Technical assistance for ensuring optimal performance of technical building systems under the new Energy Performance of Buildings Directive(EU) 2018/844

Mini-report to support the implementation and enforcement of Articles 8(1) and 8(9)

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Technical assistance for ensuring optimal performance of technical building systems under the Energy Performance of Buildings Directive

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INTRODUCTION

Technical building systems (TBS) are defined in the Energy Performance of Buildings Directive (EPBD) as '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' (Article 2(3)). The main function of the TBS in a building is to provide a comfortable, healthy and functional indoor environment when the building is occupied. There can be large differences in energy performance between TBSs designed to deliver the same functionality. These performance differences arise, for example, by the extent to which: the overshooting of comfort temperature or air quality set points is minimised, energy demand is reduced by matching service delivery with occupancy, hydronic heating or cooling distribution system losses are minimised, and heat or cold generation efficiency is optimised. Therefore, policymakers should be aware that very significant energy savings in buildings can be obtained by measures that improve the performance of technical building system (TBS). Furthermore, the rate at which TBS are renewed or retrofit is greater than that of building fabric renovation and/or of new build and thus policy measures which target TBS can access a much greater proportion of the building stock in any given period than those that concern major renovation.

In conclusion, the performance of technical building systems has a very significant impact on the overall building energy performance and therefore needs to be a major focus of building energy performance policy measures. For this reason, the 2018[1] amendment of the EPBD strengthened the measures applicable to TBS. In particular:

- Article 8(1) of the EPBD requires Member States to set system requirements on overall energy performance, proper installation, appropriate dimensioning, adjustment and control of technical building systems
- Article 8(9) of the EPBD requires Member States to ensure that when a technical building system is installed, replaced or upgraded, the overall energy performance of the altered part or (where relevant) of the complete altered system is assessed.

This mini guide provides simplified guidance to support effective implementation and enforcement of the amended Article 8(1) and Article 8(9). Guidance is provided per type of TBS: space heating, space cooling, ventilation, built-in lighting, building automation and control systems (BACS) and renewable energy system (RES) integration.

A more detailed report, which is complementary to this mini guide, is also available and published by the European Commission in the context of this project. Amongst other aspects, the more detailed report also includes more specific guidance on BACS for implementing Articles 14 (4) and 15 (4), which require that non-residential buildings with a system output of over 290 kW for heating or cooling are equipped with BACS by 2025 where technically and economically feasible.

[1] 6 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, https://eur-lex.europa.eu/eli/dir/2018/844/oj

EPBD ARTICLE 8: GUIDANCE FOR SPACE HEATING

Why meaningful Article 8(1) measures are needed

All building energy is consumed in technical building systems and space heating alone accounts for by far the largest share of primary energy use in EU buildings (~65% of the total). Whole building minimum energy performance measures only affect new building or major renovations, while Ecodesign and energy labelling apply to components or part of the system but do not address much of the savings opportunity from optimisation of the technical building system as a whole. In the case of space heating it is estimated that the adoption of comprehensive Article 8(1) requirements could reduce total EU building primary energy consumption in 2040 by between 6.5% and 16% in addition to the savings triggered by the other policy measures. Therefore, Member States are required to set such measures for space heating systems with regard to overall performance, dimensioning, installation, adjustment and control to abide by the terms of Article 8(1).

Commission guidance on interpretation of the measures

When setting Article 8(1) requirements it is helpful to consider the Commission's guidance[2] on the possible interpretation of system requirements for space heating as shown in the table below.

Table 1 Commission Article 8(1) guidance for space heating

Type of requirement	Possible interpretation for space heating	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. In particular, it is not limited to performance of heat generators and can include requirements that affect other parts of the system (e.g. insulation of distribution piping network).	EN 15316 standard series, e.g. EN 15316-1, EN 15316-2, EN 15316-3, EN 15316-4-1, EN 15316-4-2, EN 15316-4-5, EN 15316-4-8, EN 15316-5, EN 15316-4-8, EN 15316-5
Appropriate dimensioning	For heating systems, 'appropriate dimensioning' would refer to the determination of heating needs, taking into account relevant parameters (in particular intended usage of the building and its spaces) and to the translation of these requirements into design specifications for heating systems.	EN 12831-1, EN 12831–3, Module M8–2, M8–3EN 12828, EN 14337 EN 1264-3:2009
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.	EN 14336 EN 1264-4 EN 14337
Adjustment	Adjustment refers here to the test and fine tuning of the system under real-life conditions, in particular to check and possibly adjust system functions that can have an important impact on performance (e.g. control capabilities – see below).	EN 15378-1 EN 14336 EN 15378–3
Appropriate control	Concerns control capabilities that heating systems can include in order to optimize 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, etc.	EN 15500-1, EN 15316-2, EN 15232, space heater energy labelling regulations

[2] COMMISSION RECOMMENDATION (EU) 2019/1019 of 7 June 2019 on building modernisation, OJEU L165/70

Recommended measures

A non-comprehensive list of some of the most promising energy saving opportunities that could be accessed by Article 8(1) measures for space heating are set out below.

System performance requirements could be set:

- to require the installation of a heat recovery system (or an exhaust air heat pump in case of space constraints) for larger systems (>70kW) to be made mandatory whenever a major system component is installed or replaced
- to require overall space heating system energy performance limits to be met requirements, e.g. in line with the 2030 reduction target for buildings
- to oblige the replacement of old combustion (non-condensing) boilers (25–30 years old) – privately owned and used single-family houses can be excluded as well as boilers with proven fulfilment of actual minimum Ecodesign requirement
- to require installation of insulation on pipes (at a 100% of the pipe diameter in thermal effect terms) – for accessible pipes outside the heated zone for all systems.

Sizing dimensioning & installation requirements could be set:

- to ensure proper installation according to standards.

Adjustment requirements could be set:

- to promote night set-back – adjusted settings (e.g. 11pm to 6am, 2 K temperature reduction) in residential buildings if system and user allows
- to promote night set-back – adjusted settings (e.g. for offices use 5pm to 6am, 2 K temperature reduction) in non-residential buildings, if system and user allows to
- to stimulate hydronic balancing and heat zoning.

Control requirements could be set:

- to require individual heat emitter control – thermostatic radiator valves - in all buildings
- to require or incentivise larger systems >70kW to install a monitoring system, to be triggered whenever a major system component is installed or replaced, that allows comparison of actual performance with expected performance and parameters to be adapted when needed
- to require heat pumps in new buildings to be equipped with a monitoring system to visualise actual seasonal performance in relation to the calculated value of the energy performance certificate
- avoid simultaneous heating and cooling, by implementing a central controller or ensuring separate controllers do not overlap in systems >70kW
- use of weather compensation to adapt supply temperature.

Article 8(9) – assessment and documentation

Depending on the prevalent practice within a Member State, assessment can be conducted by the installers supported by simplified or more complex (depending on the nature and complexity of the system) assessment tools and checklists. Documentation can be managed through Declarations of Honour and checklists Some Member States have created public databases where such documentation of assessments must be reposited.

EPBD ARTICLE 8: GUIDANCE FOR SPACE COOLING

Why meaningful Article 8(1) measures are needed

All building energy is consumed in technical building systems and space cooling accounts for a significant and growing share of primary energy use in EU buildings (~4% of the total). Whole building minimum energy performance measures only affect new building or major renovations, while Ecodesign and energy labelling apply to components or part of the system but do not address much of the savings opportunity from optimisation of the technical building system as a whole. In the case of space cooling it is estimated that the adoption of comprehensive Article 8(1) requirements could reduce total EU building primary energy consumption in 2040 by up to 1.6% in addition to the savings triggered by the other EU policy measures. However, in climates with higher ambient temperatures, such as in southern Europe, the share of the building stock primary energy savings potential could be appreciably higher. Therefore, Member States are required to set such measures for space cooling systems with regard to overall performance, dimensioning, installation, adjustment and control to abide by the terms of Article 8(1).

Commission guidance on interpretation of the measures

When setting Article 8(1) requirements it is helpful to consider the Commission's guidance[3] on the possible interpretation of system requirements for space cooling as shown in the table below.

Table 2 Commission Article 8(1) guidance for space cooling

Type of requirement	Possible interpretation for space cooling	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. In particular, it is not limited to performance of cooling generators 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, EN 16798–13, EN 16798–15
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
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.	EN 1264-4
Adjustment	Adjustment refers here to the test and fine-tuning of the system under real-life conditions (6), in particular to check and possibly adjust system functions that can have an important impact on performance (e.g. control capabilities – see below).	EN 16798–17
Appropriate control	Concerns control capabilities that systems for space cooling can include in order to optimize performance, e.g. automatic adaptation of cooling output of emitters in individual rooms or spaces.	EN 15500-1, EN 15316-2, EN 15232

Recommended measures

A non-comprehensive list of some of the most promising energy saving opportunities that could be accessed by Article 8(1) measures for space cooling are set out below.

System performance requirements could be set:

[3] COMMISSION RECOMMENDATION (EU) 2019/1019 of 7 June 2019 on building modernisation, OJEU L165/70

- to require overall space cooling system energy performance limits to be met requirements, e.g. in line with the 2030 reduction target for buildings
- where applicable, to require the installation of a heat recovery system (or an exhaust air heat pump in case of space constraints) for larger systems (>70kW) to be made mandatory whenever a major system component is installed or replaced
- where applicable, to require installation of insulation on pipes (at a 100% of the pipe diameter in thermal effect terms) – for accessible pipes outside the cooled zone for all systems.

Sizing dimensioning and installation requirements could be set:

- per those parameters indicated in the table above
- reduce motor size (fan power) when oversized for all non-packaged systems
- to ensure proper installation according to standards.

Adjustment requirements could be set:

- to require the regular cleaning or replacement of filters
- reduce power consumption of auxiliary equipment.

Control requirements could be set:

- to oblige circulation pumps to be switched off when not required for all non-packaged systems
- to avoid simultaneous heating and cooling: by implementing a central controller or making sure that separate controllers do not overlap for all cooling systems of >70kW with heating
- shut off auxiliaries when not required for all non-packaged systems
- shut chiller plant off when not required for systems using chillers
- sequence heating and cooling for all non-packaged systems with space heating
- shut off AC equipment when not needed
- to require or incentivise larger systems >70kW to install a monitoring system, to be triggered whenever a major system component is installed or replaced, that allows comparison of actual performance with expected performance and parameters to be adapted when needed
- to require or incentivise the installation of BACS for systems >70kW.

Article 8(9) – assessment and documentation

Depending on the prevalent practice within a Member State, assessment can be conducted by the installers supported by simplified or more complex (depending on the nature and complexity of the system) assessment tools and checklists. Documentation can be managed through Declarations of Honour and checklists. Some Member States have created public databases where such documentation of assessments must be reposited and websites where assessment tools can be downloaded.

EPBD ARTICLE 8: GUIDANCE FOR VENTILATION

Why meaningful Article 8(1) measures are needed

All building energy is consumed in technical building systems and ventilation accounts for a significant share of primary energy use in EU buildings (~10% of the total). Whole building minimum energy performance measures only affect new building or major renovations, while Ecodesign and energy labelling apply to components or part of the system but do not address much of the savings opportunity from optimisation of the technical building system as a whole. In the case of ventilation, it is estimated that the adoption of comprehensive Article 8(1) requirements could reduce total EU building primary energy consumption in 2040 by between 1.5% and 3.6% in addition to the savings triggered by the other policy measures. Therefore, Member States are required to set such measures for ventilation systems with regard to overall performance, dimensioning, installation, adjustment and control to abide by the terms of Article 8(1).

Commission guidance on interpretation of the measures

When setting Article 8(1) requirements it is helpful to consider the Commission's guidance[4] on the possible interpretation of system requirements for ventilation as shown in the table below.

Table 3 Commission Article 8(1) guidance for ventilation

Type of requirement	Possible interpretation for space heating	Useful references
Overall energy performance	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, etc.	EN 16798–3, EN 16798–5–1, EN 16798–5–2
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, CEN/TR 14788, CR 1752
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
Adjustment	Adjustment refers here to the test and finetuning of the system under real-life conditions (8), in particular to check and possibly adjust system functions that can have an important impact on performance (e.g. control capabilities – see below).	EN 12599, EN 16798-17, EN 14134
Appropriate control	Concerns control capabilities that ventilation systems can include in order to optimize performance, e.g. airflow modulation.	EN 15232, EN 15500-1

Recommended measures

A non-comprehensive list of some of the most promising energy saving opportunities that could be accessed by Article 8(1) measures for ventilation are set out below.

[4] COMMISSION RECOMMENDATION (EU) 2019/1019 of 7 June 2019 on building modernisation, OJEU L165/70

System performance requirements could be set:

- to require the average specific fan power (PSFP) of fans to achieve minimum permissible performance levels; furthermore, for larger systems specific it would be reasonable to set minimum PSFP limits applicable to existing systems

- to require the installation of a heat recovery system (or an exhaust air heat pump in case of space constraints) for larger systems to be made mandatory whenever a major system component is installed or replaced

- to oblige systems using filters above a certain air flow rate to satisfy minimum filter exchange performance levels through specification of minimum filter classes

- to require overall ventilation system energy performance limits to be met requirements, e.g. in line with the 2030 reduction target for buildings.

Sizing dimensioning & installation requirements could be set:

- per the dimensioning of the parameters indicated in the table above

- to ensure proper installation according to standards

- to ensure that airflow volumes are better matched to the actual demand – adjustment could be required for all larger existing systems independently of intervention trigger points and design sizing obliged for all systems when replaced or a major component/set of components are being replaced.

Control requirements could be set:

- that require all larger systems to have airflow volume controls independently of intervention trigger points, and potentially to be verified through periodic system inspections

- that require or incentivise larger systems to install a monitoring system, triggered whenever a major system component is installed or replaced, that allows comparison of actual performance with expected performance.

Article 8(9) – assessment and documentation

Depending on the prevalent practice within a Member State, assessment can be conducted by the installers supported by simplified or more complex (depending on the nature of the system) assessment tools and checklists. Documentation can be managed through Declarations of Honour and checklists Some Member States have created public databases where such documentation of assessments must be reposited.

EPBD ARTICLE 8: GUIDANCE FOR BUILT-IN LIGHTING

Why meaningful Article 8(1) measures are needed

All building energy is consumed in technical building systems and built-in lighting accounts for a significant share of primary energy use in EU buildings (~9% of the total). Whole building minimum energy performance measures only affect new building or major renovations, while Ecodesign and energy labelling apply to components or part of the system but do not address much of the savings opportunity from optimisation of the technical building system as a whole. In the case of built-in lighting it is estimated that the adoption of comprehensive system level requirements in line with Article 8(1) could reduce total EU building primary energy consumption in 2040 by between 3.6% and 5.3% in addition to the savings triggered by the other policy measures.

Commission guidance on interpretation of the measures

When setting Article 8(1) requirements it is helpful to consider the Commission's guidance[5] on the possible interpretation of system requirements for built-in lighting as shown in the table below. Based on the findings of this study[6] new possible interpretations were identified and added in italic.

Table 4 Commission Article 8(1) guidance for built-in lighting

Type of requirement	Possible interpretation for built-in lighting	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. *In addition, it is possible to set limits to the lighting power density PDI [W/100 lx/m] and require to consider a new lighting design when the threshold is exceeded.*	EN 15193-1:2017, CEN/TR 15193-2:2017
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, CEN/TS 17165
Proper installation	Installation of electric equipment, including lighting, in accordance with applicable regulations at national level.	NA
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, CIE 222:2017

Recommended measures

A non-comprehensive list of some of the most promising energy saving opportunities that could be accessed by Article 8(1) measures for built-in lighting are set out below (more are in Task 4 of the main report).

Overall system performance requirements could be set:

[5] COMMISSION RECOMMENDATION (EU) 2019/1019 of 7 June 2019 on building modernisation, OJEU L165/70

[6] https://ec.europa.eu/energy/studies_main/preparatory-studies/technical-assistance-study-ensuring-optimal-performance-technical-building-systems-under-energy_en

For non-residential lighting in indoor workplaces in large buildings where EN 12464 (>500 m²) applies, the following data should be calculated at design stage or monitored:

- The reference Lighting Energy Numerical Indicator (LENI) [kWh/m²/h] design value should be available (EN15193) and from monitoring after installation (benchmarks are provided in the lot 37 study[2])
- The reference Power Density Indicator (PDI) [W/100 lx/m²] design value should be available [EN15193] or can be measured for existing installations, for example as PDI limits with application specific limits are applied in BE (VL)[7].

In large non-residential buildings an audit and justification for not considering a relighting and redesign could be requested when the benchmark values are exceeded for two consecutive years.

Dimensioning requirements could be set for new or replacement lighting systems:

For non-residential lighting in indoor workplaces in large buildings where EN 12464 (>500 m²) applies, the following data needs to be provided at the design stage:

- printout (pdf) of the lighting design file with calculated LENI, PDI, luminaire power (Pl), standby power consumption (Ppc) values including EN 12464 minimum values (e.g. as can be generated by DIALUX, RELUX, OXYTECH, etc. software)
- luminaire data sheets.

For other lighting applications the following data could be required:

- the total calculated luminaire power Pl [W/m²].

Control and adjustment requirements could be set:

- A requirement that lighting installations in common circulation areas in existing buildings should have a presence detector
    - for high occupancy rooms with available daylight, to have:
        - daylight dependent dimming
        - controller loops every 25 m².

Control can also be understood as monitoring requirements and therefore as part of a BACS Energy Monitoring System (EMS) the following could be required:

- monitor the LENI per month and compare it to both historical data and the design file values or the benchmark values (see Lot 37)[8].
- Check the recorded data regularly against the benchmark and in case of abnormal high consumption check in more detail for: polluted luminaires/windows/walls that benefit from cleaning, screen controls set points, occupancy schedules (if any), lighting scenes (if any) and daylight control set points and sensors.

Article 8(9) – assessment and documentation

Depending on the prevalent practice within a Member State assessment can be conducted by the installers supported by simplified or more complex (depending on the nature and complexity of the system) assessment tools and checklists. Documentation can be managed through Declarations of Honour and checklists. Some Member States have created public databases where such documentation of assessments must be reposited. For lighting, it is important that Member States can ask the electronic design file of the sector agreed lighting design software to be submitted in these public databases.

[7] https://www.energiesparen.be/bouwen-en-verbouwen/epb-pedia/technieken/verlichting/installatie-eisen

[8] https://ecodesign-lightingsystems.eu/

EPBD ARTICLE 8: GUIDANCE FOR BACS

Why meaningful Article 8(1) measures are needed

The degree and sophistication of control of technical building systems is a key aspect of their overall energy efficiency necessary to ensure that energy is only being delivered when it is needed, that technical building systems are operating at their most efficient conditions, and to manage loads. Building automation control systems (BACS) are therefore an essential element affecting the ability to achieve energy savings in technical building systems. In recognition of this the EPBD classifies them as a TBS in their own right and Member States are obliged to set Article 8(1) and 8(9) requirements for them accordingly.

Commission guidance on interpretation of the measures

When setting Article 8(1) requirements it is helpful to consider the Commission's guidance[9] on the possible interpretation of system requirements for BACS as shown in the table below.

Table 5 Commission Article 8(1) guidance for BACS

Type of requirement	Possible interpretation for space heating	Useful references
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.	EN 15232 EN 16947- 1:2017 and TR 16947-2
Appropriate dimensioning	Dimensioning would refer here not to the 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, etc.) in order to reach this optimal compromise. In the scope of these requirements, it can be useful to refer to relevant standards or guidelines.	ISO 16484-1:2010
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 and TR 16946
Adjustment	Adjustment' refers to post-installation test of the system in order to check that the system operates properly, and to fine-tuning when the system operates 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.	EN 16946- 1:2017 and TR 16946-2; ISO 50003
Appropriate control	This category mostly applies to technical building systems that are controlled (e.g. heating systems) 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 in order to support or facilitate human control (e.g. display of consumption data or any other interaction with building operator and building occupants)	EN 15232, EN 16947-1:2017 and TR 16947-2

[9] COMMISSION RECOMMENDATION (EU) 2019/1019 of 7 June 2019 on building modernisation, OJEU L165/70

Recommended measures

BACS are a horizontal topic that overarches the other TBS service domains. This means that the specification of BACS requirements under Article 8(1) could be addressed indirectly by the specification of measures that require control and monitoring capabilities for each of the other TBS (space heating, domestic hot water, space cooling, ventilation, lighting and RES). However, it is equally possible, appropriate and complementary to specify BACS functionality at the whole building level via the BACS energy performance classes defined in the standard EN 15232. The TBS control measures that could be specified under Article 8(1) provisions include requiring the capability of the:

- heat or cool generator system, or ventilation air handling unit, to vary the heating/cooling power or fresh air output upon signals from the control system / demand signals from the emission spaces – so called "modulation" of the output
- HVAC system to vary energy distribution according to actual demand (e.g. capability of the pumps, compressors and fans to adjust water/refrigerant/air flows and temperatures to actual needs)
- control system to automatically modulate and adapt the output of heat or cool emitters – e.g. radiators or a fan coil unit – to match actual and desired room temperature in individual rooms of the building – so called individual room temperature control based on various parameters such as room temperature / occupancy
- control system to adapt space heating and cooling energy output to outdoor temperatures – so called weather compensation
- control system to manage automated solar protection to ensure the correct level of HVAC / avoid unnecessary cooling and glare protection depending on natural solar gains or overheating depending on seasons
- control system to manage artificial lighting level depending on natural light through automated solar protection
- control system to coordinate systems that are integrated in order to facilitate energy efficiency and smooth operation (e.g. scheduler and setpoint manager for rooms covering all installed services (e.g. heating, cooling, ventilation, light and sun protection))
- control system to avoid simultaneous heating and cooling at the same time in the same room / space through any installed system (e.g. ventilation and heating)
- HVAC / hydronic system to ensure smooth distribution of energy across the building in water-based heating, air conditioning and cooling systems – so called dynamic hydronic balancing.

It is recommended that Member States should draw up a matrix of such control functionality requirements and ensure that appropriate Article 8(1) measures are in place to stimulate technically and economically feasible adoption of such measures for each affected TBS.

SELF-REGULATING DEVICES

Individual room temperature controls should be installed for new systems (heating or cooling) and when heat generators are replaced (heating only). Typical devices would be TRVs on radiators. The key aspect of this requirement is that it needs to be done on a room-by-room basis and therefore the control must both monitor temperature and adjust heating output in each room.

Article 8(9) – assessment and documentation

Depending on the prevalent practice within a Member State assessment can be conducted by the installers supported by simplified or more complex (depending on the nature and complexity of the system) assessment tools and checklists. Documentation can be managed through Declarations of Honour and checklists Some Member States have created public databases where such documentation of assessments must be reposited.

EPBD ARTICLE 8: GUIDANCE FOR RENEWABLE ENERGY SYSTEMS

Why meaningful Article 8(1) measures are needed

Whole building minimum energy performance measures only affect new building or major renovations, while Ecodesign and energy labelling apply to components or part of the system but do not address much of the savings opportunity from optimisation of the technical building system as a whole. Therefore, Article 8(1) requires Member States to set more specific requirements for renewable energy technical building systems, for example photovoltaic systems or solar thermal collectors with regard to overall performance, dimensioning, installation and control. In this context please also be aware that an Ecodesign and Energy label study[10] on photovoltaic systems is still ongoing whereby an installer label is considered that could support this Article 8(1) implementation.

Commission guidance on interpretation of the measures

When setting requirements it is helpful to consider the Commission's guidance[11] (lightly amended via text in italics) for Renewable Energy Systems(RES) as shown in the table below.

Table 6 Commission Article 8(1) guidance for RES

Type of requirement	Possible interpretation for space heating	Useful references
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) that are under elaboration. *In addition, for countries or regions with real time energy metering and billing requirements, consumers should be warned that this might be incompatible with HVAC self-consumption and that a battery energy storage system (BESS) might be needed.*	EN 15316-4-6, EN 61724 and IEC 61853-2:2016 for photovoltaic systems, EN 15316-4-4 standard for building-integrated cogeneration system, EN 15316-4-10 and IEC 61400-12-1 for wind power generation systems *See: ongoing Ecodesign and Energy labelling study[6].*
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.). *Additional parameters to be provided:* *Calculated annual exported electricity from PV and Self-consumption based on the local electricity metering scheme taking 'maximum time frame for credit compensation'[122]* *Inform the building owner on the impact of maximum time frame for credit compensation* *Calculated annual electricity from PV that can be taken into account for an EPC (notes: this depends on the local EPC calculation code).*	*EN ISO 52000-1, 52003-1, 52010-1, 52016-1, and 52018-1* *See ongoing study[6]*
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	For BIPV systems, EN 50583-2 For PV systems, IEC/EN 62446

[10] https://susproc.jrc.ec.europa.eu/product-bureau/product-groups/462/home

[11] COMMISSION RECOMMENDATION (EU) 2019/1019 of 7 June 2019 on building modernisation, OJEU L165/70

	technical guidelines. For photovoltaic systems, standards applying to building-integrated photovoltaics (BIPV) can be relevant in this context *Within the warranty period (2yrs) include a post-installation test of the system to check that it operates properly*	
Adjustment	*N/A*	*N/A*
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.	*See ongoing study[6] with regard to smart readiness requirements for photovoltaic inverters*

Recommended measures

The most important finding is related to dimensioning of on-site renewable electricity generation. It has been found that there are various definitions of ''on-site production of photovoltaic energy' and the various local authorities involved in Energy Performance Certificates (EPCs) of the EPBD and metering and billing need to cooperate to support the proper understanding and dimensioning of photovoltaic systems. For electricity metering and billing the important parameter in self-consumption schemes is the 'maximum time frame for credit compensation'[12]. This parameter refers to schemes that allow credits for all electricity injected during a certain period in which compensation is permitted, meaning that the injected energy can be subtracted from consumption. This period can be real-time (20ms), 15 minutes, 1 hour, 1 day, 1 month or 1 year. For example, in 2020 in Denmark 1 hour was used, in Finland (real-time), France (1/2 hour), Belgium Wallonia (annual for small systems), Belgium Flanders (20 ms), etc. Also, for EPCs the EN EPBD standard allows various methods for accounting PV to supply HVAC which range from annual, monthly or hourly time credits for self-consumption. Often the methods used for an EPC versus the metering for billing do not align, which is confusing for building owners and does not allow for an economic assessment. Therefore, also the business case for demand response and their technical requirements to increase self-consumption varies per EU country. Therefore, it is recommended to require clear dimensioning information related to this, see proposals added in the table above.

For a possible installer label and documentation requirements for photovoltaic systems, please consult the EU study on Ecodesign and energy labelling[2].

The current COMMISSION RECOMMENDATION (EU) 2019/1019 has no section related to other renewable systems for Domestic Hot Water (DHW) or heating under Article 8, which can be justified because thermal renewable energy is already well covered by EN standards Article 2 and 9 of the EPBD and Article 15 of the EED. In regions with high solar energy potential it is possible to mandate the use of renewable energy for DHW and thus solar collectors. For example, in 1999, Barcelona's City Council passed the Solar Thermal Ordinance that requires all new buildings, renovated buildings, and buildings changing their use (e.g. a villa turned into a hotel), both private and public, to supply at least 60 percent of sanitary hot water with solar energy. Depending on the local climate this can also be considered in other regions.

Banning the installation of fossil fuel heating in some types of buildings and district is a possible radical implementing measure. For example, the Netherlands wants reduce gas as heating source and therefore does not allow installation of gas boilers in some types of buildings and districts. This measure could be considered for new or deeply renovated buildings or selected districts, when a district heating network with renewable energy is available. In principle it could also be required for large SFH to install only a heat pump when there is sufficient space available. The effective enforcement can easily be done by cutting off the gas supply.

Article 8(9) – assessment and documentation

Depending on the prevalent practice within a Member State assessment can be conducted by the installers supported by simplified or more complex (depending on the nature and complexity of the system) assessment tools and checklists. Documentation can be managed through Declarations of Honour and checklists.

[12] https://iea-pvps.org/wp-content/uploads/2020/01/IEA-PVPS_-_Self-Consumption_Policies_-_2016_-_2.pdf

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