CONCERTED ACTION
ENERGY PERFORMANCE OF BUILDINGS

# (CT6) Smart Buildings
## Status in May 2022

AUTHORS
**Xavier Loncour, Peter D'Herdt,** ***Belgian Building Research Institute***

KEYWORDS
**Smart buildings, Smart homes, Smart technologies, Smart districts, Digitalisation, Building Automation and Control Systems (BACS), Smart Readiness Indicator (SRI), Technical Building Systems (TBS), Compliance checking, Enforcement**

## 1. Introduction

The concept of 'smart buildings' and the references to 'smart technologies' are new parts of Directive 2018/844/EU amending the EPBD, published in 2018. They support two complementary objectives, namely to accelerate the renovation of existing buildings by 2050 and to enhance the modernisation of all buildings with smart technologies and a clearer link to clean mobility[1].

In the context of a strong digitalisation trend and the rapid development of related markets, smart building technologies as well as information and communication technologies can drive energy efficiency in buildings and improve the living and working conditions of building users. This modernisation and digitalisation of buildings, including automation and smart appliances, could therefore place consumers at the centre of the energy market, and support the transition to smarter, renewable-energy-intensive grids. Smart technologies in buildings can help to reap the benefits of the clean energy transition which comes with new opportunities such as smarter metering of energy, the use of on-site renewable energy and the self-consumption of energy. From this perspective, smart technologies and smart buildings can be seen as key contributors to the energy transition (see §3.1).

There is, however, no commonly accepted definition of 'smart buildings' or even 'smart technologies' in the regulatory context[2], though several initiatives have worked on these definitions. Even if the concepts are not always well defined and the reference to smart technologies is relatively recent in the regulatory context, some of the underlying principles, such as the use of Building Automation and Control Systems (BACS) and their interaction with Technical Building Systems (TBS), are well known and already largely integrated into energy performance regulations (see §3.2).

The amending EPBD foresees that an optional common EU scheme for rating the smart readiness of buildings, the Smart Readiness Indicator (SRI), will be established. The SRI scheme includes the calculation methodology and technical modalities for effective implementation, including possible links with Energy Performance Certificates (EPCs). Several Member States are considering the implementation of this scheme and some of them are running a test phase (see §3.3).

The amending EPBD also introduces new requirements for the installation of self-regulating devices and BACS in buildings where specific conditions are met. These requirements will in turn require specific implementation activities at the national level. In this context, the aspects related to the compliance checking and enforcement strategies remain particularly challenging and many lessons can be learned from the already existing requirements applicable to Technical Building Systems. At the same time, the experiences and actions related to the effective compliance and enforcement of the new requirements can also strengthen and optimise the existing approach for Technical Building Systems (see §3.4).

Finally, the strong development of renewable energy sources and the uncertainty and varying availability of these sources has increased the potential to optimise the energy performance of every single building to a higher and wider level such as district or even city levels and has increased the need and development of innovative solutions and approaches (see §3.5).

# 2. Objectives

The objectives of the Central Team 'Smart Buildings' are to follow the uptake of the concept of 'smart buildings', clarify the references to 'smart technologies' and identify the best ways to integrate them in the regulatory or broader voluntary context in order to support the energy transition.

The main topics addressed are the development and roll-out of the Smart Readiness Indicator (SRI) and the new requirements on TBS and BACS. The existing energy performance regulations and their evolution are evaluated to identify the smart technologies already taken into account, and to explore the possibilities and opportunities to extend their uptake.

# 3. Analysis of Insight

## 3.1 Smart technologies and smart buildings as key contributors to the energy transition

Smart technologies are identified as a key contributor to achieve the ambitions of the European Green Deal for the European Union[3]. 'The clean energy transition should involve and benefit consumers. Renewable energy sources will have an essential role. The smart integration of renewables, energy efficiency, and other sustainable solutions across sectors will help to achieve decarbonisation at the lowest possible cost.'

Smart buildings are increasingly becoming a reality. The digitalisation and connectivity of energy systems is rapidly changing the energy landscape, from the better integration of renewables to smart-ready buildings and smart grids. Energy generation from Renewable Energy Sources (RES) is becoming more and more decentralised, and in order to increase the balance between intermittent energy generation and demand, the use of overall smart energy systems to improve energy flexibility is necessary. Smart grids can provide new opportunities and tackle certain challenges in the current management of the grid and the energy market. In this context, smart buildings can be a key contributor to decarbonisation and will play a central role in improving the efficiency of overall energy use.

### *3.1.1 The application of the 'smart' concept to buildings*

One of the EPBD objectives is to support the modernisation of all buildings through smart technologies and provide a clearer link to clean mobility. Many current concepts are called 'smart': smart homes, smart technologies, smart ready systems or smart meters. In the current European legal framework, there is no real definition of what 'smart' exactly means, but proposals for such a definition were developed outside the legal framework, e.g., in studies supporting the development of the Smart Readiness Indicator (SRI, see §3.3). The main and most important characteristic of smart technologies seems to be that they can communicate in a digitalised and bi-directional way, exchange information, and use that information to inform (e.g., fault detection) and/or undertake action (e.g., correct or improve functions or actions). In buildings, this supports the optimisation of building performance and overall energy use.

### *3.1.2 Smart technologies can enable synergies between energy-related policy areas*

Smart technologies can help achieve the European targets on future energy use. They can improve energy efficiency, optimise the integration of RES, and enable synergies between the different policy areas that apply to them. These synergies have been addressed in January 2020 during a joint workshop of three Concerted Action initiatives from three different policy areas: the energy performance of buildings, renewable energy sources, and energy efficiency. The workshop participants – 64% of them – largely recognised that smart technologies could be a key element for some aspects of the energy system of the future or could even form an essential interface to make the connection between all levels of this system. A further 14% thought that the role of smart technologies is not yet clear and should be further investigated. The primary barriers to the roll-out of smart technologies in the context of the transition to a smart energy system were identified as lack of user acceptance (22%), issues concerning cyber-security and privacy (17%), and interoperability problems (15%).

Part of the discussion focused on the possibility of enlarging the scope of the regulation from building to district, or even to the city level, and how this could be done.

| | |
|---|---|
| **Highlights of 3.1** | Many currently discussed concepts are called 'smart': smart homes, smart technologies, smart ready systems or smart meters. The definition of 'smart' is not yet clear, but the main and most important characteristic of smart technologies in the building context seems to be that they can communicate and exchange information in a digitalised way, and use that information to optimise the building performance and overall energy use. |
| | Smart technologies can help to achieve the 2030 European energy and climate targets by enabling synergies between three different policy areas: energy performance of buildings, renewable energy sources, and energy efficiency. Smart technologies are recognised as possibly being a key element for some aspects of the energy system of the future or having the potential to become an essential interface that makes the connection between all levels of this system. |

| **Main Outcomes of 3.1** |
|---|
| Even though it is not yet clearly stated what is considered 'smart', some essential characteristics are identified: the possibility to exchange digital information (two-way communication) and to act accordingly. Possible synergies with the uptake, the further introduction of renewables, and the improvement of energy efficiency can be identified and should be further investigated. |

## 3.2 Smart technologies and smart buildings – recent concepts relying on various well-known underlying technologies

Though the use of the term 'smart' in the context of building regulation is relatively recent, it relies on various, often already well-known technologies, implemented in various services with different levels of controlling possibilities (functionality levels) (see §3.3.2 for additional explanations). Certain Building Energy Management Systems (BEMS) already contain an important degree of 'smartness'. The amending EPBD (Directive EU 2018/844), for instance, promotes the use of BACS and digital monitoring in TBS which are examples of the implementation of smart technologies.

### *3.2.1 Smart technologies are often already considered in energy performance regulations and standards*

As they can have an impact on the energy performance of buildings, many control functions and aspects related to building automation are already considered to some extent in the existing national building energy performance calculation procedures and the European standards related to the energy performance of buildings.

Examples of services[4] in a specific technical domain, such as the heating of buildings, are the control of heat emission, distribution pumps or heat generators. Many of these services are described in European standards, e.g. EN ISO 52120-1[5], even if sometimes a slightly different terminology is used. The services in the standard EN 15232-1 (the predecessor which has been replaced by EN ISO 52120-1), served as a basis for many of the more than 110 smart-ready services that figured in the original catalogue of smart-ready services developed in the study for the SRI (see §3.3). Both standards offer a long and comprehensive list of the most common BACS functions that can have an impact on the energy performance of buildings. For each function, different levels of complexity (functionality level) are mentioned, and a reference is made to other European standards in which the possible impact of the systems can be quantified.

### *3.2.2 Smart receptiveness of the energy performance regulations*

The European standard EN ISO 52120-1 (and its predecessor EN 15232-1), and more specifically the description of the services and the functionality levels, offer a good starting point to assess to what extent BACS functions are or can be taken into account in existing building regulations and/or the energy performance calculation method of a Member State. In a way, the number of services that are covered in a national energy performance calculation method and the functionality level that can be valorised are a reflection of the extent to which 'smart technologies are already covered by the considered energy performance legislation' or 'how smart-compatible' the legislation actually is. The concept of ‘smart receptiveness’ was therefore introduced in the CA EPBD discussions. It was suggested that the minimum level of smart receptiveness should be that every type of service must be taken into account in the calculation method, although not necessarily always up to the most advanced functionality level. The functionality level which can be valorised in the legislation can be lower or higher than the most advanced level, as a function of the importance of the considered service or possible impact on energy performance. Possibilities must be kept open for innovative systems, for instance, by adding services and/or functionality levels to take into account the potential of those systems. A survey in 10 Member States showed that, in general, the smart receptiveness of the national energy performance calculation methods is moderate to high and showed that it is often underestimated by the administrations responsible for the development of these regulations. Their regulations are actually covering more control possibilities than they would estimate before performing a deeper analysis of their calculation method. However, the degree of implementation varies from service to service and from country to country, and the most advanced functionality levels are not always considered.

A challenge for the potential of smart systems is that the exact impact of a control system at the time of the commissioning of the building, as well as later in the lifetime of this building, can be very difficult to quantify. Because it is too difficult to accurately predict the actual use or performance (impact of user behaviour, maintenance, etc.), some Member States therefore choose not to implement very advanced control systems in their calculation methods. A check that systems are working properly could potentially be integrated into the building energy audit/inspection.

(CT6) Smart Buildings

The possibilities to follow up, control, and regulate the functioning of these (smart-ready) services (see §3.3) are key to their optimal functioning and the performance of the building.

| | |
|---|---|
| **Highlights of 3.2** | Quite often, certain control functions are already taken into account in energy performance calculations. Dealing with (the impact of) control is, however, one of the most difficult elements in a calculation procedure. Some Member States choose not to implement very advanced control systems in their calculation methods because it is too difficult to assess their impact in an accurate way. A check that systems are working properly could potentially be integrated into the building energy audit/inspection. |

| **Main Outcomes of 3.2** |
|---|
| In the building context, many functions and aspects related to building automation are already considered to some extent in the existing national energy performance calculation procedures, as they can have an important impact on the energy performance of buildings. A survey in 10 Member States showed that, in general, the smart receptiveness of the national calculation methods is moderate to high and often underestimated by the administrations responsible for the development of these regulations. Their regulations are actually covering more control possibilities than they would estimate before performing a deeper analysis of their calculation method. However, the degree of implementation varies from service to service and from country to country, and the most advanced functionality levels are not always considered. |

## 3.3 Development of the Smart Readiness Indicator (SRI)

The amending EPBD (Directive EU 2018/844) introduces the concept of a 'Smart Readiness Indicator' (SRI). The legal acts describing the SRI were officially adopted at the end of 2020. The first act[6] establishes an optional common EU scheme for rating the smart readiness of buildings, while the second[7] details technical modalities for the effective implementation of the scheme.

The SRI will allow for the rating of the smart readiness of buildings, i.e.: the capability of buildings (or building units) to adapt their operation to the needs of the occupant; the optimisation of energy efficiency and overall performance; and the adaptation of their operation in reaction to signals from the grid (energy flexibility).

The SRI should raise awareness amongst building owners and occupants about the added value offered by building automation and electronic monitoring of TBS.

### *3.3.1 Studies and support contract related to the SRI*

Two technical studies, started in February 2017 and finalised in June 2020, commissioned by the European Commission, provided technical support to feed the discussions on the SRI. The studies focused on the calculation methodology, investigated possible implementation arrangements, and performed a quantitative evaluation of possible impacts of the SRI. The results are available online at https://smartreadinessindicator.eu/.

A two-year supporting contract, started in 2021, provides technical assistance to the European Commission services and to Member States who are organising test phases or implementing the SRI in their legislation. Technical and training material available in several languages (EN, FR, DE) are amongst others developed and made available for the Member States and interested stakeholders. Extensive stakeholder concertation and working groups were organised during the two technical studies and that work continues during the supporting contract, including several interactions with the CA EPBD.

### *3.3.2 Smart-ready services, functionality levels, domains and impact criteria*

The first technical support study proposed an SRI methodology based on the inspection of the 'smart ready services' available in a building. Such services are enabled by a combination of smart-ready technologies, but defined in a technologically neutral way, e.g., the ability to 'control the distribution pumps in heating networks'. The SRI assessment procedure is based on the establishment of an inventory of the smart-ready services which could be available in a building, and an evaluation of the possibilities they can offer. Each of the services can be implemented with various degrees of smartness, referred to as 'functionality levels'. In the example of distribution pumps, this can range from 'no control' to the simple implementation of 'on/off control'; or to more elaborate control methods such as 'variable speed pump control based on internal estimation' or even 'based on external demand signal'.

The services within a building operate in multiple domains (e.g., heating, lighting, electric vehicle charging, etc.), inducing various kinds of impacts (e.g., energy savings, comfort improvement, increased energy grid flexibility, etc.). The consolidated methodology considers nine technical domains and seven impact criteria. In order to cope with this multitude of domains and impact categories, a multi-criteria assessment method was proposed and developed as the underlying methodology for calculating the SRI[8].

### *3.3.3 Developing a demand-driven market for the SRI*

It is essential to consider the voluntary nature of the SRI to create a demand-driven market for this new evaluation tool and to take this specificity into account during the development of the calculation procedure. For instance, the level of complexity according to the building type (residential vs. non-residential) and aspects such as the average time and costs necessary to deliver the SRI were identified as important elements and were taken into account when evaluating the method for implementing the SRI. The countries indicated that the SRI needs to be adapted according to the function of the different segments of the market (e.g., simple vs. complex buildings, professional building manager vs. private building owner, etc.) in order to be successful. As different buildings and people will have different needs or expectations from the SRI, there should be different methods with varying levels of complexity in order to fulfil those needs. This element was taken into account by proposing two levels of evaluation: a simplified self-evaluation and a third-party evaluation by an expert.

### *3.3.4 Implementation pathways and test phases*

The SRI scheme introduced by the amending directive (Directive EU 2018/844) is voluntary for Member States. Member States that decide to implement the SRI scheme may choose from a variety of modalities. For example, Member States may couple the SRI scheme with their energy performance certification scheme and/or with their scheme for the inspection of heating, air-conditioning and combined heating/air-conditioning and ventilation systems. If such a coupling is realised, the EPBD obligations regarding the Energy Performance Certificates and the inspection remain applicable. The introduction of the scheme can be organised via a test phase.

A survey organised in 2022 in the EPBD CA context indicates that most Member States (19 Member States) had not yet decided if the SRI will be implemented at the national level. Almost half of them will base their decision on the results of a test phase. Some Member States indicated that they will probably not implement the scheme (5 Member States) while others will most probably implement it (6 Member States).

In early 2022, formal or informal test phases are planned or are running in several countries such as Austria, Czech Republic, Denmark and France. Informal test phases can be organised at the national level via research projects for instance. The focus of the test phase varies from country to country ranging from engaging the stakeholders, testing and refining the methodology and the service catalogue, collecting the building owners' feedback to developing synergies with an existing tool such as the EPC.

| | |
|---|---|
| **Highlights of 3.3** | An optional SRI has been developed. This SRI for buildings provides information on the technological readiness of buildings to interact with their occupants and the energy grids, and on their capabilities for more efficient operation and improved performance through the use of ICT technologies. |
| | The SRI assessment procedure is based on the establishment of an inventory of the smart-ready services which could be available in a building and an evaluation of the possibilities they can offer. Each of the services can be implemented with various levels of functionality. |
| | The SRI introduced by the amending EPB directive is optional for Member States. A survey in early 2022 indicates that most Member States had not decided yet if the SRI will be implemented at the national level. Almost half of them will base their decision on the results of a test phase. |

| **Main Outcomes of 3.3** |
|---|
| The development of the new optional SRI for buildings was organised through the development of two legal acts. Two technical studies and a supporting contract provided technical support to feed the discussions on the SRI and support the Member States. Extensive stakeholder consultation including several interactions with the CA EPBD has been organised and will continue. The need for development of a demand-driven scheme that can apply a different approach depending on the type of building or other factors was taken into account by developing a simplified (self-assessment) and a more complete SRI evaluation (SRI certification). These alternatives should guarantee that the various user needs are met. National test phases with specific focus are organised in several Member States. The SRI being an optional scheme, most Member States still have to decide whether the SRI will be implemented or not and half of them will base their decision on the results of a test phase. |

## 3.4 New requirements on self-regulating devices and on Building Automation and Control Systems (BACS) for buildings

BACS and their application in interaction with TBS can lead to the integration of many smart technologies and services (§3.2).

The amending EPBD (Directive EU 2018/844) introduces new requirements on the installation of self-regulating devices and BACS in buildings when specific conditions are met. The aim of these requirements is to improve the management of energy consumption while limiting costs and guaranteeing a good indoor environmental comfort and quality.

Requirements on TBS are not new and had already been imposed earlier through Article 8 of the EPBD recast (Directive 2010/31/EU). Member States will have to extend their national regulations with the new provisions of the amending EPBD.

### *3.4.1 New requirements for countries*

In practice, Member States must require the installation of self-regulating devices for the separate regulation of the room temperature where technically and economically feasible both in new buildings and existing buildings when heat generators are replaced (Article 8(1)). They must also require, by 2025, the installation of BACS in all (existing and new) non-residential buildings with an effective rated output for heating, air-conditioning, ventilation or combined systems of more than 290 kW (Articles 14(4) and 15(4)) where technically and economically feasible. The main reason behind this requirement is that BACS can lead to significant energy savings as well as improved management of the indoor environment and, as such, are beneficial to both building owners and users of large non-residential buildings in particular.

The European Commission published a recommendation document[9] to support Member States in applying the provisions of these and other articles related to the modernisation of buildings.

### *3.4.2 The challenge of the enforcement*

Enforcement is an essential part of the implementation of requirements and effective checking of compliance is a key element. TBS requirements are typically linked to an action (new, replacement or upgrading of TBS), while the BACS requirements are linked to what is present in a building (an installation that meets the conditions stated in articles 14(4) and 15(4)). Even though this difference is essential, the experience obtained through the implementation of the TBS requirements can support the effective checking of compliance of the new requirements of BACS. On the other hand, new approaches or additional actions to organise the compliance checking of the BACS requirements can strengthen the existing framework for TBS requirements and the enforcement of the new requirements on self-regulating devices.

Member States were therefore asked to assess the success of their existing regulations for TBS in general, and specifically regarding aspects of TBS mentioned in the EPBD: overall energy performance, proper installation, appropriate dimensioning and the possibility of adjustment and control. For all these aspects, most Member States evaluate the success of their regulation as being rather average. The scores for dimensioning, adjustment and control are somewhat lower than for the other aspects concerning TBS. Regarding compliance and control, most of the Member States evaluate the efficiency of their approach as more or less average and none of the Member States judge their compliance and control systems as being excellent.

The challenge of enforcing the requirements for TBS is to develop effective supervision and control of compliance. In the 2016 Concerted Action report, the conclusions on this topic[10] mentioned that 'even if TBS are clearly defined by the EPBD, for a long period, Member States have given little attention to this part of the EPBD'. An open-ended question on best practices regarding the successful implementation of TBS requirements or on the way to guaranteeing compliance was asked in 2019, but very few Member States found they had best practices to share. The aspect of compliance checking and the existing experiences and plans were further investigated. An effective compliance control could be divided into different steps: detection of the trigger (the activation of the requirement), the assignment of the responsibility for compliance and reporting, the organisation of control combined with sanctioning, if necessary. A large majority of Member States reported that a considerable portion of the cases where the TBS requirements apply, are not detected at the administration level. This also means that, typically, the building owners or those responsible are not aware of the requirement and do not have any framework to do reporting. Different strategies to tackle this challenge were identified and all come with opportunities and additional challenges: EPC (or similar building information schemes like building passports or installation registers or logbooks), inspection reports, installers' reports after interventions.

Even though many challenges are identified, the strategies used to organise the effective enforcement of the TBS requirements are also seen as possible approaches to also organise the enforcement of the BACS requirements. Specifically for the BACS requirement, the data available through EPCs or other building information frameworks can play an important role in identifying the buildings where the requirements apply. In Member States, data are typically available somewhere, but additional actions are necessary and/or planned to enable the centralisation and exploitation of these data in order to use them effectively.

(CT6) Smart Buildings

The information that will become available through these actions might also support a more effective follow-up and compliance checking of the TBS requirements.

| | |
|---|---|
| **Highlights of 3.4** | The amending EPBD (Directive EU 2018/844) introduces new requirements for the installation of self-regulating devices and BACS in buildings when specific conditions are met. The European Commission published a recommendation document to support Member States in applying the provisions of these articles. Requirements for TBS are not new and were already imposed earlier.<br>The experiences and strategies used for enforcement can be useful in organising the effective compliance of the new requirements. Additionally, data centralisation and exploitation seems an important factor for the effective enforcement of the BACS requirements and might also offer opportunities to optimise the enforcement of the existing TBS requirements and the new requirements on self-regulating devices. |

| **Main Outcomes of 3.4** |
|---|
| The main challenge for enforcing the requirements for TBS is to develop effective supervision and control of compliance. Most Member States evaluate the efficiency of their legislation as more or less average and very few found they had best practices to share. Focusing on the detection of the trigger (actions that activate the requirements), several strategies in different states were identified, such as the use of a plant logbook or project report, each coming with challenges and opportunities. |

## 3.5 From Smart Buildings to Smart Districts and Beyond

In the past, the optimisation of the energy performance of the built environment, was generally limited to the optimisation of each individual building as an independent entity. The broad introduction of renewables and the uncertainty and variable availability of these sources has increased the potential of optimisation through an approach at a higher and wider level (district, city). It has also led to the need for innovative solutions and approaches. New developments in digitalisation and automatisation offer the opportunity to add a certain level of flexibility; and evolutions in (electrical or thermal) storage and the introduction of e-mobility strengthens even more the potential and the need for holistic thinking at a larger scale. The terminology varies according to the sources but common concepts are Smart Districts, Net-Zero Energy Districts (NZED) and Zero or even Positive Energy Districts.

### *3.5.1 Existing experience in Europe*

A distinction can be made between the building approach and smart district approach for sustainable design. The building approach looks at reducing energy demand, increasing renewable energy use and improving energy efficiency. Smart technologies can help a building to evolve from being an individual and independent element to becoming a part of a larger entity, such as a district or city. The smart district approach relies on three pillars: sharing of infrastructure (e.g. efficient use of energy through smart grids and district heating and cooling distribution systems), energy storage (also through the opportunities that come with new mobility), and the use of ICT. The three pillars should be combined into an integrated approach: the smart district approach aims to provide a reduction of cost per building owner and take a holistic perspective to create more value for stakeholders. It also increases the potential for better integration of renewables and optimisation of the use of available resources.

A broad range of experience in supporting the uptake of smart districts exists throughout Europe. A JRC study published in 2019[11] has identified 61 European projects. These projects are strongly related to municipalities and the specific targets and timelines vary from project to project. Making buildings highly energy efficient is a common aspect of all the identified projects. Additional targets, such as carbon neutrality or being self-sufficient, are sometimes set.

At the Member States level, most participants in a survey conducted in 2021 with 23 responses, place themselves at the lower end of the experience spectrum. Even though smart districts are broader than just smart grids, the latter are well known in Europe and are considered and/or supported in several of the Member States that answered the survey, through different approaches. In decreasing order of importance, the following actions are cited: research activities, private investment, subsidy schemes, grid regulation and finally building codes.

### *3.5.2 Success factor for the uptake of Smart Districts*

Smart districts is an emerging topic and it is important to share experiences on the challenges and success factors. A first exploration of the existing experience on Smart Districts in Europe was therefore organised.

The JRC study[11] identifies several factors that can lead to the successful uptake of Smart Districts. Many projects consider the energy transition and also address local and regional socio-economic concerns. Public finance has been crucial in unleashing the transition to net-zero districts. The municipalities usually leverage EU finance, in the form of grants and/or loans, with national and local funds including those from private investors. New actors emerge and innovative governance structures are set by municipalities in order to ensure that all necessary actors are involved and their roles as well as their responsibilities are clearly defined. Finally, modern (or smart) technologies are pivotal in the energy transition.

Advanced Member States with experience of supporting activities and/or on smart district pilots offered some key messages for success. The first was that the residents and workers in the area should be involved in the process in order to optimise it. The second was that Member States should strive for the integration of public and private finance to invest into the smart districts. Further exchange of international knowledge and inspiring cases remain absolutely necessary.

| | |
|---|---|
| **Highlights of 3.5** | Despite there being no fixed definition, there is a consensus that the technological pillars are sharing of infrastructure, use of ICT, energy storage, and an integrated approach. The better the integration, the more costs can be reduced. Modern (or smart) technologies are an important factor to lead to success.<br>Many smart district projects are focused not only on the energy transition but also on addressing local and regional socio-economic concerns. Public finance has been crucial in unleashing the transition to net-zero districts.<br>Innovative governance structures are set by municipalities in order to ensure that all necessary actors are involved and their roles as well as their responsibilities are clearly defined. |

| **Main Outcomes of 3.5** |
|---|
| Smart districts is an emerging topic. There are two key messages for success of these initiative: that the residents and workers in the area should be involved in the process to optimise it and that Member States should strive for the integration of public and private finance to invest in the smart districts. Further exchange of international knowledge and inspiring cases remains a must. |

# 4. Main Outcomes

| Topic | Main discussions and outcomes | Conclusion of topic | Future directions |
|---|---|---|---|
| 3.1 | The definition of 'smart' is not yet clear, but the main and most important characteristic of smart technologies in the building context seems to be that they can communicate and exchange information in a digitalised way, and use that information to optimise the building performance and overall energy use. | Smart technologies are recognised as possibly being a key element for some aspects of the energy system of the future or having the potential to become an essential interface that makes the connection between all levels of this system. | The role of smart technologies in the energy-related policy areas should be further investigated. |
| 3.2 | In the building context, many functions and aspects related to building automation are already considered to some extent in the existing national energy performance calculation procedures, as they can have an important impact on the energy performance of buildings. | Dealing with (the impact of) control is, however, one of the most difficult elements in a calculation procedure. Some Member States choose not to implement very advanced control systems in their calculation methods because it is too difficult to assess their impact in an accurate way. | The proper working of these systems is crucial to obtain the expected performance and maintain it. A check that systems are working properly could potentially be integrated into the building energy audit/inspection. |
| 3.3 | An optional SRI is developed. The SRI assessment procedure is based on the establishment of an inventory of the smart-ready services which could be available in a building and an evaluation of the possibilities they can offer. Each of the services can be implemented with various levels of functionality. SRI public resources including a training slide deck, a practical guide and an assessment-package are now available in several languages. An SRI platform was launched. It acts as an exchange forum involving all stakeholders interested in the SRI, and a forward-looking discussion hub for technical, regulatory and implementation aspects of the SRI. | The necessity to develop a demand-driven scheme that can apply a different approach depending on the goals or needs of the owner of a specific building was taken into account by developing a simplified (self-assessment) and a more complete SRI evaluation (SRI certification). Formal and informal test phases are organised in several Member States with different focus ranging from engaging the stakeholders, testing and refining the methodology and the service catalogue and finally collecting the building owners feedback. | The SRI introduced by the amending EPB directive is optional for Member States, who each decide on the concrete implementation and roll-out of the scheme. Most Member States still have to formally decide if they will implement this new scheme. Almost half of the Member States will take this decision after the test phase. A follow-up of these test phases and the rest of the decision process and exchange of ideas on the different approaches will support the uptake of the SRI throughout Europe. |
| 3.4 | The amending EPBD introduces new requirements on the installation of self- | The main challenge to enforce the requirements for TBS is to develop effective | Several new requirements like the ones on BACS still have to be implemented in practice. |

| Topic | Main discussions and outcomes | Conclusion of topic | Future directions |
|---|---|---|---|
| | regulating devices and BACS in buildings when specific conditions are met. Requirements for TBS are not new and had already been imposed earlier, and the experiences and strategies used for the enforcement can be useful to organise effective compliance checking of the new requirements. Additionally, data centralisation and exploitation seems an important factor for the effective enforcement of the BACS requirements and might also offer opportunities to optimise the enforcement of the existing TBS requirements and the new requirements on self-regulating devices. | supervision and control of compliance. Most Member States evaluate the efficiency of their legislation as average and very few found they had best practices to share. Focusing on the detection of the trigger (actions that activate the requirements), different strategies in different Member States were identified, each coming with challenges and opportunities. | The control and compliance aspects could still be improved. Experience with the different strategies and more particularly on the data centralisation and exploitation should be shared amongst the Member States.<br>The practical implications of these requirements and their consequences for the systems and the technologies in buildings still have to be tested. |
| 3.5 | At the Member States level, most participants place themselves at the lower end of the experience spectrum on the topic of the Smart Districts. Even though smart districts are broader than just smart grids, the latter are well known in Europe and are considered and/or supported in several Member States, through different approaches. In decreasing order of importance, the following actions are cited: research activities, private investment, subsidy schemes, grid regulation and finally building codes. | Smart districts is an emerging topic. Two key messages for success of such initiatives are that the residents and workers in the area should be involved in the process to optimise it and that Member States should strive for the integration of public and private finance to invest into the smart districts. | Further exchange of international knowledge and inspiring cases remain a must. |

# 5. Lessons Learned and Recommendations

The use of the term 'smart' in the context of building regulation is relatively recent. Even though it is not yet clearly defined, two essential characteristics of what can be considered as smart are: the ability to exchange digital information (two-way communication) and the ability to act on any issues which arise from this exchange.

It is expected that smart technologies will help to achieve the European targets on future energy use by enabling synergies between three different policy areas: energy performance of buildings, renewable energy sources and energy efficiency.

In the building context, the concept of 'smart' relies on various technologies, often already well known, such as BACS, implemented in various services with different levels of control possibilities.

A survey undertaken among 10 Member States showed that their existing energy performance regulations are already taking into account many control possibilities, even though the most advanced levels of control are not always considered, sometimes on purpose. Most of the existing national regulations can be considered as 'smart receptive'.

From a policy point of view, several developments are ongoing:

- The implementation of the voluntary SRI scheme. This indicator provides information on the technological readiness of buildings to interact with their occupants as well as the energy grids, and on their capabilities for more efficient operation and improved performance through the use of ICT technologies. Most MS still have to formally decide whether the scheme will be implemented and the half of them will base their decision on the results of test phases.
- A significant development of the integration of BACS is also expected in the coming years with the implementation of the requirements in the amending EPBD in this field.

Future work will cover the further implementation of the SRI, the practical enforcement and compliance checking of the requirements on BACS and TBS, opportunities and challenges that come with extending the scope from smart buildings to smart districts and beyond, and the extent to which existing systems can respond to the aims of the EPBD.

Finally, it should be remembered that the renovation wave and the focus on energy efficient building envelopes and installations will be a very important contributor to achieving the European Commission's climate and decarbonisation ambitions. Additionally, the integration of smart technologies can offer complementary gains through the increased flexibility, the better integration of renewables, the optimisation of the building's operation in function of the user needs, and the exploitation of the full energy efficiency potential through monitoring, follow-up and by taking into account less straightforward and predictable influence factors.

# 6. Endnotes

1. The aspects related to electromobility and charging infrastructure are handled by a different Central Team.

2. Definitions of 'smart-ready technology' and 'smart-ready-services' are presented in the Commission Delegated Regulation of 14.10.2020 supplementing Directive (EU) 2010/31/EU of the European Parliament and of the Council by establishing an optional common European Union scheme for rating the smart readiness of buildings.

3. The European Green Deal, COM(2019) 640 final

4. The terminology used in this report makes the distinction between 1. 'Technical domains', e.g. heating, cooling, domestic hot water, etc.; 2. 'Services' in a 'technical domain', e.g. for heating systems the control of heat emission; and 3. 'Functionality levels', describing for every 'service' the level of control complexity from the simplest to the most advanced ones – extract from Commission Delegated Regulation (EU) 2020/2155

5. EN ISO 52120-1 – Energy Performance of Buildings – Contribution of building automation, controls and building management – Part 1: General framework and procedures

6. Commission Delegated Regulation of 14.10.2020 supplementing Directive (EU) 2010/31/EU of the European Parliament and of the Council by establishing an optional common European Union scheme for rating the smart readiness of buildings

7. Commission Implementing Regulation of 14.10.2020 detailing the technical modalities for the effective implementation of an optional common Union scheme for rating the smart readiness of buildings

8. Information material on the SRI including an introduction video is available on the European Commission website : https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/smart-readiness-indicator_en

9. Commission Recommendation (EU) 2019/1019 of 7 June 2019 on building modernisation

10. Implementing the Energy Performance of Building Directive - Inspections - OVERVIEW AND OUTCOMES - AUGUST 2015 - cited on page 32 – ISBN 978-972-8646-32-5

11. From nearly-zero energy buildings to net-zero energy districts - Lessons learned from existing EU projects. Saheb et al – JRC Technical Reports – 2019 - EUR 29734 EN - ISBN 978-92-76-02915-1

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement № 820497.