs (i.e. the equivalent of a 'thermal zone', a common concept in the scope of energy performance calculation).

Here are two examples of cases ([21]) where it may be justified to consider zone-level instead of room-level for the application of requirements:

(a) adjacent offices with identical indoor environment requirements in an office building;

(b) adjacent rooms/spaces that are not physically separated one from the other (e.g. open-plan kitchen and living room in an apartment).

The assessment of the most appropriate scope of the regulation (room or zone) will generally depend on the design and intended use of the specific building or building unit, and of the spaces therein. In making this assessment, the main parameter to consider will generally be whether several rooms can share the same indoor environment requirements and, therefore, could be merged into a single zone (from a temperature regulation perspective). Such cases should be well justified.

However, taking into account certain national, regional or local specificities, Member States may allow zone-level temperature regulation for some categories of buildings or building units, when there is sufficient justification for doing so. In such cases, Member States should clarify the categories of buildings or building units targeted and the national, regional or local specificities considered. They should also justify ([22]) allowing an upfront deviation from the principal requirement for these categories of buildings or building units.

2.3.3.3. When do the obligations apply? (Article 8(1), 14(4) and 15(4) of the EPBD)

(a) Self-regulating devices (Article 8(1) of the EPBD)

The text requires that new buildings are equipped with self-regulating devices. It requires the same for existing buildings when heat generators are being replaced.

([21]) These are indicative examples. There can be other cases where zone-level regulation is justified.
([22]) Such justification can, for example, be based on scientific studies whose results would back the assessment that zone-level regulation is preferable in the considered cases.

The obligations apply to all types of buildings and all types of systems unless meeting them is not technically and economically feasible (see section (b)).

Article 2(15b) of the EPBD defines a 'heat generator' as follows:

"'heat generator" means the part of a heating system that generates useful heat using one or more of the following processes:

(a) the combustion of fuels in, for example, a boiler;

(b) the Joule effect, taking place in the heating elements of an electric resistance heating system;

(c) capturing heat from ambient air, ventilation exhaust air, or a water or ground heat source using a heat pump;'

It is important to note that this definition does not differentiate between heat generators that are distinct from heat emitters (e.g. boiler and radiators) and those that are integrated with the heat emitter in a standalone heating system (e.g. electric resistance heaters). This means that the obligations (on self-regulation) should also apply in the latter case (i.e. when a standalone heating system is replaced in an existing building).

When buildings are equipped with multiple heat generators, situations may arise where only a part of the heat generators is replaced. In such situations, the requirement to install self-regulating devices should also apply, where technically and economically feasible. In particular, if several heat generators are coupled together and serve the same space, and at least one of the heat generators is replaced, then the requirement applies. If a building is equipped with several heat generators that are independent and serve different spaces, Member States may allow the requirement to apply only to the space(s) served by the replaced heat generator(s).

Where existing buildings are connected to district heating and are not equipped with any heat generators at building level, the requirement to install self-regulating devices would normally apply when district heat generators are replaced. In some cases, this could lead to difficulties, e.g. related to ownership ([23]) or to economic feasibility ([24]). In such cases, Member States may investigate alternative paths to ensure that self-regulating devices are installed, for instance:

(a) requiring that self-regulating devices are installed when heat exchangers in buildings are replaced;

(b) drawing up and implementing a roadmap for the progressive deployment of self-regulating devices, aiming at full coverage of buildings but spreading the costs over a sufficient time period.

The installation of a new heating system in an existing building or building unit that was already equipped with a heating system (e.g. installation of a central heating system that replaces individual heating systems in a building) should trigger the requirement to install self-regulating devices, as it implies the replacement of heat generators.

The installation of a heating system in a construction that was formerly not a building within the meaning of the EPBD but which, for example subsequently, due to restoration works, becomes a building in the sense of the EPBD, should also trigger the requirement to install self-regulating devices.

(b) BACS (Article 14(4) and 15(4) of the EPBD)

The provisions on installing building automation and control systems apply to all (i.e. new and existing) non-residential buildings with heating, air-conditioning, combined heating and ventilation, combined air-conditioning and ventilation systems with an effective rated output over 290 kW.

The 290 kW threshold applies to each system individually, i.e. the obligations apply in all of the following cases, according to Article 14(4) and 15(4):

(a) when the effective rated output of the heating system is above 290 kW;

([23]) When the district heating system and buildings connected to it are under different ownerships.
([24]) When a high number of buildings is impacted by the requirement at the same time, which could lead to disproportionate costs. Such cases should however be covered by the economic feasibility conditions defined by Member States.

(b) when the effective rated output of the combined heating and ventilation system is above 290 kW;

(c) when the effective rated output of the air-conditioning system is above 290 kW;

(d) when the effective rated output of the combined air-conditioning and ventilation system is above 290 kW.

Additional clarifications on how to determine effective rated output are given in section 2.3.2.2.

2.3.4. *Technical, economic and functional feasibility (Article 8(1), 14(4) and 15(4) of the EPBD)*

The notion of 'feasibility' is relevant for:

(a) the application of system requirements under Article 8(1) of the EPBD, which states that system requirements must be applied *'in so far as these are technically, economically and functionally feasible* ([25])'; and

(b) the installation of self-regulating devices (Article 8(1)) of the EPBD and BACS (Article 14(4) and 15(4) of the EPBD), as related requirements apply only *'where technically and economically feasible'*.

Note that it is for Member States to detail in which specific cases 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 ([26]).

The interpretation of technical, economic and functional feasibility should not be left to the sole judgement of interested parties (e.g. owners or system installers ([27])). The conditions under which feasibility is evaluated should be defined at Member State level or, where regional conditions affect only part of a Member State's territory, at regional level. However, in the latter case, regional conditions should be defined in national transposition measures. In all cases, these conditions should be documented (e.g. as part of technical guidelines) and should apply uniformly on the national, or, where applicable, regional, territory. Finally, the non-application of system requirements should be assessed using 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 would 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 Directive allows Member States to introduce derogations in the application of minimum energy performance requirements (Article 4(2) of the EPBD).

Nevertheless, the specificities of certain buildings can be taken into account when evaluating the technical, economic and/or functional feasibility of meeting the requirements. In exceptional cases, where the evidence points to the conclusion that compliance with the requirements is technically, economically or functionally impossible for a specific building, the 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.

([25]) This mention was already included before the amendment.
([26]) It is recommended that Member States ensure the adequate involvement of stakeholders in defining conditions for technical, economic and functional feasibility.
([27]) Meaning that, in cases where such parties are responsible for assessing feasibility, their interpretation has to 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.

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

Table 4

Interpretation of technical, economic and functional feasibility

Type of feasibility (1)	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 inlet 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 the costs of applying the requirements and whether: (i) these costs are proportionate with regard to the costs of the planned intervention (e.g. system upgrade); (ii) the expected benefits outweigh the costs (2) taking into account the expected lifetime of the system.	Economic feasibility can e.g. be calculated based on: — a maximum ratio between the costs of applying the requirements and the costs of the planned intervention (e.g. heat generator replacement); — a maximum recovery period, taking into account monetary benefits of applying the requirements.
Functional feasibility (3)	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 building space).

(1) The two first rows (technical and economic feasibility) apply to system requirements in Article 8(1) of the EPBD, and to requirements on the installation of self-regulating devices (Article 8(1)) and BACS (Article 14(4) and 15(4) of the EPBD), while the third row (functional feasibility) applies only to system requirements in Article 8(1).

(2) 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 lead to the costs being recovered (in particular due to energy cost savings).

(3) Applies only to system requirements in Article 8(1) of the EPBD.

(a) Additional considerations related to the technical and economic feasibility of installing self-regulating devices

In the vast majority of cases, the question of technical and economic feasibility of installing self-regulating devices will not apply to new buildings, as the need for temperature self-regulation at room (or zone) level can be addressed in the design phase, which prevents technical barriers from appearing in subsequent steps and ensures that related costs are optimal. One straightforward example of a case where it would not be technically feasible to install self-regulating devices in a room or a zone is when this room or zone will not be heated (or cooled).

For existing buildings, technical feasibility can be an issue where it is not possible to install self-regulating devices without carrying out substantial alterations to the systems and/or to the building, which would inevitably lead to prohibitive costs (this can e.g. be the case for some types of floor heating systems in existing buildings).

Economic feasibility can be an issue for existing buildings as well, when the cost of installing the self-regulating devices is excessive as compared to the cost of replacing the heat generator. When they choose to evaluate feasibility based on costs, Member States should clarify how the costs are calculated and how they compare. The two following approaches may be considered:

(a) Comparing the upfront costs of installing self-regulating devices with the costs of replacing the heat generators and setting a threshold for the maximum ratio between the two. This approach is in line with recital 21 of Directive (EU) 2018/844, which reads as follows:

'The installation of self-regulating devices in existing buildings for the separate regulation of the temperature in each room or, where justified, in a designated heated zone of the building unit should be considered where economically feasible, for example where the cost is less than 10 % of the total costs of the replaced heat generators.'

(b) Comparing the upfront costs of installing self-regulating devices with the expected energy cost savings resulting from their installation and setting a threshold for the maximum cost recovery period (e.g. 5 years).

While both approaches are possible, the latter option should be preferred, as in the vast majority of cases the initial costs will be recovered within a short period of time (typically 2 to 3 years).

Table 5

Possible interpretation of technical and economic feasibility for the installation self-regulating devices

Type of feasibility	How it can translate	Can apply to	
		New buildings	Existing buildings
Technical feasibility	The room (zone) has no heating/cooling.	Yes (but rare)	Yes (but rare)
	The heating system makes it impossible to install self-regulating devices.	No	Yes (but not frequent)
Economic feasibility	The upfront costs are too high compared to other costs.	No	Yes (but not frequent)
	The investment cannot be sufficiently recovered.	No	Yes (but rare)

(b) Additional considerations related to the technical and economic feasibility of installing BACS

In the vast majority of cases, the question of whether installing self-BACS is technically and economically feasible will not apply to new buildings, as:

(a) the building- and system design can ensure that there are no technical barriers to installing BACS;

(b) the building- and system design can ensure that the costs of installing BACS are minimised;

(c) installing BACS is already part of common practice for new large non-residential buildings.

For existing buildings, the only cases where technical feasibility can be an issue are those where the technical building systems cannot be controlled, or when making them controllable would require substantial alterations to the system and/or the building, which would inevitably lead to prohibitive costs. Such situations are limited to buildings that are equipped with old systems and should rarely arise.

The economic feasibility of installing BACS in existing buildings can also be linked to the upfront and running costs and/or to the cost recovery period required. A possible approach is to evaluate economic feasibility based on the expected energy cost savings generated by the BACS and to compare them to the upfront and running costs of installing the BACS, over the system's lifetime. This can be supplemented by an evaluation of the proportionality of the upfront costs of installing BACS in the building in question, based on such parameters as e.g. building size or energy consumption ([28]).

Table 6

Possible interpretation of technical and economic feasibility for the installation of BACS

Type of feasibility	How it can translate	Can apply to	
		New buildings	Existing buildings
Technical feasibility	The technical building systems cannot be controlled without substantial alterations.	No	Yes (but rarely)
Economic feasibility	The upfront costs are excessive compared to the building's characteristics.	No	Yes (but rarely)
	The investment cannot be sufficiently recovered.	No	Yes (but rarely)

2.4. Guidelines on transposition of provisions on technical building systems and their inspections, self-regulating devices and BACS

2.4.1. *Technical building systems requirements, and assessment and documentation of overall energy performance of technical building systems (Article 2, 8(1), 14 and 15 of the EPBD)*

2.4.1.1. Transposition of definitions (Article 2 of the EPBD)

Where relevant, Member States should consider giving additional clarifications to supplement the definitions of technical building systems, for instance to describe in more detail the capabilities that building automation and control systems are expected to achieve.

2.4.1.2. Establishment of system requirements (Article 8(1) of the EPBD)

(a) New technical building systems

For systems that were not considered before the amendment (building automation and control systems and on-site electricity generation), Member States will have to define and lay down system requirements at national level and ensure that these requirements cover all the aspects referred to in Article 8(1) of the EPBD: 'overall energy performance', 'proper installation', 'appropriate dimensioning', 'adjustment' and 'control'. The following table outlines the meaning of each of these requirement areas, giving examples (for illustration purposes only) for the two types of systems that have been added to the list of technical building systems in the EPBD.

([28]) The 'décret tertiaire' French act (2017) e.g. set a threshold of maximum 200 EUR/m² for the investment and a maximum payback time of 10 years for public buildings and 5 years for others (hotels, offices, etc.).

Table 7

Different system requirements areas

Type of requirement	Refers to	Examples	
		BACS	On-site electricity generation
'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)	Control capabilities that have an impact on building energy performance (e.g. following EN 15232 standard ([1]))	System performance factor of a photovoltaic (PV) system (e.g. following EN 15316-4-6 standard ([2]))
'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 control capabilities based on the type of building, expected usage, potential energy savings	Determine the optimal size of the PV system based on electricity cost reduction, available mounting area and other constraints that could apply
'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
'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	Sequence of tests to be performed after installation to check that the system operates in accordance with its specifications
'appropriate control'	Desired or required control capabilities of systems	Scope of control functions	(Where applicable) control of electricity feed (e.g. to grid, self-consumption, or storage)

([1]) EN 15232 'Energy performance of buildings — Impact of Building Automation, Controls and Building Management'.
([2]) EN 15316-4-6 'Heating systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-6: Heat generation systems, photovoltaic systems'.

(b) Systems already covered before the amendment

For systems already covered before the amendment, Member States could consider using the transposition of Directive (EU) 2018/844 as an opportunity to review and possibly update applicable system requirements. This review could in particular be an opportunity to check that the applicable requirements cover sufficiently the different areas listed in the EPBD and assess whether the requirements could be further developed. Feedback from the Concerted Action EPBD ([29]) European network suggests that: (i) the focus of applicable requirements is generally on component-level performance requirements; and (ii) the way other areas (i.e. proper installation, appropriate dimensioning, adjustment and control) are addressed can vary across the EU. Member States are therefore encouraged to take part in this review and, where relevant, draw on available good practices.

([29]) 'Book: 2016 — Implementing the Energy Performance of Buildings Directive (EPBD) — Featuring Country Reports', Concerted Action EPBD, 2016, https://www.epbd-ca.eu/ca-outcomes/2011-2015

(c) Consideration of product-specific Regulations under the ecodesign Directive

Technical building systems include many products that are regulated under product-specific Regulations that implement Directive 2009/125/EC ('ecodesign Directive'). In relation to product-specific Regulations implementing the ecodesign Directive which concern products that can be part of technical building systems as defined in Article 2(3) of the EPBD, it is worth emphasising that requirements under Article 8(1) of the EPBD apply to whole systems, as installed in buildings, and not to the performance of standalone components, which falls under the scope of product-specific Regulations implementing the ecodesign Directive. By way of example, the scope of requirements of Article 8(1) of the EPBD for a building hydronic heating system would cover the whole system (boilers, distribution and emission components), whereas the scope of ecodesign requirements for products being part of the same system would be limited to those applying to boilers.

It is generally beneficial to encourage the installation of high-performance products, however, where requirements under Article 8(1) of the EPBD would apply to products already covered by product-specific Regulations implementing the ecodesign Directive, these requirements must not go beyond the requirements set by the latter, as product-specific Regulations implementing the ecodesign Directive are directly applicable harmonisation measures.

Banning specific types of products which comply with the applicable ecodesign requirements would go beyond what the EPBD requires and allows, because products from other Member States which comply with all ecodesign requirements could not be sold on other national markets, in breach of the basic principle of free movement of goods.

However, Member States may, in certain cases, restrict the free movement of goods for environmental reasons, but only after having notified the Commission ([30]). This is consistent with recital 35a ([31]) and Article 6 ([32]) of the ecodesign framework.

2.4.1.3. Transposition of the provisions on assessing and documenting system performance (Article 8(1) of the EPBD)

(a) System or altered part?

Article 8(9) of the EPBD stipulates that when a technical building system is installed, replaced or upgraded, the overall performance 'of the altered part and, where relevant, of the complete altered system', must be assessed and documented.

This means that:

(a) in all cases, the performance of the altered part has to be assessed and documented. For example, if the heat generator of a heating system is replaced — which corresponds to a system upgrade, the performance of the new heat generator should be assessed and documented;

(b) in some cases (i.e. 'where relevant'), the performance of the whole system must be assessed and documented. This should be required in the following three situations:

(i) a new system is installed;

(ii) a whole system is replaced;

(iii) a part, or parts, of a system undergo a *major* upgrade that can significantly affect that system's overall performance.

([30]) For further information, see Article 114(4) and (5) of the Treaty on the Functioning of the European Union (TFEU).

([31]) This recital states that: 'Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings requires Member States to set energy performance requirements for building elements that form part of the building envelope and system requirements in respect of the overall energy performance, the proper installation, and the appropriate dimensioning, adjustment and control of the technical building systems which are installed in existing buildings. It is consistent with the objectives of this Directive that these requirements may in certain circumstances limit the installation of energy-related products which comply with this Directive and its implementing measures, provided that such requirements do not constitute an unjustifiable market barrier.'

([32]) The Energy Efficiency Directive adds the following sentence to Article 6 of the Ecodesign framework ('Free movement'): 'This shall be without prejudice to the energy performance requirements and system requirements set by Member States in accordance with Article 4(1) and Article 8 of Directive 2010/31/EU.'

Cases referred to in points (i) and (ii) of subparagraph (b) are straightforward: when a whole new system is installed or replaced (whether in a new building or in an existing building), there is a clear need to assess and document the performance of the whole (new) system.

In the case referred to in point iii of the subparagraph (b), a part or parts of the system are replaced or improved, thereby upgrading their energy performance. Because the part is so important, this results in an upgrade in the performance of the whole system. In this scenario, the whole system performance should be assessed. For instance:

(a) replacing a major component (e.g. the heat generator in a system) or a large number of minor components (e.g. all heat emitters in a building) should be considered in principle as a major upgrade as it has a potentially significant impact on overall performance.

(b) altering aspects of the whole system (e.g. improved insulation of pipes, replacement of pipes, replacement of all light sources, replacement of all radiators) should be considered in principle as a major upgrade.

(c) the same applies to any upgrade or alteration that affects the balance of the system.

In the following examples, the assessment obligation should not be triggered:

(a) maintenance and repairs that only aim to ensure the safe and optimal operation of the system;

(b) replacement of a minor system component (e.g. replacement of a heat emitter).

In any case, it is up to Member States (and not to building and dwelling owners) to set out in their national legislation the cases where it is relevant to assess the performance of the whole system, as opposed to those where only the assessment of the performance of the altered part is required.

In this context, Member States may differentiate between the different buildings and building units that can be affected by these provisions. This can concern for example the type of buildings (for example, residential or non-residential, individual dwelling or multi-family building). This can also possibly relate to system size, as it may be more appropriate to perform a more detailed assessment when a system is larger and more complex.

(b) Overall performance

Within the scope of the provisions on assessing and documenting system performance, assessing the overall performance (of the altered part or of the whole system) means taking the necessary steps to evaluate and express the energy performance (of the altered part or of the whole system).

The term ‘overall’ emphasises the need — where it applies — to assess the performance of the system as a whole opposed to performance at product or component level. This is less relevant when it is the performance of the altered part that is being assessed.

Member States should ensure that the scope of overall energy performance of a technical building system under Article 8(9) of the EPBD includes for assessment and documentation purposes at least the scope of overall energy performance under Article 8(1) for system requirements, and also those aspects that can affect overall energy performance under the other requirement areas (in particular control). This will ensure that compliance with system requirements is assessed and documented, that the owner is made aware of this compliance and that compliance can be proven (e.g. when the building or building unit is sold to a new owner).

Performance can be assessed in different ways; Member States should clarify which approach should be followed. These can vary depending on different factors (e.g. type of system considered, type of intervention: installation, replacement, upgrade, etc.) Upgrades that are limited in scale and impact could lead to lighter assessment approaches e.g. recording the intervention and ensuring that all relevant technical documents on the component(s) impacted are collected. More substantial interventions (typically installation or replacement) could require a more thorough assessment of the impact on the system as a whole e.g. based on the simulation of system performance when the system is designed and on verification of key system capabilities after instalment.

When determining their approach to performance assessment, Member States should ensure consistency with the requirements in Article 14 and 15 of the EPBD on inspections of heating, air-conditioning and ventilation systems, in particular in relation to the requirement to assess (where relevant) the system’s capabilities under typical or average operating conditions. For instance, where guidelines or templates for the inspection of technical building systems under Articles 14 and 15 of the EPBD are available, references to these guidelines or templates may be made in the performance assessment under Article 8 of the EPBD.

(c) Documentation of system performance

Article 8(9) of the EPBD requires that the results of the assessment of the system (or of an altered part of it) performance are documented and passed on to the building owner. Member States are free to determine the form and content of this documentation, which can vary depending on the type of intervention considered. However, in this context, Member States should ensure that the documentation covers the scope of the assessment performed and can be useful for the verification of compliance with the minimum requirements on energy performance laid down pursuant to Article 8(1) of the EPBD and for energy performance certification (see next sub-section). Member States are also free to determine how the documentation is to be passed on to the building owner.

(d) Relation with building energy performance requirements and energy performance certificates

The obligations in Article 8(9) of the EPBD on documenting system (or altered part) performance aim to ensure that up-to-date information on technical building system performance is made available to building owners. Such information can be used, for instance, for energy performance certification or to verify compliance with minimum energy performance requirements (e.g. when a building undergoes a major renovation). It is up to Member States to decide whether a new energy performance certificate (EPC) will have to be issued as a result of the energy performance assessment of the technical building system (or an altered part of it).

2.4.2. *Inspection of heating, air-conditioning, combined heating and ventilation, and combined air-conditioning and ventilation systems (Article 14 and 15 of the EPBD)*

2.4.2.1. Inspections of heating and combined heating and ventilation systems (Article 14 of the EPBD)

(a) Systems to be inspected

The amendment to the EPBD expands the scope of systems to be inspected under Article 14(1), to include combined heating and ventilation systems.

Member States should include a definition of 'combined heating and ventilation system' in their national legislation.

Member States should ensure that the definition of such systems includes heat pumps and determine whether they fall within the scope of Article 14 or 15 of the EPBD (see Section 2.3.2.4).

(b) Effective rated output

Article 14(1) of the EPBD requires inspections of systems with an effective rated output over 70 kW. Before the amendment to the EPBD, the threshold laid down in its Article 14(1) for inspections of a boiler's effective output was only 20 kW.

This change affects both the threshold on output (increased from 20 kW to 70 kW) and the scope to consider when rating the output. Before the amendment, the rating made reference only to the boiler, while the rating in the EPBD now makes reference to the system as a whole. Systems with multiple heat generators (e.g. Type 1 and Type 2 systems as described in section 2.2) should also fall under the obligation laid down in Article 14(1) of the EPBD if the overall rating of multiple heat generators serving the same area or building unit exceeds 70 kW.

As indicated in recital 39 of Directive (EU) 2018/844, Member States may choose to continue applying the inspection regimes already in place, including inspections for smaller heating systems (i.e. of a threshold between 20 kW and 70 kW of effective rated output). If Member States decided to continue to operate those schemes, there would be no obligation on Member States to notify those more stringent requirements to the Commission.

(c) Performance under typical or average operating conditions

According to Article 14(1) of the EPBD, Member States must expand the scope of the inspection to include, where relevant, assessment of the system under typical or average operating conditions.

Member States should determine what changes are required in the inspection methodology. This should focus on inspection requirements and guidelines.

(d) Exemptions based on energy contracts or agreements

Member States may update their national legislation to include exemptions for buildings covered by an agreed energy performance criterion or a contractual arrangement specifying an agreed level of energy performance improvements. Member States may also include exemptions for buildings operated by a utility network or operator.

If Member States decide to allow such exemptions, they should ensure that new legislation addresses the definition of 'energy performance criterion' or 'contractual arrangement specifying an agreed level of energy performance'.

If Member States decide to include the exemptions indicated under Article 14(2) of the EPBD, they must ensure that the overall impact of the approach is equivalent to those of inspections resulting from Article 14(1) of the EPBD.

To ensure this equivalence, it is recommended that Member States make use of the possibilities to implement Article 18 of the EED by creating a publicly available list of certified/accredited companies. In addition, Member States would need to produce publicly available models for energy performance contracts in line with Annex XIII to the EED.

For those Member States without a list of certified/accredited companies or without publicly available models for energy performance contracts, the equivalence should be established on a case-by-case basis. Under this scenario, the contracting parties could facilitate the process by introducing an annex in their contract clearly identifying the following points from Annex XIII to the EED:

(a) guaranteed savings to be achieved by implementing the measures of the contract;

(b) duration and milestones of the contract terms and period of notice;

(c) reference date to establish achieved savings;

(d) obligation to fully implement the measures in the contract and documentation of all changes made during the project;

(e) clear and transparent provisions on measurement and verification of the guaranteed savings achieved, quality checks and guarantees (ideally with reference to national or EU standards).

(e) Voluntary requirements for residential buildings

Article 14(5) of the EPBD refers to the option to introduce both functionalities (i.e. electronic monitoring and effective control functionalities) for residential buildings.

Member States that decide to introduce the requirements for residential buildings should include a clear definition of the meaning of continuous electronic monitoring and effective control functionalities.

Article 14(5) of the EPBD has an optional character (i.e. the term 'may' is used in its wording) and does not include details on thresholds in terms of effective rated output. Instead it implicitly refers to all residential buildings regardless of their size. It is recommended that Member States take into consideration the differences in types of systems or buildings when laying down the requirements.

(f) Exemptions based on BACS or continuous electronic monitoring and effective control functionalities

The EPBD exempts from inspection technical building systems that comply with Article 14(4) (building automation and control systems) and 14(5) (voluntary requirements for residential buildings).

Member States must update national legislation to introduce the definition of BACS.

Member States may decide to lower the threshold for the requirement on installing BACS indicated in Article 14(4) of the EPBD. Those buildings under the new requirement and with BACS installed should also be exempt from inspections.

Member States may decide to extend the exemption on inspections for individual building owners with systems under 290 kW that have BACS installed in compliance with Article 14(4) of the EPBD. Member States that extend this exemption should inform the Commission of this when they notify it of their transposition measures.

Member States that choose to introduce requirements for residential buildings should also consider exemptions to inspections.

(g) Alternative measures

The transposition of Article 14 of the EPBD for Member States that decide to apply alternative measures is to a large extent only affected by the changes in scope, thresholds and exemptions (see Section 2.3.2.8). Member States may continue to apply the same range of measures.

Member States already applying alternative measures must ensure, according to Article 14(3) of the EPBD, that the measures in place are equivalent to those set out in Article 14(1) of the EPBD. This may require adaptation of the alternative measures. According to Article 14(3) of the EPBD, Member States must document in a report to the Commission the equivalence of the measures and the report must be sent before any new or adapted measures are put in place.

If at some point after transposition of the EPBD, a Member State decides to modify the range or scope of existing measures or introduce new measures, it must notify the Commission of such changes. To do so, Member States must submit a report on the equivalence of the measures, before the new or adapted measures are put in place.

In accordance with Regulation (EU) 2018/1999, each Member State must submit equivalence reports required by the EPBD as part of its national energy and climate plan (NECP). The timeline for submitting NECPs and progress reports is indicated in Section 2.3.2.9.

If the timing of the NECPs is not suitable for a Member State, it may submit the equivalence report directly to the Commission. However, the Member State must ensure that the equivalence report is also included in the next step of the NECP.

2.4.2.2. Inspections of air-conditioning and combined air-conditioning and ventilation systems (Article 15 of the EPBD)

As with Article 14, the requirements of Article 15 of the EPBD must also be incorporated into national law. The obligations in Article 14 are the same as those for Article 15. The provisions in this Annex relating to Article 14 should also be applied by analogy in the context of Article 15.

Information on how to transpose Article 15 of the EPBD is provided in Sections 2.4.2.1(a) to 2.4.2.1(g) of this Annex:

(a) systems to be inspected (Section 2.4.2.1(a));

(b) effective rated output (2.4.2.1(b));

(c) performance under typical operating conditions (2.4.2.1(c));

(d) exemptions based on energy contracts or agreements (2.4.2.1(d));

(e) voluntary requirements for residential buildings (2.4.2.1(e));

(f) exemptions based on BACS or continuous electronic monitoring and effective control functionalities (2.4.2.1(f));

(g) ensuring transposition of Article 14(3) of the EPBD — alternative measures (2.4.2.1(g)).

2.4.3. *Requirements on installation of self-regulating devices and BACS (Article 8(1), 14(4) and 15(4) of the EPBD)*

2.4.3.1. Transposition of requirements on installation of self-regulating devices (Article 8(1) of the EPBD)

Under the obligations on installing self-regulating devices (Article 8(1) of the EPBD):

(a) every new building must be equipped with self-regulating devices by the transposition deadline. This should be ensured in the case of buildings for which permit applications are submitted after the transposition deadline.

(b) all existing buildings whose heat generators are replaced as from the date of the national transposition of these obligations must be equipped with self-regulating devices.

Those obligations apply except in infrequent/rare cases where it is not technically or economically feasible to install such devices.

Member States should advertise these requirements sufficiently in advance so that professionals can take them into account early enough when designing new buildings and when preparing the replacement of heat generators in existing buildings.

In transposing the requirements on the installation of self-regulating devices, Member States should ensure that the expected self-regulating capability of such devices is clearly expressed and in line with the one given in Article 8(1) of the EPBD, as detailed in Section 2.3.3 of this Annex.

In the EPBD, this self-regulating capability is expressed in a technology-neutral way. This leaves flexibility on the specific solutions that can be used to achieve this capability. While this flexibility can be considered beneficial (as it allows designers and installers to select the best solution for a given building or building unit), Member States are also encouraged to provide further technical guidance on how to implement self-regulation for the various systems that can be encountered, in particular the most common ones. The table in Section 2.3.3.2 gives some examples.

On the scope of regulation (i.e. room or zone), Member States are also encouraged to provide technical guidance on cases where zone-level regulation could help professionals in their assessment and could support consistent implementation of the requirements in the national (or, where applicable, regional) territory.

In cases where Member States allow zone-level regulation for well-identified categories of buildings or building units (see Section 2.3.3.2(b)), this should be made clear in the transposition of the requirements or in the technical guidelines supporting their implementation.

2.4.3.2. Transposition of requirements on the installation of BACS (Article 14(4) and 15(4) of the EPBD)

Articles 14(4) and 15(4) of the EPBD refer to 2025 as the date by which non-residential buildings must be equipped with building automation and control systems satisfying the conditions established in those articles. However, the requirements ensuring installation are required to be transposed by the transposition deadline of 10 March 2020.

In transposing the BACS installation requirements, Member States must ensure that the capabilities of the required systems are in line both with: (i) the definition of building automation and control systems in Article 2(3a) of the EPBD; and (ii) the capabilities listed in points (a), (b) and (c) of Articles 14(4) and 15(4) of the EPBD (see Section 2.3.3.1).

While compliance with the definition of BACS should not bring any particular difficulty, it can be challenging to identify — for a given building — the available capabilities and how they correspond to those provided for under the EPBD. One way to make this easier is to map these capabilities to BACS functions and classes as defined in available standards, in particular under EN 15232 ([33]).

([33]) As a first-order estimate, the BACS capabilities required under Article 14-15 could correspond to B-class BACS under EN 15232.

In any case, Member States are encouraged to provide professionals with dedicated technical guidelines. Such guidelines would help professionals assess BACS capabilities and identify potential gaps, and would give recommendations on how to fill such gaps effectively.

2.5. Additional considerations on system requirements, system performance assessment and documentation, inspections and BACS

This section will highlight good practices. The information and references provided here are neither exhaustive nor prescriptive — they are provided for information only.

2.5.1. *Possible interpretations of requirements on technical building systems (Article 8(1) of the EPBD)*

2.5.1.1. New technical building systems

Two new technical building systems are introduced in the EPBD: (i) building automation and control systems (BACS); and (ii) on-site electricity generation systems. The following tables summarise how such requirements could be interpreted when implementing the EPBD.

As regards on-site electricity generation, our assumption is that the main target is photovoltaic panels. However, wind turbines (where their size allows for on-site usage) and micro combined heat and power (micro CHP) systems are also within the scope of the EPBD.

Table 8

Possible interpretation of system requirements for BACS

Type of requirement	Possible interpretations for BACS	Useful references ([1])
'overall energy performance'	Minimum requirements on control capabilities that have an impact on building energy performance. These requirements can concern the scope of control (i.e. which systems are controlled), the depth (or granularity) of control, or both. In defining these requirements, references can be made to available standards, for instance to BACS energy classes as defined in EN 15232 standard. Requirements can vary depending on the type of buildings (e.g. residential vs non-residential) and on some characteristics of buildings (e.g. surface area).	EN 15232 ([2]), EN 16947-1:2017 ([3]) and TR 16947-2 ([4])
'appropriate dimensioning'	Dimensioning would refer here not to system size (as it would for some other systems), but more to the way the design of a BACS can be tailored to a specific building. The aim of dimensioning is to reach the best compromise between costs and capabilities in consideration of the specific needs of the considered building. Requirements on dimensioning will list the relevant aspects that should be taken into account when designing a BACS for a specific building (e.g. expected or measured energy consumption, building usage, technical building systems installed in the building, operation and maintenance requirements) in order to reach this optimal compromise. Within the scope of these requirements, it can be useful to refer to relevant standards or guidelines.	ISO 16484-1:2010 ([5])
'proper installation'	Requirements on the 'proper installation' is a generic reference to the need to ensure that the system (here, the BACS) is installed in a way that will ensure safe and optimal operation. Usually this is linked to requirements on the qualification of the installer (e.g. certified installer) and to specific technical guidelines.	EN 16946-1:2017 ([6]) and TR 16946-2 ([7])

Type of requirement	Possible interpretations for BACS	Useful references [1]
'appropriate adjustment'	'Adjustment' refers to: (i) a post-installation test of the system to check that it operates properly; and (ii) fine-tuning when the system is operating under real conditions. Such actions would generally require human intervention, but BACS give the opportunity to also consider ongoing commissioning approaches where this process is partially automated [8].	EN 16946-1:2017 [6] and TR 16946-2 [7]; ISO 50003 [9]
'appropriate control'	This category applies mostly to technical building systems that are controlled (e.g. heating systems) rather than to BACS, whose main purpose is to control other systems. However, 'appropriate control' can refer here to the functions that a BACS can offer to support or facilitate human control (e.g. display of consumption data or any other interaction with building operator and building occupants).	EN 15232 [2], EN 16947-1:2017 [3] and TR 16947-2 [4]

[1] The references given all relate to standards. In addition to these, Member States can consider drawing on the practices of some industry-led schemes, whether European, e.g. the eu.bac certification scheme (https://www.eubac.org/system-audits/index.htm) or national, e.g. in Germany the VDMA 24186-4 'Program of services for the maintenance of technical systems and equipment in buildings — Part 4: Measurement and control equipment and building automation and control systems'.
[2] EN 15232 'Energy performance of buildings — Impact of Building Automation, Controls and Building Management'.
[3] EN 16947-1:2017 'Energy Performance of Buildings — Building Management System — Part 1'.
[4] TR 16947-2 'Building Management System — Part 2: Accompanying prEN 16947-1:2015'.
[5] ISO 16484-1:2010 Preview 'Building automation and control systems (BACS) — Part 1: Project specification and implementation'.
[6] EN 16946-1:2017 'Energy Performance of Buildings. Inspection of Automation, Controls and Technical Building Management'.
[7] TR 16946-2 'Inspection of Building Automation, Controls and Technical Building Management — Part 2: Accompanying TR to EN 16946-1'.
[8] This comment also applies to some extent to all technical building systems that are monitored and controlled by BACS.
[9] ISO 50003:2014 'Energy management systems — Requirements for bodies providing audit and certification of energy management systems'.

Table 9

Possible interpretation of system requirements for on-site electricity generation

Type of requirement	Possible interpretations for on-site electricity generation systems	Useful references [1]
'overall energy performance'	Minimum requirements on the performance of the system (as installed) in terms of electricity generation under typical operating conditions. In defining these requirements, Member States are encouraged to consider applicable standards, in particular from the list of EPB standards (see third column), and applicable Ecodesign and Energy Labelling regulations [2].	EN 15316-4-6 [3] EN 61724 [4] and IEC 61853-2:2016 [5] for photovoltaic systems, EN 15316-4-4 standard [6] for building-integrated cogeneration system, EN 15316-4-10 [7] and IEC 61400-12-1 [8] for wind power generation systems

Type of requirement	Possible interpretations for on-site electricity generation systems	Useful references [1]
'appropriate dimensioning'	Dimensioning can first relate to the generation capacity of the system considered. One aim can be to ensure that this capacity is adequate with regard to considered needs (e.g. the design of heat load for cogeneration space heaters). Dimensioning can also relate to the physical dimensions of systems' components, taking into account the constraints that apply to the specific building [9] (e.g. position, orientation, slope of photovoltaic panels, maximum power point tracking configuration, cable size, etc.).	Calculation of design heat load: EN 12831-1 [10] ISO 15927-5:2004 [11]
'proper installation'	Requirements on 'proper installation' is a generic reference to the need to ensure that the system is installed in a way that will ensure safe and optimal operation. Usually this is linked to requirements on the qualification of the installer (e.g. certified installer) and to specific technical guidelines. For photovoltaic systems, standards applying to building-integrated photovoltaics (BIPV) can be relevant in this context.	For BIPV systems, EN 50583-2 [12]
'appropriate adjustment'	'Adjustment' refers to: (i) a post-installation test of the system to check that it operates properly; and (ii) fine-tuning when the system is operating under real conditions.	For PV systems, IEC/EN 62446 [13]
'appropriate control'	In this context, 'control' refers to the ability of the system to control its own operation, taking into account parameters from the environment and from the building. This is most relevant for micro CHP systems, due to their simultaneous production of thermal and electrical energy.	N/A

(1) The references focus on EU standards. In addition to these, Member States are invited to consult available resources at national level, e.g. in Belgium the 'Spécifications techniques (STS)' on photovoltaic systems: https://economie.fgov.be/sites/default/files/Files/Publications/files/STS/STS-72-1-systemes-photovoltaiques.pdf

(2) To date, the most relevant regulation for on-site electricity generation is the one on heaters and water heaters, which covers cogeneration space heaters, see 'Commission Regulation (EU) No 813/2013 of 2 August 2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for space heaters and combination heaters'. In addition, the Ecodesign working plan 2016-2019 (COM(2016) 773 final) mentions that solar panels and inverters will be subject to preparatory studies, which means such systems could be covered by Ecodesign and/or energy labelling regulations in the future. See http://susproc.jrc.ec.europa.eu/solar_photovoltaics/projectplan.html for more details.

(3) EN 15316-4-6 'Heating systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-6: Heat generation systems, photovoltaic systems'.

(4) IEC/EN 61724: Photovoltaic system performance monitoring — Guidelines for measurement, data exchange and analysis.

(5) IEC 61853-2:2016 'Photovoltaic (PV) module performance testing and energy rating — Part 2: Spectral responsivity, incidence angle and module operating temperature measurements'.

(6) EN 15316-4-4 'Heating systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-4: Heat generation systems, building-integrated cogeneration systems'.

(7) EN 15316-4-10 'Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-10: Wind power generation systems'.

(8) IEC 61400-12-1 Ed. 2.0 b:2017 'Wind energy generation systems — Part 12-1: Power performance measurements of electricity producing wind turbines'.

(9) The aim is to ensure that the system will have optimal performance over its lifetime. Suboptimal dimensioning could lead to poor performance, which is detrimental to the building owner.

(10) EN 12831-1 'Energy performance of buildings — Method for calculation of the design heat load'.

(11) ISO 15927-5:2004 'Hygrothermal performance of buildings — Calculation and presentation of climatic data — Part 5: Data for design heat load for space heating'.

(12) EN 50583-2:2016 'Photovoltaics in buildings. BIPV systems'.

(13) IEC/EN 62446 'Grid connected photovoltaic systems — Minimum requirements for system documentation, commissioning tests and inspection'.

(a) Built-in lighting systems

Lighting systems were already part of the technical building systems before the amendment but were not covered by the provisions on system requirements. However, following the amendment, system requirements have to be established for 'built-in' lighting systems. As explained in Section 2.3.1.1, the update of the wording is only a clarification of the scope. The new wording of the scope 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.

Table 10

Possible interpretation of system requirements for built-in lighting

Type of requirement	Possible interpretations for lighting systems	Useful references
'overall energy performance'	Minimum requirements on the performance of the built-in lighting system as a whole, taking into account relevant parameters. The LENI (lighting energy numeric indicator) as defined in EN 15193-1:2017 standard can, for example, be a way to express requirements on the performance of lighting systems.	EN 15193-1:2017 ([1]), CEN/TR 15193-2:2017 ([2])
'appropriate dimensioning'	For lighting systems, 'appropriate dimensioning' refers to: (i) determining illumination level requirements, taking into account relevant parameters (in particular intended usage of the building and its spaces); and (ii) translating those requirements into design specifications for lighting systems.	EN 12464-1 ([3]), CEN/TS 17165 ([4])
'proper installation'	Installation of electric equipment, including lighting, in accordance with applicable regulations at national level.	N/A
'appropriate adjustment'	Adjustment may refer here to: (i) checking that capabilities of lighting systems comply with design specifications, particularly in terms of controls and; (ii) performing any relevant fine-tuning.	Same as below
'appropriate control'	In this context, 'control' refers to the ability of the lighting system to control the lighting level, taking into account parameters from the environment (e.g. daylight) and from the building (e.g. occupation).	CEN/TR 15193-2 ([5]), CIE 222:2017 ([6])

([1]) EN 15193-1:2017 'Energy performance of buildings — Energy requirements for lighting — Part 1: Specifications'.
([2]) CEN/TR 15193-2 'Energy performance of buildings — Energy requirements for lighting — Part 2: Explanation and justification of EN 15193-1, Module M9'.
([3]) EN12464-1:2011 'EN12464-1:2011 Light and lighting — Lighting of workplaces Part 1: Indoor work places'.
([4]) CEN/TS 17165 'Light and Lighting — Lighting System Design Process'.
([5]) CEN/TR 15193-2:2017 'Energy performance of buildings — Energy requirements for lighting — Part 2: Explanation and justification of EN 15193-1, Module M9'.
([6]) CIE 222:2017 'Decision Scheme for Lighting Controls in Non-Residential Buildings'.

2.5.1.2. Systems already covered before the amendment

Systems for space heating, space cooling, domestic hot water and ventilation were already covered by the provisions on system requirements under the EPBD. However, the transposition of the EPBD offers an opportunity to update these requirements.

Table 11

Possible interpretation of space heating system requirements

Type of requirement	Possible interpretations for space heating systems (1)	Useful references (2)
'overall energy performance'	In this context, overall performance refers to the performance of the whole process of energy transformation in heat generators, heat distribution across the building, heat emission in individual rooms or spaces of the building and, where applicable, heat storage. It is not limited to the performance of heat generators and can include requirements that affect other parts of the system (e.g. insulation of the distribution piping network).	EN 15316 standard series, e.g. EN 15316-1 (3) EN 15316-2 (4) EN 15316-3 (5) EN 15316-4-1 (6), EN 15316-4-2 (7) EN 15316-4-5 (8), EN 15316-4-8 (9) EN 15316-5 (10)
'appropriate dimensioning'	For heating systems, 'appropriate dimensioning' refers to: (i) determining heating needs, taking into account relevant parameters (in particular the intended usage of the building and its spaces); and (ii) translating these requirements into design specifications for heating systems.	EN 12831-1 (11) EN 12831-3 (12), Module M8-2, M8-3EN 12828 (13), EN 14337 (14), EN 1264-3:2009 (15)
'proper installation'	Proper installation refers to the need to ensure the system will be able to operate in accordance with design specifications. Ensuring proper installation can rely on e.g. national technical guidelines, product manufacturer documentation, certification of installers.	EN 14336 (16) EN 1264-4 (17) EN 14337 (14)
'appropriate adjustment'	Adjustment refers here to the testing and fine-tuning of the system under real-life conditions (18), in particular to check and possibly adjust system functions that can have an impact on performance (e.g. control capabilities — see below).	EN 15378-1 (19), EN 14336 (16), EN 15378-3 (20)
'appropriate control'	Concerns control capabilities that heating systems can include in order to optimise performance e.g. automatic adaptation of heat output of emitters in individual rooms or spaces, adaptation of system temperature based on outside temperature ('weather compensation') or time schedules, dynamic and static hydronic balancing, system operation monitoring, adjustment of water-/air-flow depending on needs.	EN 15500-1 (21) EN 15316-2 (4), EN 15232 (22), space heater energy labelling regulations (23)

(1) Most of the information given in this table also applies to systems for domestic hot water.

(2) The references focus on EU standards. In addition to these, Member States are invited to consult available resources at national level, e.g. in Belgium the 'Spécifications techniques (STS)' on thermal solar systems: https://economie.fgov.be/sites/default/files/Files/Publications/files/STS/STS-72-3-systemes-solaires-thermiques.pdf

(3) EN 15316-1:2017 'Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 1: General and Energy performance expression, Module M3-1, M3-4, M3-9, M8-1, M8-4'.

(4) EN 15316-2:2017 'Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 2: Space emission systems (heating and cooling), Module M3-5, M4-5'.

(5) EN 15316-3:2017 'Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 3: Space distribution systems (DHW, heating and cooling), Module M3-6, M4-6, M8-6'.

(6) EN 15316-4-1:2017 'Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-1: Space heating and DHW generation systems, combustion systems (boilers, biomass), Module M3-8-1, M8-8-1'.

(7) EN 15316-4-2:2017 'Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-2: Space heating generation systems, heat pump systems, Module M3-8-2, M8-8-2'.
(8) EN 15316-4-5:2017 'Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-5: District heating and cooling, Module M3-8-5, M4-8-5, M8-8-5, M11-8-5'.
(9) EN 15316-4-8:2017 'Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-8: Space heating generation systems, air heating and overhead radiant heating systems, including stoves (local), Module M3-8-8'.
(10) EN 15316-5:2017 'Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 5: Space heating and DHW storage systems (not cooling), Module M3-7, M8-7'.
(11) EN 12831-1:2017 'Energy performance of buildings — Method for calculation of the design heat load — Part 1: Space heating load, Module M3-3'.
(12) EN 12831-3 'Energy performance of buildings — Method for calculation of the design heat load — Part 3: Domestic hot water systems heat load and characterisation of needs, Module M8-2, M8-3'.
(13) EN 12828:2012+A1:2014 'Heating systems in buildings — Design for water-based heating systems'.
(14) EN 14337:2005 'Heating Systems in buildings — Design and installation of direct electrical room heating systems'.
(15) EN 1264-3:2009 'Water based surface embedded heating and cooling systems — Part 3: Dimensioning'.
(16) EN 14336:2004 'Heating systems in buildings — Installation and commissioning of water based heating systems'.
(17) EN 1264-4:2009 'Water based surface embedded heating and cooling systems — Part 4: Installation'.
(18) Member States may consider ensuring a degree of alignment between the methods followed for adjusting heating systems for the purpose of compliance with Article 8(1) on heating system requirements and the methods followed to assess performance of heating systems under typical or average operating conditions, where relevant, under Article 14-15.
(19) EN 15378-1:2017 'Energy performance of buildings — Heating systems and DHW in buildings — Part 1: Inspection of boilers, heating systems and DHW, Module M3-11, M8-11'.
(20) EN 15378-3 'Energy performance of buildings –Heating and DHW systems in buildings — Part 3: Measured energy performance, Module M3-10 and M8-10'.
(21) EN 15500-1:2017 'Energy Performance of Buildings — Control for heating, ventilating and air conditioning applications — Part 1: Electronic individual zone control equipment — Modules M3-5, M4-5, M5-5'.
(22) EN 15232 'Energy performance of buildings — Impact of Building Automation, Controls and Building Management'.
(23) Commission Delegated Regulation (EU) No 811/2013 of 18 February 2013 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to the energy labelling of space heaters, combination heaters, packages of space heater, temperature control and solar device and packages of combination heater, temperature control and solar device (OJ L 239, 6.9.2013, p. 1).

Table 12

Possible interpretation of space cooling system requirements

Type of requirement	Possible interpretations for space cooling systems (1)	Useful references
'overall energy performance'	In this context, overall performance refers to the performance of the whole process of energy transformation in cooling generators, cooling distribution across the building, cooling emission in individual rooms or spaces of the building and, where applicable, cool storage. It is not limited to performance of cooling generators, but it can include requirements that affect other parts of the system (e.g. insulation of distribution piping network).	EN 16798 standard series on cooling systems, e.g. EN 16798-9 (2), EN 16798-13 (3), EN 16798-15 (4)

Type of requirement	Possible interpretations for space cooling systems [1]	Useful references
'appropriate dimensioning'	Dimensioning refers to the optimal sizing of the cooling system with regard to the cooling needs of the building and its spaces.	EN 1264-3:2009 [5]
'proper installation'	Proper installation refers to the need to ensure the system will be able to operate in accordance with design specifications. Ensuring proper installation can rely e.g. on national technical guidelines, product manufacturer documentation, certification of installers.	EN 1264-4 [6]
'appropriate adjustment'	Adjustment refers here to the testing and fine-tuning of the system under real-life conditions [7] in particular to check and possibly adjust system functions that can have a significant impact on performance (e.g. control capabilities — see below).	EN 16798-17 [8]
'appropriate control'	Concerns control capabilities that space cooling systems can include to optimise performance e.g. automatic adaptation of cooling output of emitters in individual rooms or spaces.	EN 15500-1 [9], EN 15316-2 [10], EN 15232 [11]

[1] In line with Article 2(3) and 8(1) of the EPBD, this table focuses on active cooling in buildings. While not covered here, it is worth bearing in mind that passive cooling — e.g. shading — is also effective.
[2] EN 16798-9 'Energy performance of buildings — Ventilation for buildings — Part 9: Calculation methods for energy requirements of cooling systems (Modules M4-1, M4-4, M4-9) — General'.
[3] EN 16798-13 'Energy performance of buildings — Ventilation for buildings — Part 13: Calculation of cooling systems (Module M4-8) — Generation'.
[4] EN 16798-15 'Energy performance of buildings — Ventilation for buildings — Part 15: Calculation of cooling systems (Module M4-7) — Storage'.
[5] EN 1264-3:2009 'Water based surface embedded heating and cooling systems — Part 3: Dimensioning'.
[6] EN 1264-4:2009 'Water based surface embedded heating and cooling systems — Part 4: Installation'.
[7] Member States may consider ensuring a degree of alignment between: (a) the methods followed for adjusting space cooling systems in order to comply with the provisions of Article 8(1) on requirements for space cooling systems; and (b) the methods followed to assess performance of air-conditioning systems under typical or average operating conditions, where relevant, under Article 14-15.
[8] EN 16798-17 'Energy performance of buildings — Ventilation for buildings — Part 17: Guidelines for inspection of ventilation and air conditioning systems (Module M4-11, M5-11, M6-11, M7-11)'.
[9] EN 15500-1:2017 'Energy Performance of Buildings — Control for heating, ventilating and air conditioning applications — Part 1: Electronic individual zone control equipment — Modules M3-5, M4-5, M5-5'.
[10] EN 15316-2:2017 'Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 2: Space emission systems (heating and cooling), Module M3-5, M4-5'.
[11] EN 15232 'Energy performance of buildings — Impact of Building Automation, Controls and Building Management'.

Table 13

Possible interpretation of ventilation system requirements

Type of requirement	Possible interpretations for ventilation systems	Useful references [1]
'overall energy performance'	Refers to the energy performance of the ventilation system as a whole, taking into account e.g. fans energy efficiency, the characteristics of the ventilation duct network, heat recovery.	EN 16798-3 [2], EN 16798-5-1 [3], EN 16798-5-2 [4]

Type of requirement	Possible interpretations for ventilation systems	Useful references [1]
'appropriate dimensioning'	Dimensioning refers to the optimal sizing of the ventilation system with regard to the ventilation needs of the building and its spaces.	EN 16798-7 [5], CEN/TR 14788 [6], CR 1752 [7]
'proper installation'	Proper installation refers to the need to ensure the system will be able to operate in accordance with design specifications. Ensuring proper installation can rely e.g. on national technical guidelines, products manufacturer documentation, certification of installers.	N/A
'appropriate adjustment'	Adjustment refers here to the testing and fine-tuning of the system under real-life conditions [8], in particular to check system components and functions that can have an impact on performance (e.g. ductwork air-tightness).	EN 12599 [9], EN 16798-17 [10], EN 14134 [11]
'appropriate control'	Concerns control capabilities that ventilation systems can include to optimise performance e.g. air-flow modulation.	EN 15232 [12], EN 15500-1 [13]

[1] The references focus on EU standards. In addition to these, Member States are invited to consult available resources at national level, e.g. in France, the NF DTU 68.3 'Installations de ventilation mécanique' standard.

[2] EN 16798-3 'Energy performance of buildings — Ventilation for buildings — Part 3: For non-residential buildings — Performance requirements for ventilation and room-conditioning systems (Modules M5-1, M5-4)'.

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

[4] EN 16798-5-2 | Energy performance of buildings — Ventilation for buildings — Part 5-2: Calculation methods for energy requirements of ventilation systems (Modules M5-6, M5-8, M6-5, M6-8, M7-5, M7-8) — Method 2: Distribution and generation.

[5] EN 16798-7 | Energy performance of buildings — Ventilation for buildings — Part 7: Calculation methods for the determination of air flow rates in buildings including infiltration (Module M5-5).

[6] CEN/TR 14788:2006 'Ventilation for buildings — Design and dimensioning of residential ventilation systems'.

[7] CR 1752:1998 'Ventilation for buildings — Design criteria for the indoor environment'.

[8] Member States may consider ensuring a degree of alignment between the methods followed for adjusting heating systems for the purpose of compliance with the provisions of Article 8(1) ventilation system requirements and the methods followed to assess performance of combined heating/air-conditioning and ventilation systems under typical or average operating conditions, where relevant, under Article 14-15.

[9] EN 12599:2012 'Ventilation for buildings — Test procedures and measurement methods to hand over air conditioning and ventilation systems'.

[10] EN 16798-17 'Energy performance of buildings — Ventilation for buildings — Part 17: Guidelines for inspection of ventilation and air conditioning systems (Module M4-11, M5-11, M6-11, M7-11)'

[11] EN 14134:2004 Ventilation for buildings — Performance testing and installation checks of residential ventilation systems.

[12] EN 15232 'Energy performance of buildings — Impact of Building Automation, Controls and Building Management'.

[13] EN 15500-1:2017 'Energy Performance of Buildings — Control for heating, ventilating and air conditioning applications — Part 1: Electronic individual zone control equipment — Modules M3-5, M4-5, M5-5'.

2.5.2. *System performance assessment and documentation (Article 8(9) of the EPBD)*

2.5.2.1. Scope of performance assessment

Section 2.4.1.3(a) gives guidance on how to interpret the scope of performance assessment (altered part v whole system) under Article 8(9) of the EPBD. One additional consideration is that it will be beneficial to ensure a degree of alignment between Article 8(1) and Article 8(9) of the EPBD. This means in particular that, unless there is a justification for doing otherwise, a system upgrade under Article 8(1) of the EPBD should generally also be a system upgrade under Article 8(9) of the EPBD. Member States may however wish to deviate from this approach for smaller, minor upgrades, which could lead to documenting the performance of the altered part of the system, while not triggering the application of any system requirements

2.5.2.2. Overall performance

Section 2.4.1.3(b) gives guidance on how to interpret overall performance and on how to frame the assessment of overall performance. In particular, the need to ensure consistency with inspection practices under Articles 14 and 15 of the EPBD is emphasised for the relevant technical building systems. An additional consideration is that, for system installation, replacement and upgrades that lead to the application of system requirements, Member States may find it beneficial to ensure a degree of alignment between the tests performed for the purpose of compliance with the requirements for system adjustment and those that may be required to assess overall energy performance for documentation purposes.

2.5.2.3. Documentation of system performance

As mentioned in Section 2.4.1.3(c), Member States are free to determine the form and content of the documentation (on system performance) that is passed on to building owners, provided that this documentation covers the scope of the assessment of overall system performance. It would also be beneficial if this information were provided in a way that highlights the compliance of the technical building system with the applicable requirements. A checklist that sets out the applicable system requirements and how these were assessed, and summarises the results of the assessment (including tests under average or typical conditions) could do this.

As mentioned in section 2.4.1.3(d), it is for Member States to decide whether a new energy performance certificate (EPC) will have to be issued as a result of the assessment of the technical building system's (or the altered part's) energy performance. However, Member States are encouraged to require a new EPC where the performance of a whole system may be affected (i.e. in cases involving installation, replacement or major upgrades) as, in such cases, it is likely that the performance of the whole building will also be affected.

Member States may also consider it beneficial to consider existing guidelines at national level ([34]) and outcomes from relevant EU projects ([35]).

2.5.3. *Inspections (Article 14 and 15 of the EPBD)*

2.5.3.1. Establish training needs

Due to the expanded scope of the EPBD, Member States should evaluate whether new or additional training is necessary. This is particularly the case for those areas of competence that relate to typical or average operating conditions.

Member States should also decide whether this training requires re-accreditation. A calendar for providing training should also be drawn up.

2.5.3.2. Changes in the reporting methodology

Member States should evaluate whether the reporting methodology, report templates, databases, etc. need to be updated.

([34]) E.g. in Germany, the guidelines from AMEV (https://www.amev-online.de/AMEVInhalt/Infobereich/Aktuelles/technisches-monitoring-2017.docx).

([35]) The QUANTUM Project (https://www.quantum-project.eu) has developed an approach for an appropriate and cost effective quality management process to assess and document building and system performance. In particular, QUANTUM aims to gives recommendations on data provided by technical building systems in order to be able to test performance.

2.5.3.3. Changes in the database

Member States should evaluate whether the database of reports (where this exists) and reporting mechanisms need updating or upgrading.

For those systems that are exempt under Articles 14(2) or 14(6) of the EPBD, the databases should be able to record the period of validity of these exemptions.

2.5.3.4. Changes to the assurance mechanism

Member States should evaluate the need for updating or upgrading the quality assurance process. Reports are likely to increase in length, which may therefore require further resources.

2.5.4. *Building automation and control systems: requirements for mixed-used buildings and maintenance (Article 14(4) and 15(4) of the EPBD)*

2.5.4.1. Mixed-use buildings

The requirements for installing BACS apply to non-residential buildings only. These are buildings that are used for a purpose other than residential (i.e. office buildings, healthcare buildings, wholesale and retail trade buildings, educational buildings, hotels and restaurants, etc.)

With regard to mixed-used buildings, i.e. buildings that include both residential and non-residential units (e.g. a residential building with shops on the ground floor), Member States may identify the most appropriate approach. However, they should consider the following guidelines in order to avoid legal loopholes.

When systems are integrated (i.e. the non-residential units and the residential ones use the same systems) and the effective rated output is above the threshold, the following options are open to Member States:

(a) apply the requirements to the whole building;

(b) apply the requirements only to non-residential units;

(c) apply the requirements only to non-residential units if the associated 'non-residential' rated output is above the threshold ([36]).

When systems are separate (i.e. the non-residential units and the residential ones have different systems) and the effective rated output of the non-residential units' systems is above the threshold, the requirements should apply to at least the non-residential units.

2.5.4.2. Maintenance of BACS

As for any technical building system, BACS should be properly maintained to ensure that they operate appropriately, in particular when it comes to their ability to predict, detect and address sub-optimal functioning or malfunctioning of other technical building systems.

It is therefore important that BACS, as other technical building systems, are monitored over their lifetime in order to check their performance and make any changes needed. This issue is well known and there are different schemes, from the industry ([37]) and national authorities ([38]), as well as relevant standards ([39]), to support the proper maintenance of BACS.

([36]) In this latter case, the effective rated output associated with non-residential units can be based on the proportion of non-residential units in the building. This can be calculated using the energy consumption or (though probably less relevant) the surface area. For instance: a mixed-use buildings with an effective rated output for heating of 500 kW, in which non-residential buildings represent 70 % of total energy consumption, would lead to a non-residential effective rated output of 0,7 × 500 = 350 kW, which is above the threshold.

([37]) E.g. eu.bac system certification (https://www.eubac.org/system-audits/index.html) or, in Germany, VDMA 24186-4 'Program of services for the maintenance of technical systems and equipment in buildings — Part 4: Measurement and control equipment and building automation and control systems' (https://www.vdma.org/en/v2viewer/-/v2article/render/15979771).

([38]) E.g. in Germany, AMEV Wartung (https://www.amev-online.de/AMEVInhalt/Betriebsfuehrung/Vertragsmuster/Wartung%202014/).

([39]) E.g. EN 16946-1:2017 'Energy Performance of Buildings. Inspection of Automation, Controls and Technical Building Management'.

3. PROVISIONS ON ELECTROMOBILITY

3.1. **Aim: to support the deployment of a recharging infrastructure for electric vehicles**

The lack of a recharging infrastructure is a barrier to the take-up of electric vehicles in the EU. The new provisions aim to accelerate the development of a denser network of this infrastructure. Buildings can promote electromobility effectively, particularly by focusing on the private sector (car parks in or adjacent to private buildings) where up to 90 % of charging takes place. The EPBD complements Directive 2014/94/EU of the European Parliament and of the Council ([40]) which, inter alia, defines technical specifications for alternative fuels infrastructure, including recharging points, and requires Member States to adopt national policy frameworks to ensure their deployment

3.2. **Scope of provisions on electromobility**

Article 1 of Directive (EU) 2018/844 introduces new provisions related to electromobility into Article 8 of the EPBD. Those provisions relate to requirements for installing recharging points and ducting infrastructure, as summarised in the following table.

Table 14

Summary of electromobility requirements

Scope		MS obligation
New buildings and buildings undergoing major renovation	Non-residential buildings with more than 10 parking spaces	Ensure the installation of at least 1 recharging point Ensure the installation of ducting infrastructure for at least 1 in 5 parking spaces
	Residential buildings with more than 10 parking spaces	Ensure the installation of ducting infrastructure for every parking space
Existing buildings	Non-residential buildings with more than 20 parking spaces	Set out requirements for the installation of a minimum number of recharging points — applicable from 2025

Member States are also required to provide for measures to simplify the deployment of recharging points in new and existing buildings and to address possible regulatory barriers.

All obligations related to electromobility in the EPBD are new obligations. The aim of this section is to provide clarity to Member States on the correct transposition of these provisions into national law.

3.3. **Understanding the provisions on electromobility**

3.3.1. *Parking spaces (Article 8(2) to 8(8) of the EPBD)*

The scope of the obligations in the EPBD extends to certain parking spaces — namely, those located in car parks

(a) with a minimum number of parking spaces; and

(b) in or adjacent to certain types of building.

3.3.2. *When are obligations triggered? (Article 8(2) and 8(5) of the EPBD)*

3.3.2.1. Basic criteria

The obligations to install recharging points or ducting infrastructure are triggered depending on whether a *building* is new, undergoing a major renovation or already exists. The Directive does not specify who is responsible for installing the recharging points and ducting infrastructure (i.e. the owner or the tenant). This is something Member States should determine in their transposing legislation. Where there is a major renovation, obligations may also be triggered if the *electrical infrastructure* of the building or of the car park is included in the renovation measures.

([40]) Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure (OJ L 307, 28.10.2014, p. 1).

The requirements for new buildings and buildings undergoing major renovation apply only to buildings:

(a) with car parks with more than 10 parking spaces; and

(b) where the car park is inside the building or physically adjacent to it.

Where there is a major renovation, the requirement only applies if renovation measures include the car park or the electrical infrastructure of the building (if the car park is inside the building ([41])). Member States may consider establishing minimum information requirements for permitting procedures which enable the verification of whether or not this condition is triggered.

3.3.2.2. Buildings that have both a residential and a non-residential function

The EPBD does not include any express provision regulating the application of electromobility requirements with regard to buildings that have both a residential and a non-residential function (e.g. a residential building with commercial spaces on the ground floor), Member States may therefore identify the most appropriate approach for such cases ([42]).

3.3.3. *Meaning of terms (Article 8(2) to 8(8) of the EPBD)*

A number of terms are particularly relevant and are not always explicitly defined.

Car park — no express definition is provided in the EPBD. However, within the context of the EPBD, 'car park' should exclude on-street parking located on public roads, for example.

Residential/non-residential — this distinction is present in the EPBD, although it is not defined. 'Residential' should be interpreted as including single-family and multi-family dwellings. 'Non-residential' includes buildings that are used for a purpose other than residential (i.e. office buildings, healthcare buildings, wholesale and retail trade buildings, educational buildings, hotels and restaurants, etc.).

Electrical infrastructure (of a building/of a car park) — no express definition is provided in the EPBD. However it should be understood as referring to the electrical installation (either the whole installation or any part of it) of the building or of the car park — including the electrical wiring, apparatus and associated equipment.

Major renovation is defined in Article 2(10) of the EPBD ([43]). That definition is applicable to the provisions on electromobility of the EPBD.

Physically adjacent — no express definition is provided in the EPBD

The notion of physical adjacency is relevant where a car park is not located inside a building, but it nevertheless has clear links with the building.

A priori, physical adjacency implies that the perimeter of the car park touches the perimeter of the building in at least one place.

When defining, in their national legislation, the scope of the obligation to deploy recharging points and ducting infrastructure in buildings with car parks which are physically adjacent, Member States could also consider a number of additional criteria in their national legislation, such as:

(a) Is there a physical/technical connection between the car park and the building?

(b) Is the car park used only or mostly by the occupants of the building?

(c) Is there a degree of joint ownership between the car park and the building?

([41]) In paragraph (a), reference to 'electrical infrastructure' is made in relation to the *building*, when a distinction between car park and electrical infrastructure of the building is necessary. In paragraph (b), reference to 'electrical infrastructure' is made in relation to the *car park*. Here, the distinction between *car park* and *electrical infrastructure of the car park* is not necessary since the electrical infrastructure of the car park is part of the car park.

([42]) Recital 24 of Directive (EU) 2018/844 states that in the implementation of electromobility requirements, Member States should consider potential diverse conditions, such as the case of buildings that have both a residential and a non-residential function.

([43]) 'major renovation' means the renovation of a building where: (a) the total cost of the renovation relating to the building envelope or the technical building systems is higher than 25 % of the value of the building, excluding the value of the land upon which the building is situated; or (b) more than 25 % of the surface of the building envelope undergoing renovation. Member States may choose to apply option (a) or (b).

Member States have some flexibility on how to interpret the notion of adjacency and on how to address specific cases, and are encouraged to take these three criteria into consideration when transposing and implementing the obligations.

In particular, there may be situations where the car park is not strictly speaking physically adjacent to the building (e.g. on the other side of a street, or separated from the building by a green area) but it has a clear link with the building in terms of ownership and/or usage. This would make application of the obligations relevant and appropriate (e.g. the parking spaces are owned and used by the occupants in the case of a multi-family buildings).

The following table sets out examples of situations in which the suggested criteria could be applied.

Table 15

Possible connections between buildings and car parks

Criterion	Situation	Comment	Examples
Physical/technical connection			
	Car park shares the same electrical infrastructure as the building	Generally relevant to apply the obligations: strong likelihood that owners of the building and the car park are the same.	Car park for a shopping centre or a shared residential building.
	Car park located beside the building and has separate electrical infrastructure	Assessment will depend on ownership and/or usage.	Public or private shared car park with several buildings nearby.
Use			
	Users of the building are users of the car park	Generally appropriate to apply the obligations to the car park.	Company car park used by company employees.
Ownership			
	Owner(s) of the building is(are) the same as the owner(s) of the car park	In such situations, the obligations will generally be applicable to the car park.	Non-residential building and car park owned by a company; parking spaces belonging to apartments in a multi-family building.
	Owner(s) of the building is(are) different from the owner(s) of the car park	Will depend on the use of the car park; in most cases, it will be appropriate to apply the obligations to the car park	Non-residential building owned by a company and car park used only or mostly by the company's employees; the car park is rented

3.3.4. *Requirements for installation of a minimum number of recharging points (Article 8(3) of the EPBD)*

In addition to the installation requirements set out in Article 8(2) and (5) of the EPBD, Article 8(3) requires Member States to lay down requirements for the installation of a minimum number of recharging points for all non-residential buildings with more than 20 parking spaces. These requirements must apply by 1 January 2025.

The requirements, to be laid down by 10 March 2020, must at least determine a minimum number of recharging points per non-residential building with more than 20 parking spaces. Member States also have the discretion to adopt requirements with a broader scope (such as also including requirements for installation of ducting infrastructure, or determining a minimum number of recharging points for non-residential buildings with 20 or *fewer* parking spaces or for *residential* buildings).

The adoption of these requirements by 10 March 2020 will ensure that building owners ([44]) have a period of almost 5 years (10 March 2020 to 31 December 2024) during which they can take the necessary steps to make their buildings compliant.

To ensure the proportionate and appropriate deployment of recharging points, Member States should take different factors into account when determining the minimum number ([45]):

(a) relevant national regional and local conditions; and

(b) possible diversified needs and circumstances based on area, building typology, public transport coverage and other relevant criteria.

Member States may decide to carry out an inventory of car parks with more than 20 spaces in order to identify those which would be subject to these requirements.

The requirements laid down by Member States under Article 8(3) of the EPBD will apply individually to each non-residential building with a car park that exists on 1 January 2025 and which has more than 20 parking spaces.

Member States could determine the minimum number of recharging points by taking into consideration, inter alia, the estimated number of registered electric vehicles in the Member State at the end of 2024 (date after which the requirements under Article 8(3) of the EPBD are applicable ([46])).

For new buildings or buildings undergoing major renovation with more than 20 parking spaces, where the requirements set out in Article 8(2), including for ducting infrastructure, differ from the requirements laid down by a Member State pursuant to Article 8(3) of the EPBD, both requirements apply and must be taken into account.

3.3.5. *Directive 2014/94/EU*

The EPBD and Directive 2014/94/EU are complementary legislative instruments. Both include provisions on the deployment of recharging points for electric vehicles, but their scope and the obligations they place upon Member States differ.

Directive 2014/94/EU sets the overall legislative framework ([47]) for the standardisation and deployment of alternative fuels infrastructure (which includes recharging infrastructure for electric vehicles), including user information, while the EPBD sets specific requirements for installing infrastructure for electric vehicles in certain buildings.

Directive 2014/94/EU relates to all recharging points ([48]) (both public and private and including those which are not necessarily in or physically adjacent to a building). Article 8 of the EPBD only concerns electromobility in relation to parking spaces in car parks which are in or physically adjacent to buildings (both public and private).

([44]) The EPBD does not specify whether it is the owner, the operator or the tenant of a non-residential building who would be required to install the recharging point and ducting infrastructure pursuant to Article 8(3). Alternatively, standard lease and/or contract law may apply. Member States have a degree of flexibility to define the remit of the obligations in transposing the legal obligations of the EPBD.

([45]) Recital 26 of Directive (EU) 2018/844.

([46]) This is similar to the approach used in Directive 2014/94/EU, Article 4(1).

([47]) Directive 2014/94/EU defines alternative fuels and sets out minimum requirements for the building-up of infrastructure for alternative fuels that require distinct infrastructure (electricity, natural gas and hydrogen), to be implemented using Member States' national policy frameworks. Importantly, Member States have to adopt national policy frameworks for the development of the market as regards alternative fuels in the transport sector and the deployment of infrastructure.

([48]) A 'normal power recharging point' is defined in Article 2(4) of Directive 2014/94/EU as 'a recharging point that allows for a transfer of electricity to an electric vehicle with a power less than or equal to 22 kW, excluding devices with a power less than or equal to 3,7 kW, which are installed in private households or the primary purpose of which is not recharging electric vehicles, and which are not accessible to the public.' A combined reading of Article 4(4) of Directive 2014/94/EU excludes recharging points that meet all of the following conditions from complying with the standards in Annex II of the EPBD: have a power less than or equal to 3,7 kW; are installed in private households or their primary purpose is not recharging electric vehicles; and are not accessible to the public. The definition of 'high power recharging point', in Article 2(5) of Directive 2014/94/EU, does not contain any similar exclusion of non-publicly accessible recharging points. The fact that a recharger is not publicly accessible is not in and of itself enough to exclude it from complying with the technical specifications set out in Annex II to Directive 2014/94/EU. Only normal power sockets installed in private households and not made accessible to the public are excluded from these definitions. Consequently, all recharging infrastructure installed under the EPBD is *de facto* covered by Directive 2014/94/EU standards and requirements, except if the criteria above are cumulatively met.

Directive 2014/94/EU defines recharging points (including normal power and high power recharging points), sets common technical specifications for recharging points and enables the Commission to adopt further standards and requirements in this respect through delegated acts ([49]). The EPBD makes reference to these definitions and specifications.

Directive 2014/94/EU requires Member States to adopt national policy frameworks and to include in them national targets for the deployment of public and private recharging stations ([50]). In its Article 4, Directive 2014/94/EU sets a number of minimum requirements in relation to the installation, operation and use of recharging points.

The EPBD sets out specific installation requirements (for non-residential and residential buildings which are new or undergoing major renovation) and requires Member States to lay down requirements for a minimum number of recharging points for certain existing buildings.

Under Directive 2014/94/EU, Member States had to notify their national policy frameworks to the Commission by 18 November 2016. National targets set therein are to ensure that an appropriate number of recharging points accessible to the public are put in place by 31 December 2020 in order to ensure that electric vehicles can circulate at least in urban/suburban agglomerations and other densely populated areas, and, where appropriate, within networks determined by the Member States. Installation requirements in the EPBD relating to new buildings and major renovations will apply from 10 March 2020 and those laid down by Member States and relating to existing buildings will apply by 1 January 2025.

The Commission is required under Directive 2014/94/EU to monitor that an additional number of recharging points accessible to the public are put in place in each Member State by 31 December 2025, at least on the TEN-T Core Network, in urban/suburban agglomerations and other densely populated areas. Member States must also take measures within their national policy frameworks to encourage and facilitate the deployment of recharging points not accessible to the public.

Directive 2014/94/EU extends to all types of recharging infrastructure: for electric vehicles, as well as for buses ([51]), trucks and vessels. The EPBD by definition concerns recharging infrastructure for passenger cars and vans only.

Although Directive 2014/94/EU primarily relates to 'publicly accessible recharging points', it also includes a number of provisions which apply to all recharging points, public and private alike (including those that are accessible to the public and those that are not). These are requirements which apply in the case of recharging points installed under the EPBD:

(a) Article 4(3) of Directive 2014/94/EU requires that Member States encourage and facilitate deployment of charging points not accessible to the public.

(b) Article 4(4) of Directive 2014/94/EU requires that Member States ensure that all normal and high power recharging points comply with the technical specifications set out in Annex II to Directive 2014/94/EU.

(c) Article 4(12) of Directive 2014/94/EU requires that Member States ensure that the legal framework permits choice of electricity supply for all recharging points associated with a household or premises.

3.4. **Guidelines for transposition of provisions on electromobility**

3.4.1. *Ensure correct transposition (Article 8(2) to 8(8) of the EPBD)*

Member States are required to transpose all these obligations by the transposition date of 10 March 2020. This includes setting national requirements for a minimum number of recharging points for electric vehicles for parking spaces in car parks in existing non-residential buildings, even though these do not need to come into force until 2025 ([52]).

([49]) For instance, the Commission has done so for L-category motor vehicles: Commission Delegated Regulation (EU) 2018/674 (OJ L 114, 4.5.2018, p. 1), available here: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018R0674&from=EN

([50]) See Article 3(1) second indent, in conjunction with Article 4(1) to 4(3) of Directive 2014/94/EU.

([51]) The relevant standards for recharging points for e-buses are under development under the Mandate M/533. Adoption is foreseen by end 2019 or early 2020.

([52]) The wording of Recital 26 of Directive (EU) 2018/844 rules out a hypothetical alternative interpretation, under which the date of 2025 in Article 8(3) would apply to the transposition and not the implementation of this requirement.

Some definitions originate in Directive 2014/94/EU and therefore should already have been transposed into national legislation, including:

Electric vehicle (or Plug-in Electric Vehicle (PEV ([53]))) is defined in Article 2(2) of Directive 2014/94/EU. An electric vehicle is 'a motor vehicle equipped with a powertrain containing at least one non-peripheral electric machine as energy converter with an electric rechargeable energy storage system, which can be recharged externally'. This definition includes different types of electric vehicles, including electric passenger cars and light electric vehicles, e.g. motorcycles.

Recharging point is defined in Article 2(3) of Directive 2014/94/EU as: 'an interface that is capable of charging one electric vehicle at a time or exchanging a battery of one electric vehicle at a time'

Directive 2014/94/EU also defines 'normal power' (Article 2(4)) and 'high power' (Article 2(5)) recharging points.

In transposing the Article 8 provisions in the EPBD, Member States have the discretion to determine (or not to determine) whether the recharging points to be deployed are to be normal or high power recharging points as per the definitions set out in Directive 2014/94/EU.

However, the EPBD contains the following new definition which must be transposed:

Ducting infrastructure ([54]) means 'conduits for electric cables' (Article 8(2) of the EPBD). Here, the wording should be understood in a broad sense, including cable *ducting fixed to walls*.

3.4.2. *Exemptions (non-application) (Article 8(4) and 8(6) of the EPBD)*

The requirements to install recharging points and ducting infrastructure are subject to a number of possible exemptions (non-application). These are set out in Article 8(4) and 8(6) of the EPBD.

3.4.2.1. Member States' discretion not to lay down or apply requirements in relation to SMEs

Pursuant to Article 8(4) of the EPBD, Member States may decide not to lay down or apply the requirements referred to in Article 8(2) and (3) of the EPBD to buildings owned and occupied by small and medium-sized enterprises (SMEs). These are defined in Title I of the Annex to Commission Recommendation 2003/361/EC ([55]) as referred to in Article 8(4) of the EPBD.

3.4.2.2. Member States' discretion not to apply certain requirements to specific categories of buildings

During transposition, Member States may decide not to apply the obligations referred to in paragraphs 8(2), 8(3) and 8(5) in specific situations. These cases are exhaustively listed in Article 8(6) of the EPBD.

3.4.3. *Define and lay down requirements for the installation of recharging points (Article 8(2), 8(3) and 8(5) of the EPBD)*

3.4.3.1. Technical requirements for recharging points

Recharging points deployed under the EPBD must comply with the technical specifications set out in Annex II of Directive 2014/94/EU as well as with any additional technical standards adopted by means of Delegated Acts under Directive 2014/94/EU — these include normal and high power recharging points and recharging points for L-category motor vehicles (2- and 3-wheel vehicles and quadricycles) ([56]).

Article 4(4) of Directive 2014/94/EU requires Member States to ensure that normal and high power recharging points comply with at least the technical specifications set out in point 1.1 of Annex II, as well as with specific safety requirements in force at national level.

([53]) PEVs include two categories: battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs).
([54]) The EPBD covers recharging points and ducting infrastructure, while Directive 2014/94/EU does not specifically refer to ducting infrastructure.
([55]) Commission Recommendation 2003/361/EC of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises (OJ L 124, 20.5.2003, p. 36).
([56]) Delegated Regulation (EU) 2018/674.

In transposing the EPBD (notably Article 8(2), 8(3) and 8(5)), Member States have the discretion as to whether or not to set out whether the recharging points to be deployed are normal or high power recharging points, as per the definitions in Directive 2014/94/EU.

3.4.3.2. Other requirements

Additional requirements may also apply depending on the building, and in many cases on whether the recharging point will or will not be publicly accessible ([57]).

Requirements relating to electromobility should also be seen in the context of Directive 2009/72/EC of the European Parliament and of the Council ([58]) that sets the market framework for the efficient integration of batteries (including vehicle batteries) into the electricity system. However, in order for vehicles to provide the necessary flexibility to the system through smart charging and vehicle to grid ([59]), charging infrastructure and the underlying electricity infrastructure should be fit for purpose.

Provided that the requirements of the EPBD are transposed, the following additional (type of) element(s) could be incorporated into national legislation:

(a) specifications for ducting infrastructure ([60]);

(b) specifications relating to fire safety ([61]);

(c) specifications for recharging points ([62]) including relating to accessibility for persons with disabilities ([63]);

(d) requirements related to dedicated parking infrastructure for electrical bicycles, including (electric-) cargo-bikes, and for vehicles of people with reduced mobility ([64]);

(e) requirements related to smart/intelligent metering ([65]);

(f) requirements related to smart charging ([66]);

(g) requirements which would facilitate the use of car batteries as a source of power (vehicle to grid) ([67]);

(h) for publicly accessible charging points, requirements related to *ad hoc* charging and transparency of recharging prices ([68]);

([57]) Some of these requirements are obligatory in certain situations by virtue of Directive 2014/94/EU.
([58]) Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC (OJ L 211, 14.8.2009, p. 55).
([59]) 'Smart charging' means the possibility to shift charging to times when electricity is widely available and networks are not congested. Smart charging can facilitate optimisation of load on the electricity system, in particular where loads may increase due to the number of electric vehicles charging at the same time. 'Vehicle to grid' means the possibility to feed electricity stored in the car battery back onto the grid.
([60]) See for example the Austrian legislation.
([61]) To address any fire risks associated with electric vehicles and charging infrastructure.
([62]) Technical specifications in Annex II to Directive 2014/94/EU, which includes a reference to standard EN 62196-2.
([63]) Accessibility of recharging points for people with disabilities should address the following components: the user interface of the recharger, including payment interface, the accessibility of the plug and connections with the car, and all user information needed to use the recharger itself (in line with the provisional agreement resulting from interinstitutional negotiations reached on 19 December 2018 on a Proposal for a directive of the European Parliament and of the Council on the accessibility requirements for products and services (COM(2015) 615 — C8-0387/2015 — 2015/0278(COD))), the location of the recharging point should be accessible (for example reachable for persons using a wheelchair); the parking space for vehicles needing an accessible recharging point should also be accessible, ensuring sufficient manoeuvring space; a minimum number of recharging points should be 'accessible recharging points.' Relevant standardisation mandates to CEN, Cenelec and ETSI include: mandate M/420 in support of European accessibility requirements for public procurement in the built environment and mandate M/473 to include 'Design for All' in relevant standardisation initiatives.
([64]) Recital 28 of Directive (EU) 2018/844.
([65]) See Directive 2014/94/EU, Article 4(7).
([66]) Recital 22 of Directive (EU) 2018/844 states that buildings can be leveraged for the smart charging of electric vehicles. Smart charging may require data transmission capabilities. A number of Member States have included references to smart charging in their legislation. See for example legislation in the UK — Automated and Electric Vehicles Act 2018 (Chapter 15 in part II)/http://www.legislation.gov.uk/ukpga/2018/18/section/15/enacted; France — Arrêté du 19 juillet 2018 relatif aux dispositifs permettant de piloter la recharge des véhicules électriques; and Finland -https://www.finlex.fi/fi/laki/alkup/2017/20170478
([67]) Recital 22 of Directive (EU) 2018/844 — basis for Member States to use car batteries as a source of power.
([68]) See Directive 2014/94/EU, Article 4(9) and 4(10) respectively.

(i) requirements related to recharging point operators being free to purchase electricity from any EU electricity supplier ([69]) and the possibility for users to contract with a supplier other than the entity supplying electricity to the household or premises ([70]).

Member States should determine to what extent such specific technical requirements for the installation need to be defined in national legislation.

Simplification of the deployment of recharging points

Article 8(7) of the EPBD requires Member States to provide for measures to simplify deployment of recharging points in new and existing residential and non-residential buildings and to address possible regulatory barriers, including permitting and approval procedures ([71]). This obligation must be fulfilled by transposing the EPBD into national legislation by the transposition deadline at the latest.

3.4.3.3. Split incentives and administrative complications ([72])

Lengthy and complex approval procedures can be a major barrier to owners and tenants installing recharging points in existing multi-tenant residential and non-residential buildings. Obtaining the necessary approvals can create delays or prevent installation

'Right to plug' or 'right to charge' requirements ensure that any tenant or co-owner is able install a recharging point for an electric vehicle without having to obtain (potentially difficult) consent from the tenant's landlord or from the other co-owners.

In Spain, for example, legislation allows a co-owner to install a recharging point for private use when located in an individual parking place and when the association of co-owners has been informed in advance. The co-owners cannot block the installation. The cost of the installation and of the subsequent electricity consumption is assumed by the individual who has installed the recharging point.

3.4.4. *Sustainability (Article 8(8) of the EPBD)*

Article 8(8) of the EPBD requires that Member States consider the need for coherent policies for buildings, soft (or active) and green mobility, and urban planning.

The Sustainable Urban Mobility Planning (SUMP) initiative is a cornerstone of EU urban mobility policy. Incorporating electromobility early in the development of mobility plans adopted under SUMP can help to realise the objectives of Article 8(8) of the EPBD.

SUMP provides a long-term, multi-disciplinary, comprehensive approach, covering all transport modes, to help tackle issues such as congestion, air and noise pollution, climate change, road accidents, health impact, accessibility for persons with disabilities and older persons, inefficient use of public space and improved quality of life. It is complemented by the SUMP guidelines and by comprehensive information on SUMP, available in the 'Mobility Plans' section of the Eltis website — the urban mobility observatory ([73]). Over 1 000 cities have already implemented sustainable urban mobility plans and the concept has proven its value in bringing together different public and private stakeholders in urban mobility planning.

In this context, the Urban Agenda for the EU was initiated within the framework of intergovernmental cooperation in 2016 with the overall objective of including the urban dimension in policies affecting cities in view of achieving better regulation, better funding and better knowledge for cities in Europe. The Agenda is implemented through Partnerships in a multi-level governance format, and one of the Partnerships is focused on Urban Mobility. It aims to propose solutions to improve the framework conditions for urban mobility for European cities including issues relevant to technological advancements, encouraging the use of active modes of transport as well as improving public transport.

([69]) See Directive 2014/94/EU, Article 4(8).
([70]) See Directive 2014/94/EU, Article 4(12).
([71]) These measures should be without prejudice to property and tenancy laws in the Member State.
([72]) Recital 23 of Directive (EU) 2018/844 — Building codes can be effectively used to introduce targeted requirements to support the deployment of recharging infrastructure in car parks of residential and non-residential buildings. Member States should provide for measures to simplify the deployment of recharging infrastructure with a view to addressing barriers such as split incentives and administrative complications which individual owners encounter when trying to install a recharging point on their parking space.
([73]) http://www.eltis.org/mobility-plans

Member States without requirements or guidelines on bicycle parking should develop as a minimum, guidelines to local authorities on the inclusion of bicycle parking requirements in building regulations and urban planning policies. These guidelines should include both quantitative (i.e. number of parking spaces) as well as qualitative elements.

3.4.5. *Long-term policy and financial measures (Article 2a of the EPBD)*

In addition, Member States are encouraged to consider policy and financial measures also as part of their long-term renovation strategies (Article 2a of the EPBD). These can support and accelerate the deployment of electro-mobility infrastructure in existing buildings, in cases of major renovation (Article 8(2) and (5)) and to meet the minimum requirements for non-residential buildings set in Article 8(3), taking into account that the situation on the relevant markets over time is likely to develop, gradually overcoming certain current market failures.

4. PROVISIONS ON THE CALCULATION OF PRIMARY ENERGY FACTORS

4.1. **Aim: transparency in the calculation of primary energy factors**

The energy performance of a building must be expressed by a numeric indicator of primary energy use, which is the energy needed to satisfy the energy needs of a building. 'Primary energy' is calculated from the amounts of energy flows delivered, using primary energy conversion factors (PEFs) or weighting factors ([74]). Energy flows include electric energy drawn from the grid, gas from networks, oil or pellets (all with their respective primary energy conversion factors) transported to the building for feeding the buildings technical systems, as well as heat or electricity produced on-site.

Under the EPBD, Member States are responsible for calculating PEFs for different energy carriers used in buildings. The calculation of PEFs may be affected by different national electricity mixes, the efficiency of the power plants share, the share of renewable energy, and different calculation methodologies. Experience has shown that figures reported by Member States differ significantly and the procedures used to define PEFs are not always transparent.

To meet the objectives of energy efficiency policy for buildings, the transparency of energy performance certificates should be improved by ensuring that all the necessary parameters for calculations are set out and applied consistently, for both minimum energy performance requirements and for certification.

The objectives of the Annex I, point 2 of the EPBD are to introduce a degree of transparency in calculating PEFs, to ensure the central role of the building envelope and to address the role of on-site and off-site renewable energy sources ([75]).

4.2. **Scope of the provisions on the calculation of primary energy factors**

Annex I of the EPBD has been amended in order to improve the transparency and consistency of the 33 different regional and national energy performance calculation methodologies currently used.

In particular, Annex I, point 2 of the EPBD has been amended to (i) better reflect the energy needs associated with the typical use of a building in the light of developments in the construction sector; and (ii) give additional things to consider when setting PEFs.

([74]) 'Weighting factor' is the terminology used in the CEN overarching standard when referring to PEFs, so 'primary energy factors' and 'weighting factors' are considered to have an equivalent meaning. Both terms are used by Member States.

([75]) With regard to the default PEF value (2.1) for electricity generation in the Energy Efficiency Directive, it has to be noted that in the context of the EPBD, Member States are free to apply their own PEFs, including for electricity from the grid, even at sub-national level.

Article 3 requires the adoption of national methodologies for calculating the energy performance of buildings. The provisions of Article 3 and those related to the calculation of cost-optimal levels (Articles 4 and 5 ([76])) remain unchanged.

4.3. Understanding of the provisions on calculating primary energy factors

4.3.1. *The energy needs to be considered (Annex I, point 2, first paragraph, of the EPBD)*

In order to calculate the energy performance of a building, the energy needs should be initially defined. They refer to the amount of energy (regardless of its source) to be delivered in order to maintain intended indoor conditions. Defining the energy needs of a building is an important step for calculating its energy performance, in line with the cost-optimal methodology. This gradually expands the system boundary from energy needs, to energy use and then to delivered energy and finally to primary energy.

The EPBD sets out that the energy needs for space heating, space cooling, domestic hot water, ventilation, lighting and potentially other areas are to be covered, reflecting the extended definition of 'technical building systems' (Article 2(3) of the EPBD). As with determining the energy uses of a building, it is for Member States to decide if additional energy needs from the broader definition of technical building systems will be considered in calculating energy performance. Member States are also invited to note that built-in lighting is an important energy use for all buildings, in particular for the non-residential sector.

This provision highlights that the calculation of energy needs must lead to optimise health, indoor air quality and comfort levels, as defined by Member States at national or regional level, in calculating energy needs ([77]). These elements ([78]) are crucial, as buildings are defined in the EPBD as constructions for which energy is used to condition the indoor climate. Moreover, better performing buildings provide higher comfort levels and wellbeing for their occupants and improve healthy indoor climate conditions. These requirements are not new, as the EPBD already required (before the amendment) general indoor climate conditions to be taken into account when determining the minimum energy performance requirements (Article 4).

The cost-optimal calculation exercise should be designed in such a way that differences in air quality and comfort are transparent, in line with the Delegated Regulation (EU) No 244/2012. To avoid the deterioration of indoor air quality, comfort and health conditions in the European building stock, the stepwise tightening of minimum energy performance requirements resulting from the implementation of nearly zero-energy buildings (NZEBs) across Europe should be done, together with appropriate strategies dealing with indoor environment ([79]).

4.3.2. *Definition of PEFs (Annex I, point 2, second paragraph of the EPBD)*

The EPBD clarifies that PEFs or weighting factors per energy carrier may be based on national, regional or local annual, seasonal or monthly weighted averages or on more specific information made available for individual district systems. This explicitly acknowledges the current flexibility for Member States when defining PEFs.

([76]) The calculation of energy performance of buildings for setting minimum energy performance requirements must also follow the common methodology framework in the Commission Delegated Regulation (EU) No 244/2012 of 16 January 2012 supplementing Directive 2010/31/EU of the European Parliament and of the Council on the energy performance of buildings by establishing a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements (OJ L 81, 21.3.2012, p. 18).

([77]) The EPB Standard EN 16798-1 (revision of EN 15251) 'Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics' provides reference comfort conditions. Annex B.7 of this standard provides WHO health-based criteria for indoor air and suggested guideline values for indoor and outdoor air pollutants.

([78]) Together with the definition of the outdoor conditions (climate).

([79]) Commission Recommendation (EU) 2016/1318 of 29 July 2016 on guidelines for the promotion of nearly zero-energy buildings and best practices to ensure that, by 2020, all new buildings are nearly zero-energy buildings (OJ L 208, 2.8.2016, p. 46).

One example relates to the treatment of electricity (and to some extent district heating) networks, where the use of seasonal or monthly factors for electricity instead of single annual average values could be more suitable in the case of heating. Similarly, the photovoltaic component of generation is better described on a seasonal basis. Local conditions can also be taken into account when defining PEFs for the purpose of calculating the energy performance of buildings.

4.3.3. *Pursuing the optimal energy performance of the building envelope (Annex I, point 2, third paragraph of the EPBD)*

Annex I, point 2, third paragraph of the EPBD requires Member States to ensure that the optimal energy performance of the building envelope is pursued in applying primary energy and weighted factors. Reducing the overall energy demand is a crucial component when optimising the energy performance of a building. In this context, the consideration of the envelope should not be underestimated ([80]). In addition, technical building systems and building automation and control systems (BACS) have more impact and are most easily optimised in combination with highly performing envelopes.

In line with the Commission's recommendation for the promotion of nearly zero-energy buildings ([81]), renewable energy and efficiency measures should work together.

4.3.4. *On-site and off-site renewable energy sources (Annex I, point 2, fourth paragraph of the EPBD)*

The EPBD provides that Member States may take into account the renewable energy sources (RES) supplied through the energy carrier and the RES that are generated and used on-site when defining PEFs. The provision does not specify the treatment of on-site or off-site RES, allowing Member States to calculate PEFs according to local or national conditions ([82]).

The EPBD explicitly sets out the possibility of addressing renewable energy sources when defining PEFs. Several considerations are worth recalling in this regard:

(a) the energy produced on-site reduces the primary energy associated with the delivered energy;

(b) the calculation of primary energy factors includes both non-renewable energy and renewable energy supplied to the building (total PEF);

(c) the separation of primary energy into non-renewable and renewable components allows for the comparison of results between electricity from different renewable energy sources, and also with electricity generation from fossil fuels;

(d) a distinction between renewable and non-renewable primary energy factors can help people to understand the energy consumption of a building.

The EPBD further clarifies that it is possible to consider renewable energy sources (supplied through the energy carrier, and generated on-site), provided that the calculation of primary energy factors applies on a non-discriminatory basis.

Generally, the principle of non-discrimination requires that comparable situations should not be treated differently and that different situations should not be treated in the same way unless such treatment is objectively justified. This allows Member States to choose the arrangements that are best suited to its particular situation, taking into account specific national circumstances ([83]).

([80]) The consideration of building envelope elements and their influence on the energy performance of buildings also depends on the calculation methodologies applied. For instance, the 'energy balance' approach, which takes into account both energy losses (related to heat loss) as well as energy gains (from passive capture of solar irradiance on buildings and building elements) when calculating the energy performance of a building or a building element of the building envelope, is an approach used in some Member States to take into account solar conditions (in relation to Annex I, point 4 of the EPBD).

([81]) Recommendation (EU) 2016/1318.

([82]) According to EN ISO 52000, there are three types of PEFs: the non-renewable PEF, the renewable PEF and the total PEF.

([83]) Case C-195/12: Industrie du bois de Vielsalm & Cie SA ('IBV') vs Région wallonne (Walloon Region) [2013], paragraph 50-52, 62.

Deducting the renewable energy share from the total primary energy factor (non-renewable factor) is one possible way to ensure that on-site and off-site renewables are treated comparably, preventing limits to the calculation of the energy performance of buildings from having an effect on national or regional renewable energy policies.

Member States may similarly balance the principle of non-discrimination of renewable energy sources as compared to non-renewable energy sources. One possible way of ensuring non-discriminatory treatment is ensuring transparency on figures, conventions (i.e. ways in which Member States treat particular aspects of the PEF calculation, such as frequency of revision of values, choice between retrospective and prospective values, definition of network boundaries, variation of PEF over time, etc.) and underlying assumptions for calculating renewable and non-renewable PEFs.

The following table describes possible situations that may arise, providing examples of the non-discriminatory treatment of on-site and off-site RES:

Table 16

Treatment of on-site and off-site RES — examples

<table>
<tr><th colspan="2">Examples</th><th>Are they comparable?</th><th>Is RES treatment comparable/non-discriminatory treatment?</th></tr>
<tr><td>On-site RES</td><td>Off-site</td><td rowspan="2">Not fully comparable situations.
Off-site RES is connected to the grid, which most likely delivers electricity to the building through a mix of different sources.
Even with the same technology (e.g. PV panels) the results could be different.</td><td rowspan="3">The results can significantly vary based on the treatment of off-site RES
Some issues to be considered include:
— Energy provided from any kind of grid (e.g. electricity or district heating) is often a mix of different sources.
— When comparing situations, it is not only the technology (or mix of technologies) to be considered, but also the quality of the mix (i.e. the RES component). RES should therefore be reflected in the calculation of PEF values.
— Deducting the renewable energy share from PEFs (non-RES PEF) could help ensure that on-site and off-site RES are treated in a comparable positive way.
— Transparency on figures, conventions and underlying assumptions for calculating renewable and non-renewable PEFs is important.</td></tr>
<tr><td>e.g. PV panels
PEF = 0
RES produced on-site is deducted from the energy delivered</td><td>high RES component in the grid (e.g. PV panel park)
PEF = 1</td></tr>
<tr><td></td><td>e.g. district heating network with high RES component (e.g. solar, wind)
PEF = 0,5</td><td>Not fully comparable situations.</td></tr>
</table>

4.4. Transposition of the provisions on the calculation of primary energy factors

Member States are encouraged to review their building codes and, if not already stated in their current national calculation methodologies, make the energy needs clear in their respective transposition measures by the transposition date.

5. VERIFICATION AND ENFORCEMENT

As part of their wider responsibility and work to ensure the effective implementation and enforcement of the EPBD, Member States will also have to consider how to verify compliance with and to enforce:

(a) system requirements established pursuant to Article 8(1) of the EPBD;

(b) requirements for the installation of self-regulating devices under Article 8(1) of the EPBD;

(c) requirements for the installation of BACS under Articles 14(4) and 15(4) of the EPBD;

(d) requirements for electromobility under Article 8 of the EPBD;

It is important that owners, facility manager or energy managers of buildings falling under these requirements are made aware of the entry into force of the requirements in advance, so that they can plan and carry out the necessary works in the best way.

In addition, as regards requirements for installing self-regulating devices:

(a) where these requirements apply to new buildings, Member States may rely on existing processes related to building permits;

(b) where these requirements apply to existing buildings where heat generators are replaced, Member States may rely on existing processes to verify the compliance of heating systems with the requirements set in Article 8(1), as the replacement of heat generators will generally constitute a system upgrade and trigger the application of the requirements.

In addition, as regards requirements for installing BACS:

(a) As all Member States have put in place inspections of heating and air-conditioning systems, or equivalent alternative measures, before the amendment of the EPBD, Member States may consider using those schemes to verify and enforce the requirements for installing BACS, as all buildings that fall under these requirements are also in scope for mandatory inspections (or alternative measures) under Articles 14 and 15 of the EPBD;

(b) Member States may also consider linking the supervision and enforcement of these requirements with the enforcement of system requirements under Article 8(1) of the EPBD, as the installation, replacement or upgrade of a heating, air-conditioning and/or ventilation system may be an opportunity to also install a BACS.

6. SUMMARY OF RECOMMENDATIONS

6.1. **Recommendations relating to technical building systems and their inspections, self-regulating devices and BACS**

(1) The amendment to the EPBD updates and extends the definition of technical building systems, introducing additional definitions for specific systems (e.g. building automation and control systems). When transposing these definitions, Member States are encouraged to provide additional details on the systems concerned, while ensuring full alignment with the Directive, and also referring, where relevant, to any applicable standards or technical guidelines, in order to aid understanding by professionals.

Sections 2.2.1, 2.3.1.1, 2.3.1.2, 2.3.1.3, 2.3.1.5 and 2.4.1.1 of this document.

(2) The EPBD requires system requirements to be drawn up for all technical building system requirements. This particularly entails drawing up requirements for systems that were not required to have them before the amendment. In doing this, all areas of system requirements must be covered: overall energy performance, proper installation, appropriate dimensioning, adjustment and control. Applicable standards and technical guidelines at EU and national level should also be considered, in particular the Energy Performance of Buildings standards developed by CEN ([84]) under Mandate M/480 ([85]).

Sections 2.2.1, 2.3.1.1, 2.3.1.2, 2.4.1.2 and 2.5.1 of this document.

([84]) European Committee for Standardisation (https://www.cen.eu/Pages/default.aspx).
([85]) M/480 Mandate to CEN, Cenelec and ETSI for the elaboration and adoption of standards for a methodology calculating the integrated energy performance of buildings and promoting the energy efficiency of buildings, in accordance with the terms set in the recast of the Directive on the energy performance of buildings (Directive 2010/31/EU).

(3) Member States are encouraged to support awareness and understanding by building owners, system installers and other parties involved, of the interventions that trigger the application of system requirements and the assessment and documentation of system performance in all buildings (Article 8(1) and 8(9) of the EPBD). These interventions are the installation, replacement and upgrade of a system. In particular, Member States are invited to give additional details on what should be considered a system upgrade, possibly differentiating between different types of systems, and putting a particular emphasis on those systems that are the most common in the national building stock.

Sections 2.3.1.4, 2.4.1.3 and 2.5.2 of this document.

(4) 'Self-regulating devices' is a concept that could be interpreted in different ways. In transposing the provisions on installing self-regulating devices, it will be useful for Member States to give additional details on which devices can meet the relevant needs, in particular for those systems that are the most frequently used in the national building stock. In relation to the same provisions, Member States should clarify situations where the self-regulating capability could be applied at zone (as opposed to room) level. Lastly, it will be useful if Member States can support awareness and understanding by building owners, system installers and other parties involved, of the situations that lead to the requirement for installing self-regulating devices in existing buildings being applied, in particular by providing additional details on what to interpret as a replacement of heat generators in ambiguous cases.

Sections 2.2.3, 2.3.3.2, 2.3.3.3(a) and 2.4.3.1 of this document.

(5) BACS installed in non-residential buildings pursuant to the obligations of Article 14(4) and 15(4) of the EPBD are required to comply with the definition of Article 2(3a) and include the capabilities listed in 14(4) and 15(4), at least for the technical building systems that fall under the scope of Articles 14 and 15. Those capabilities go beyond what are expected from usual BACS. Therefore, in transposing these requirements, Member States should ensure the interested parties are made aware of the exact implications of these requirements and give clear guidance on how to assess the capabilities of BACS with regard to the requirements and, where relevant, on how to implement the required upgrades.

See sections 2.2.4, 2.3.3.1, 2.3.3.3(b), 2.4.3.2 and 2.5.4 of this document.

(6) Some provisions apply only when feasibility conditions are met: technical and economic feasibility for requirements on the installation of self-regulating devices and BACS; and technical, economic and functional feasibility for system requirements. Member States are responsible for ensuring that the assessment of feasibility is properly framed and supervised as part of enforcement and verification mechanisms. In doing so, it is recommended that Member States support the interpretation and assessment of feasibility, e.g. through dedicated guidance and procedures.

See sections 2.3.4 and 5 of this document.

(7) Inspections of technical building systems are already in place in many Member States but the amendment of the EPBD has led to significant modifications of the scope of these inspections. This is particularly the case for the threshold on effective rated output above which inspections are required and the types of systems that should be inspected. Member States are encouraged to support understanding of these changes and their implications for all interested parties. In particular, it will be helpful for Member States to support the identification of combined systems that should be inspected and give guidance on inspecting ventilation systems, where applicable.

See sections 2.2.2, 2.3.2.1 to 2.3.2.5, 2.4.2.1(a) and 2.4.2.1(b), 2.4.2.2, and 2.5.3 of this document.

(8) One significant change in inspections of technical building systems provided for in Articles 14 and 15 of the EPBD is the need to consider (where relevant) system performance under typical or average operating conditions. This should lead to changes of inspection practices and the related framework, e.g. training schemes. In order to support this transition, it is recommended that Member States translate this general requirement into technical guidance to support the consideration of performance under typical or average operating conditions in practice, for the different types of systems affected.

See section 2.3.2.6 and 2.4.2.1(c) of this document.

(9) In transposing the provisions on the inspection of heating and air-conditioning systems, it is recommended that Member States give due consideration to the framing and supervision of exemptions that can apply. In particular, Member States will find it beneficial to set out the capabilities expected from continuous electronic monitoring systems in residential buildings, as alternatives to inspections, and to ensure that energy performance contracts that cover technical building systems, when these lead to exemptions, comply with applicable requirements and good practices.

See sections 2.3.2.7, 2.3.2.8, 2.3.2.9, and 2.4.2.1(d) to 2.4.2.1(g) of this document.

6.2. **Recommendations relating to electromobility**

(10) Provisions on electromobility introduce new terms and concepts into building regulation in most Member States. Member States are encouraged to provide guidance on interpreting these new terms and concepts in order to ensure correct implementation. This applies particularly to the scope of the requirements, the relation between buildings and car parks (e.g. the notion of physical adjacency) and the scope of the renovation measures that trigger the requirements (e.g. the car park or electrical infrastructure).

See sections 3.2, 3.3.1, 3.3.3 and 3.4.1 of this document.

(11) The requirements for the installation of a minimum number of recharging points in non-residential buildings (Article 8(3)) are an important aspect of the provisions on electromobility. The definition and implementation of these requirements should be based on careful planning, in order to ensure an optimal coverage of the targeted buildings and smooth deployment thereafter. In laying down these requirements, Member States are particularly encouraged to draw from the experience of EU Member States that have already drawn up similar requirements.

See section 3.3.4 of this document.

(12) The provisions of the EPBD on electromobility are complementary to Directive 2014/94/EU. It is recommended that Member States pay particular attention to implementing the two Directives consistently, in particular when it comes to drawing up requirements for the installation of a minimum number of recharging points in non-residential buildings. This may require working closely with the ministry and teams responsible for implementing Directive 2014/94/EU as well as taking a multi-disciplinary, comprehensive approach across policy areas such as buildings, urban planning, transport and mobility.

See Sections 3.3.4 and 3.3.5 of this document.

(13) The provisions of the EPBD are equally complementary to Directive 2009/72/EC which promotes the development of a flexible electricity system. In order to efficiently integrate new loads into the electricity system, such as electric vehicles, smart charging and vehicle to grid technologies need to be enabled. Those concepts are especially relevant for charging at homes, offices and car parks where cars are often parked for several hours and hence can provide services to the grid operator. Investments in charging infrastructure under the EPBD should take due account of existing and future smart charging and vehicle to grid standards (e.g. ISO 15118) and be connected to fully functional smart metering systems.

See section 3.4.3 of this document.

(14) Member States are encouraged to clarify the technical specifications and other requirements for recharging points that will be deployed under the electromobility provisions of Article 8, including Article 8(3), of the EPBD. Considerations such as specifications relating to minimum charging capacity, ducting infrastructure, fire safety, accessibility for people with reduced mobility including persons with disabilities and smart charging can help ensure effective implementation and can support the uptake of electric vehicles.

See Section 3.4.3 of this document.

(15) Regulatory barriers and market failures may impede the deployment of electromobility infrastructure and, consequently, the uptake of electric vehicles. Regulatory simplification, long-term planning and financial incentives may be necessary to tackle these challenges. To simplify the deployment of recharging points (Article 8(7) of the EPBD), Member States are encouraged to ensure the 'right to plug' to address split incentives and administrative complications, notably in the case of multi-family dwellings. In addition, Member States are encouraged to consider policy and financial measures also as part of their long-term renovation strategies (Article 2a of the EPBD) which can support and accelerate the deployment of electromobility infrastructure in existing buildings, both in cases of major renovation (Article 8(2) and (5) of the EPBD) and to meet the minimum requirements for non-residential buildings set in Article 8(3)), taking into account that the situation on the relevant markets over time is likely to develop, gradually overcoming certain current market failures.

See sections 3.4.3.3 and 3.4.5 of this document.

6.3. Recommendations relating to the calculation of primary energy factors

(16) PEFs should be regularly reviewed, to reflect changes in the national energy mix and in the energy market over time, and in underlying calculation methodologies.

See section 4.2 and 4.3.2 of this document.

(17) When determining their national calculation methodology, Member States should always try to find the best combination of energy efficiency and renewable measures. Member States should always ensure the optimal energy performance of the building envelope and, therefore, renewable energy solutions should be used in conjunction with optimum energy savings from the building envelope and its technical building systems.

See section 4.3.1, 4.3.3 and 4.3.4 of this document.

(18) Technical guidelines could be provided at national or regional level on how to improve the indoor quality of buildings by avoiding thermal bridges, inadequate insulation and unplanned air pathways that can result in surface temperatures below the dew point of the air and dampness.

See section 4.3.3 of this document.

6.4. Cross-cutting recommendations

(19) As for all other provisions of the EPBD, enforcement and supervision will be paramount for the effective implementation of the provisions discussed in this Annex. Member States should pay particular attention to enforcement and supervision measures, including verification and control of exemptions where applicable, when transposing these provisions. Where relevant, Member States will find it beneficial to make use of schemes that are already in place (e.g. inspections schemes for technical building systems).

See sections 2.3.1.4, 2.3.2.8, 2.3.3.3, 2.3.4, 3.3.2, 3.4.2 and 5 of this document.