SRI2MARKET

SRI2MARKET Project – Paving the way to adoption of the SRI into national regulation and market

D2.1 Policy context for the SRI

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UPRC

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Abbreviations

BACS	Building('s) Automation and Control System
D2.1	Deliverable 2.1
DBL	Digital Building Logbook
DH	District heating
DR	Demand-Response
DSO	Distribution System Operator
EC	European Commission
EED	Energy Efficiency Directive
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificate
ETS	Emissions Trading System
EV	Electric Vehicle
EU	European Union
GDPR	General Data Protection Regulation
HVAC	Heating, Ventilation, and Air Conditioning system
LTRS	Long-Term Renovation Strategy
MS(s)	Member State(s)
NECP	National Energy and Climate Plan
PV	Photovoltaics

REC	Renewable Energy Community
RES	Renewable Energy Source(s)
SRI	Smart Readiness Indicator
SWOT	Strengths, Weaknesses, Opportunities, Threats
TSO	Transmission System Operator

Executive summary

Advancements in smart technologies and their integration in the building sector allow buildings to consume, produce, store and supply energy, and to contribute to a more flexible and efficient energy system, by enhancing the integration of energy efficiency, renewable energy, and distributed resources. The smartness of a building refers to its ability to sense, interpret, communicate and actively respond in an efficient manner to changing conditions in relation to the operation of technical building systems, the external environment, and the demands of building occupants. In 2018, the EPBD was revised to further promote smart building technologies and particularly to include the establishment of the "Smart Readiness Indicator" (SRI) as an optional common EU instrument. The SRI is an instrument designed to assess the ability of buildings (or building units) to perform three discrete functionalities. These functionalities include the adaptation of building's operation to the needs of the occupant, the optimisation of energy efficiency and overall in-use performance, and the adaptation of its operation in reaction to signals from the grid. This indicator is expected to raise awareness among building owners and occupants regarding the benefits of building automation, monitoring and control of technical building systems, as well as provide occupants with confidence in the actual savings resulting from the implementation of these advanced features.

The Deliverable 2.1 (D2.1) assesses the level of integration of smart technologies in EU's building sector, seeks the insight of the implementation of SRI in six European countries, namely Austria, Croatia, Cyprus, France, Portugal, and Spain, identify related challenges and provide robust and country-tailored policy recommendations for the successful rollout of SRI. In particular, considering the status of smart technology integration into the EU's building stock, D2.1 examines recent directives, recommendations, and policy documents at the EU level in order to identify the main policy directions and objectives that aim to leverage the integration of smart technologies into buildings. To assess the energy performance aspect of smartness, D2.1 reviews legislation regarding building renovation, the expansion of the EU Emissions Trading System (ETS) for buildings and transportation, the minimum energy performance requirements and standards, the Energy Performance Certificate (EPC) and the Renovation Passport. For the aspect of smartness regarding buildings' response to the needs of the grid, D2.1 examines legislation concerning on-sight energy generation and storage, flexibility and Demand-Response (DR) market and sustainable mobility. In terms of buildings' response to the needs of the occupant aspect, legislation on Building's Automation and Control Systems (BACSs) and data exchange were reviewed.

Moreover, in order to gain a deeper understanding of the policy contexts inside the targeted Member States (MSs), D2.1 employs a multi-method approach involving desk research and consultation with national stakeholders of the energy and building sectors. Based on these insights, a thorough examination known as SOAR (Strengths, Opportunities, Aspirations, and Results) analysis for successful implementation of SRI in each MS is conducted. The SOAR analysis is a customized appreciative inquiry tool designed to facilitate strategic planning in relation to clearly defined objectives (Li, 2020). Distinguishing itself from the well-known SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis, SOAR analysis diverges in two dimensions; it concentrates on future prospects and results from a subject of interest, while SWOT addresses inherent weaknesses and perceived threats (Gürel and Tat, 2017). According to (Ramdhani, Srisusilawati and Ibrahim, 2020), SOAR analysis is a methodology that is developed based on the available strengths and opportunities in order to adapt to existing aspirations, in order to obtain measurable results to be used as a reference point in the strategic planning stages. In D2.1, SOAR analysis is used to identify the strengths, opportunities, aspirations and results associated with the rollout and the implementation test-phase of SRI. According to the outcomes obtained from this approach, specific conclusions are developed, and robust and country-tailored policy recommendations for the successful rollout of SRI are provided.

1. Introduction

Energy efficiency and renewable energy have permanently changed – and will continue to change – the future of the electricity grid (Rinaldi, Bunnen and Rogers, 2019). Renewable energy generation is creating new imbalances between energy production and demand, where variable renewable energy and customer demand do not match up, and new need for utilities to manage demand to align with least-cost energy generation (Cara Carmichael and Taylor, 2021).

Buildings are not only large energy consumers; they also are part of the grid infrastructure. Recent advances in smart technologies, such as the diffusion of smart meters, Internet of Things and Artificial Intelligence instruments have made it feasible to discuss the smarter renovation of buildings, while it was completely out of focus in the (recent) past (Siemens Switzerland and Delta-EE, 2021). In line with these developments, buildings are experiencing a transformation phase, from inactive and highly-energy-demanding assets to dynamic micro energy-hubs, which consume, produce, store and supply energy, contributing to a more flexible and efficient energy system (Al Dakheel *et al.*, 2020). Therefore, buildings can play a key role in helping address new grid challenges, but there needs to be a break down the silos between energy efficiency, renewable energy and the growing number of behind-the-meter distributed energy resources. In this context, new technologies, strategies, and policies should be employed to ensure efficiency and RES are deployed in mutually supportive ways, when and where they are needed most, to ensure energy affordability and grid reliability.

Over the past twenty years, the EU has adopted a set of directives and initiatives with the aim to improve the energy performance of buildings, enhance their interaction with the grid and gradually turn them into micro energy-hubs (Economidou *et al.*, 2020).

The EPBD[1], together with the relevant provisions of the EED[2] and the Renewable Energy Directive (RED)[3], is the main piece of EU legislation impacting the building sector (Brugger *et al.*, 2021). First adopted in 2010 and revised in 2018, the EPBD aims to improve the energy performance of the European building stock by introducing measures and obligations for both new and existing buildings, fostering energy efficiency and thereby contributing to the reduction of GHG emissions and the incorporation of RES in the building sector (European Parliament and Council of the European Union, 2018).

1.1 Smart Readiness Indicator development timeline

The 2018 revision of the European EPBD aimed to further promote smart building technologies, in particular through the establishment of the SRI as an optional[4] common EU instrument to evaluate the technological readiness of buildings to interact with their occupants, the energy grids and to operate more efficiently (Litiu *et al.*, 2021). The purpose of the indicator is to allow 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, also optimizing energy efficiency and overall performance, and to adapt their operation in reaction to signals from the grid (energy flexibility). The expected advantages of smart technologies in buildings are shown in **Figure 1**. Through the introduction of SRI instrument the directive sent a strong message about the EU's commitment to modernise its building sector in the light of realised technological improvements and the urgent requirement to increase the current rate of building renovations.

[1] https://eur-lex.europa.eu/legal-content/EN/ALL/;ELX_SESSIONID=FZMjThLLzfxmmMCQGp2Y1s2d3TjwtD8QS3pqdkhXZbwqGwlgY9KN!2064651424?uri=CELEX:32010L0031

[2] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02012L0027-20210101

[3] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02018L2001-20181221

[4] EU countries can freely decide whether or not they want to test and/or implement the SRI scheme

Figure 1. The expected advantages of smart technologies in buildings. Source: (energy.ec.europa.eu, 2023).

The SRI concept was further developed through extensive stakeholder consultation activities that took place in the framework of two SRI technical support studies contracted by the European Commission's (EC) Directorate General for Energy aiming to deliver a common methodological framework for assessing the smart readiness of the building stock and foreseeing potential implementation pathways for SRI (Litiu *et al.*, 2021). In 2020, the final report on the technical support for the development of a SRI for buildings was completed, delivering a reliable and tested definition associated with a comprehensive assessment methodology for the SRI. As stated in the final report: "*The SRI scheme is intended to raise awareness about the benefits of smart buildings - in particular from an energy perspective - and thereby stimulate investments in smart building technologies and support the uptake of technology innovation in the building sector. It is also within the scope of the SRI to enhance synergies between energy, buildings and other policy segments, in particular in the information and communications technology (ICT) area, and through this contribute to cross-sectorial integration of the buildings sector into future energy systems and markets"* (Verbeke *et al.*, 2020). Beyond the SRI methodology, the final report yielded a diverse set of potential implementation pathways of the SRI for the MSs. The suggested implementation pathways range from more institutionalised roll-out through linking it to EPCs (potentially obligatorily) or laying it down as a requirement for new buildings, to more flexible, market-based options such as linking it to the deployment of smart meters and BACS, possibly supported by online tools and third-party certified assessments.

Alongside, the SRI legal acts (SRI delegated act, SRI implementing act), after a prior official EC feedback round during Summer 2020 have been published in the Official Journal of the EU on December 21st, 2020 and have entered into force on January 10th, 2021:

• SRI delegated act[5] - *Regulation establishing an optional common Union scheme for rating the smart readiness of buildings that is to say the definition of the smart readiness indicator and a common methodology by which it is to be calculated. The methodology consists of calculating smart readiness scores of buildings or building units and deriving smart readiness rating of buildings or building units*.

• SRI implementing act[6] - *Regulation detailing the technical modalities for the effective implementation of an optional common Union scheme for rating the smart readiness of buildings established in the SRI delegated act.*

To support the implementation of the SRI across Europe, a third SRI technical support service had been contracted[7] by the EC for a duration of 2 years (mid-2021 to mid-2023). The purpose of the study was to:

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[5] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2020.431.01.0009.01.ENG&toc=OJ:L:2020:431:TOC

[6] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2020.431.01.0025.01.ENG&toc=OJ:L:2020:431:TOC

[7] Call for tenders ENER/2020/OP/0015: Technical Assistance for Testing and Implementation of the SRI under the EPBD.

- provide technical assistance to the Commission services and to EU countries in testing and implementing the SRI;
- provide technical assistance to the Commission services in establishing and operating a permanent setup to effectively support the broad roll-out of the SRI in the EU, in cooperation with both EU countries and relevant stakeholders;
- provide technical assistance to the Commission services in the preparation of guidance for the implementation of the SRI, including aspects related to the design of the SRI, and to investigate any additional technical support at EU level that could effectively support the implementation of the SRI;
- assist the Commission services in the promotion of the SRI;

Overall, the study facilitated the needed means of sharing experiences between MSs and contributed to the formulation of the "SRI platform"[8]. The SRI platform contributes to the promotion of the SRI and related best practices. It acts as an exchange forum involving all stakeholders interested in the SRI, and a forward-looking discussion hub.

The Commission proposed a revision of the EPBD in December 2021[9]. Both the Council and the Parliament have adopted their mandates and started interinstitutional negotiations in 2023 (European Parliament, 2023b, 2023a).

Part of the revision is to reinforce the SRI for large non-residential buildings as of 2026 under Article 13 (European Commission, 2021). In particular, it is mentioned that: "*The Commission would make further advances in developing a Smart Readiness of Buildings indicator applicable across the EU, by means of a delegated act due by the end of 2025. This would apply to all large non-residential buildings (defined as an effective rated output >290 kW)*" (European Parliament, 2023b). Discussions are still ongoing and the final directive is expected in 2023 or early 2024.

1.2 Smart Readiness Indicator Methodology

The SRI delegated act established the definition of the SRI and a common methodology by which it is to be calculated. Its annexes provide information about (among other things): the calculation of smart readiness scores, the weighting of impact criteria in key functionalities, the weighting of technical domains and the smart readiness rating. The calculation method is based on the final report on the technical support to the development of an SRI for buildings.

The proposed methodology is simple. The SRI assessment starts with determining which smart ready services are present in a building. These are subdivided into multiple **domains** (e.g. heating, lighting, electric vehicle (EV) charging, etc.) as presented in **Figure 2**. Subsequently, an evaluation of the **functionalities** these services can offer is made. Each of the services can for example be implemented with various degrees of smartness (referred to as '**functionality levels'**). Let's take lighting control as an example: this can range from the simple implementation of "manual on/off control of lighting" to more elaborate control methods such as "automatic on/off switching of lighting based on daylight availability", or even "automatic dimming of lighting based on daylight availability".

[8] https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/smart-readiness-indicator/stakeholders-events-and-news_en#sri-platform-structure-and-governance

[9] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021PC0802&qid=1641802763889

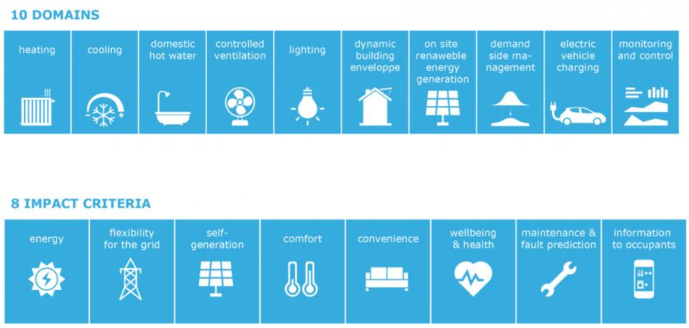

Figure 2. Domains and impact criteria of the SRI assessment methodology.

After the services present in a building are determined the impact score is assessed based on various **impact criteria** (energy savings, comfort improvements, flexibility towards the energy grid, etc.) as illustrated in **Figure 2**. Based on a **checklist** these impacts and functionalities are then aggregated into an overall score displaying the smart readiness of a building. The result can be presented as an overall single score, as a relative score (e.g. indicating that a building achieves 65% of its potential smartness impacts) or as a label classification (e.g. SRI label class 'B'). Sub-scores can also be presented (e.g. 72% on energy savings and 63% on comfort).

Two assessment methods have been developed for the SRI: **A** (simplified method) and **B** (detailed method). A brief presentation of the methods specifications is shown below:

Method A	Method B
✓ Simplified service catalogue ✓ Typically for existing residentialbuildings or small non-residential buildings (low complexity) ✓ Check-list approach ✓ Assessment time < 1 hour ✓ Self-assessment possible	✓ Full, detailed service catalogue ✓ Typically for new buildings and nonresidential buildings (higher complexity) ✓ On-site inspection / walk-through needed ✓ Assessment time < 1 day ✓ Necessary involvement of an expert, with support from a facility manager

The assessment process is the same for both methods, however the service catalogue is different, which means the level of expertise required to conduct the assessment is different.

In addition, an updated SRI assessment package comprising a calculation sheet and a practical guide can be provided upon request by filling this form.

Also training packages are publicly available explaining how to conduct an SRI assessment and training webinars are organised to facilitate the understanding of the SRI methodology.

1.3 Smart Readiness Indicator implementation and testing phase

EU countries may decide to implement the SRI on (part of) their territory, for all buildings or only for certain categories of buildings. Alternatively, EU countries interested in the SRI scheme can start by launching a non-committal test phase.

According to the SRI implementing act, all arrangements of the SRI national test phases must be defined by EU countries, including the duration, phasing, types of building and geographical zones targeted, aspects of the SRI framework that are tested, arrangements for collecting feedback, criteria for the choice of experts carrying out the SRI assessments, the decision on whether an independent control system should be established as part of the test phase, the decision on whether certificates should be issued and made available to economic operators during the test phase, and designation of a third party to manage the test phase, where relevant.

EU countries that plan to undertake a national test phase must notify the Commission ahead of launching the test phase, also indicating applicable arrangements. At the end of the national test phases, countries shall assess the outcomes and decide whether they will implement the SRI. They must submit a report on the related feedback to the Commission, at the latest 6 months after the conclusion of the test phase. Feedback from national test phases will allow adjusting the implementation modalities of the scheme.

The SRI is currently being officially tested in the 8 EU countries depicted in **Figure 3**, namely Austria, Croatia, Czech Republic, Denmark, Finland, France, Slovenia and Spain. In each of the 8 front-running countries, the national administration is supported by one or several local technical partners and by the SRI Support Team.

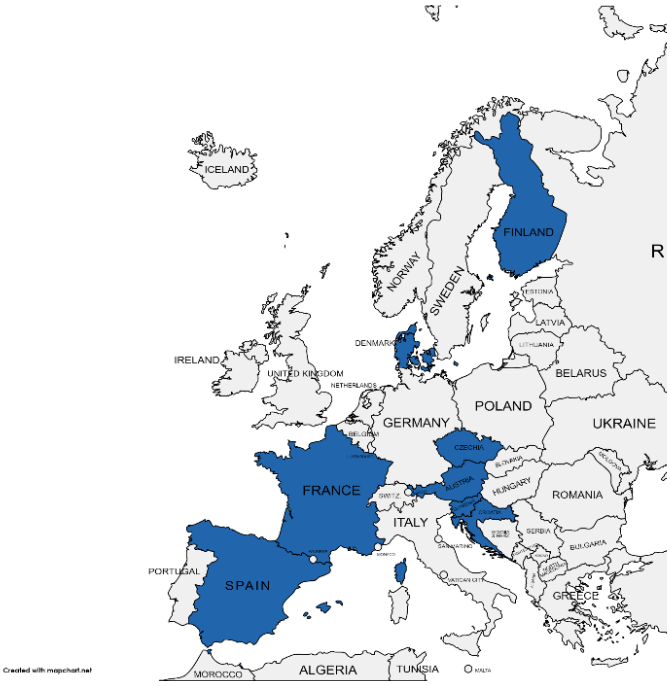

Figure 3. Map of the countries officially testing the SRI.

Finally, as part of the 2021 calls from the LIFE Clean Energy Transition program, four proposals aimed to support the successful uptake of the SRI have been selected. These projects started in the fourth quarter of 2022: they are bound to implement SRI supporting activities in full consistency and complementarity with the SRI policy implementation work, in particular thanks to the SRI platform:

- EasySRI - Improving and demonstrating the potential of SRI
- SRI2MARKET - Paving the way for the adoption of the SRI into national regulation and market
- SRI-ENACT - Co-creating Tools and Services for SRI Uptake
- Smart^2 - Smart Tools for Smart Buildings: Enhancing the intelligence of buildings in Europe

1.4 Objective and scope of this report

Many position papers support the revision changes regarding the SRI and some mention that the mandatory application should be expanded also to medium-sized buildings and be linked to the deadline and scope for the implementation of the Building Automation and Control System requirements (31 December 2024) under Art. 20 (European Building Automation Controls Association, 2022), while others highlight the need to integrate the SRI with EPCs to facilitate the further the uptake and investments for digital solutions enhance the mandatory nature of the SRI (DIGITALEUROPE, 2022; EuroACE, 2022; Europe, 2023). Finally, some of the position papers also highlight their agreement with the application of a common, harmonised EU scheme for rating the smart readiness of buildings and they are in favor of removing the flexibilities given to MSs to adjust the common calculation methodology (DIGITALEUROPE, 2022; EuroACE, 2022).

Many scientific articles have also underlined the possibility of the SRI application becoming mandatory for more types of buildings since the need for "smart retrofitting" has become crucial for transforming existing buildings into more responsive and efficient buildings (Fokaides, Panteli and Panayidou, 2020; Vigna *et al.*, 2020; Canale *et al.*, 2021; Apostolopoulos *et al.*, 2022).

However, many studies argue that a common implementation approach would fail to capture the specific features and reflect the actual “readiness” of buildings because of the different climate conditions, building typologies and uses.

Specifically, Ramezani et al., 2021, applied the SRI in two service buildings with different levels of energy and indoor environment quality performance located in an area with a Mediterranean climate and the results implied that, although the proposed methodology was able to recognise the overall characteristics of the sample buildings, they fail to capture the specific features of non-residential Mediterranean climate buildings. Specifically, they mention that the defined weighting factors fail to reflect the actual energy performance of the service buildings and need to be revised. Finally, they underlined that the current retrofitting actions which were implemented to improve energy efficiency and thermal comfort in the building were not as effective as expected in enhancing the SRI value (Ramezani, Silva and Simões, 2021).

Another study, by Vigna et al., 2020, highlights the need for establishing a more tailored SRI framework considering the peculiarities of the various building typologies, based on the building size, the construction date, the systems type (autonomous or centralized) and the building users’ activities, as a critical aspect that should be addressed in the future by the SRI rationale. While the study also emphasizes as a critical issue the integration of quantitative aspects in the calculation of the indicator (Vigna *et al.*, 2020).

Varsami and Burman, 2021, mention that despite the strengths, the format and methodology of the SRI there are several potential weaknesses that need to be addressed before introducing the scheme as an EU-wide mandatory instrument. In particular, they explain that the indicator measures the smart capability of buildings and can fail to translate it into actual performance, thus contributing to the performance gap that other performance certifications face. Also, they stress the risk that two separate methodologies that exist may lead to inconsistent certifications. Finally, a major conclusion of the study is that a lack of clear guidelines and subjective decisions during the evaluation, may lead to unreliable assessments. These inconsistencies can create confusion among end users and threaten the credibility and success of the framework (Varsami and Burman, 2021).

The findings of Janhunen et al., 2019, who applied the SRI for cold climate countries imply that regardless of the SRI’s conceptualization as a system oriented (smart grid) approach, in its current form, it was not able to recognize the specific features of cold climate buildings, specifically those employing advanced district heating (DH) systems. Another, more practical, implication of the study was that due to the subjective nature of the proposed process for selecting SRI relevant building services, the applicability of SRI as a fair rating system across the EU MSs is problematic (Janhunen *et al.*, 2019).

Finally, according to Eloranta, 2020, who examined the applicability evaluation of SRI for buildings some services in the SRI catalogue were not relevant for any assessed building because of regional factors. Furthermore, some services were conflicting with local design conventions and indoor climate requirements, which was the case with services concerning automatic window opening systems, for example. The study also indicated that SRI does not fully identify advantages of typical Nordic building systems such as advanced DH networks. In this context, it was proposed that results could be made more reliable and comparable by implementing national norms for weighting factors and triaging conditions. Additionally, it is recommended in the study that some climate-specific services could be added to better represent regional features, especially in the heating and ventilation domains but they emphasize that a region-specific SRI catalogue additions would complicate international result comparability (Vilppu Eloranta, 2020).

Although most studies in the literature highlight the need for a smart readiness assessment instrument and are overall in favor of the SRI scheme, there is still confusion regarding the assessment methodology and the most suitable implementation and application framework for the SRI-scheme. To summarize there are still ongoing discussions and arguments on whether: 1) Quantitative aspects should be included in the methodology; 2) SRI should be buildings -tailored (e.g., SRI for historical buildings, SRI for SMEs, SRI for residential buildings, etc.); 3) SRI should be climate-tailored taking into account different climatic and regional particularities and 4) SRI should be integrated into other instruments, such as EPCs, Digital logbooks, etc.

To this end, the overall objective of D2.1 is to acquire a better understanding of the market and policy context related to the SRI of the targeted MSs (indicated in **Figure 4**), namely Austria, Croatia, Cyprus, France, Portugal and Spain, and provide an extensive analysis from their first experiences with the SRI implementation.

to facilitate the successful rollout of SRI into their national regulation. Thus, it aims to answer the following questions:

i) *How ready and able are the targeted MSs to integrate SRI into their national regulation?*
ii) *How are they progressing with the SRI implementation and what are their plans for the future regarding SRI?*

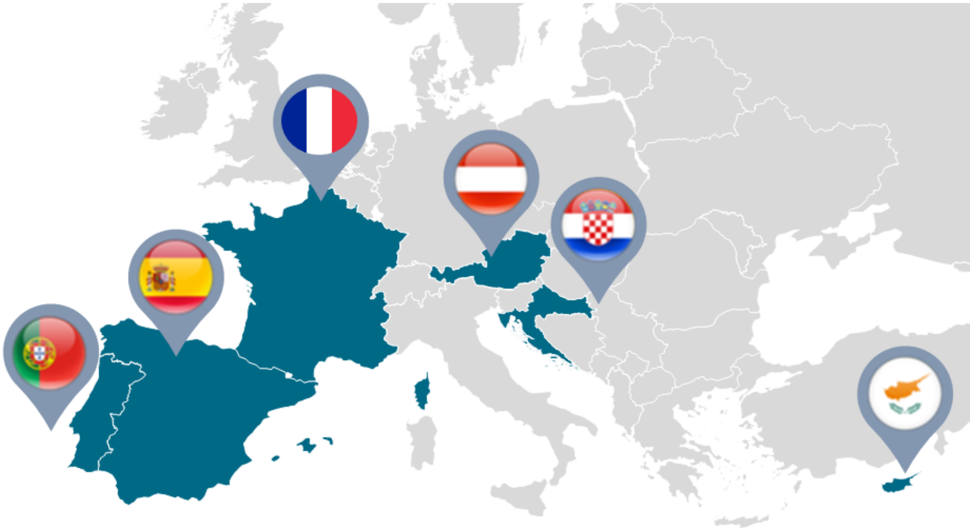

Figure 4. Map of the countries examined in this study.

A multi-method approach will be used to respond to these questions, including desk research on the policy context at the EU and national levels, and consultation with national stakeholders. The task will ultimately result in a SOAR analysis of the SRI instrument for the targeted countries, which will consequently, lay the groundwork for tasks 2.2, 2.3 and 2.4 by providing credible insights about the particularities of the national policy contexts of the targeted MSs which might be particularly relevant for assessing different implementation pathways, public funding schemes and SRI calculation methodologies across the targeted MSs.

1.5 Structure of this report

In details, this report has been structured as follows. **Section 1**, introduces the SRI concept, explores definitions and experiences within EU and identifies the current challenges regarding the implementation of the SRI. **Section 2** presents the participatory multi-method approach we followed to come up with a robust set of recommendations for the roll-out of the SRI scheme. **Section 3** presents the EU market and policy context related to the SRI instrument and **Section 4** presents the MSs market and policy context and details the status of current activities in these countries. Finally, in **Section 5** the key findings are summarised in SOAR analysis tables and in a short discussion and **Section 6** outlines a series of recommendations for the introduction of the SRI across the EU and at national level.

2. Methodology

This section presents in detail the methodological approach we used to reach the objectives and the overall goal of this study. The approach consists of the following steps, visualised in **Figure 5**.

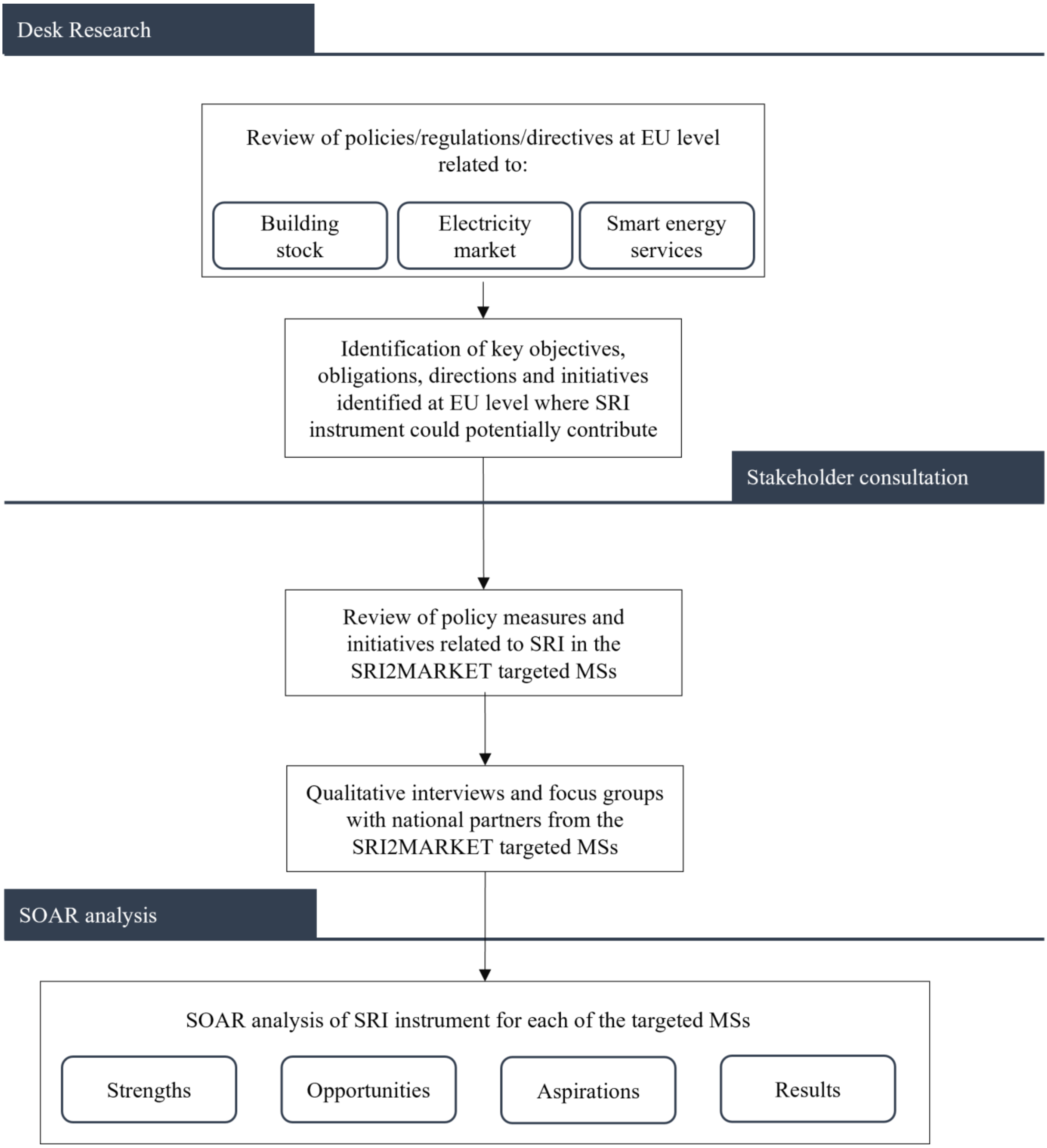

Figure 5. The overarching methodological approach we followed for the study.

2.1 Review of the policy context for the SRI at the EU level.

As a first step, we did extensive desk research to review the existing legislative framework in the EU relevant to the SRI. The material we reviewed consisted of policy and regulatory documents, academic papers and grey literature. The key topics that we focused on were:

- The existing EU regulatory environment, disaggregated by areas.
- The relevance of the SRI and the associated regulatory environment behind EU policy developments.

- Identifying and analysing legislative/ policy and implementation gaps and identifying synergies on how SRI could serve its main goal of promoting the transformation of buildings into active energy hubs that interact with their users and the electricity grid.

2.2 Review of the national policy context for the SRI of the targeted MSs

Our desk research was followed by a comprehensive overview of the recent policy developments in the SRI2MARKET targeted countries. Recent policies concerning the energy performance of their national building stock, the national electricity market and data management legislation, are examined. Policies and regulations that aim to tackle the twin challenges of the green and digital transition of the building stock and those that perceive buildings and thus their users as active participants in the national energy system are especially important for SRI2MARKET.

2.3 National stakeholders' consultation

To increase the robustness of our policy analysis and identify the most relevant policy measures and initiatives at the national level of the targeted MSs we added an extra layer of validation by conducting a two-fold stakeholder consultation process. This process was based on a questionnaire filled in by national energy and building stakeholders regarding the general policy context in their countries and online interviews with them with a more specific questionnaire on the SRI developments and experience in their countries. Our main objective was to validate the review process's findings and to elicit additional insights, and updates on forthcoming national regulations and legislation of interest. The first questionnaire is included in **Appendix A** and the second questionnaire is included in **Appendix B**.

2.4 SOAR analysis

A SOAR analysis is used to summarize key findings from the analysis of the policy context of the targeted MS toward the adoption of SRI into their national legislation. A SOAR analysis maintains the Strengths and Opportunities sections of a SWOT analysis but introduces Aspirations and Results in place of Weaknesses and Threats. Aspirations focus on what the policy instrument wants to achieve, who it wants to serve, and what it wishes to influence. The Results section discusses how to identify and track the progress toward Aspirations and Opportunities. The SOAR analysis, looking from a positive point of view, aims to facilitate strategic planning and implementation procedures designed for the SRI tool by exploring current and future perspectives in the targeted MS. As indicated in **Figure 6**, the four sections of the SOAR analysis are distinguished based on their scope and timeframe.

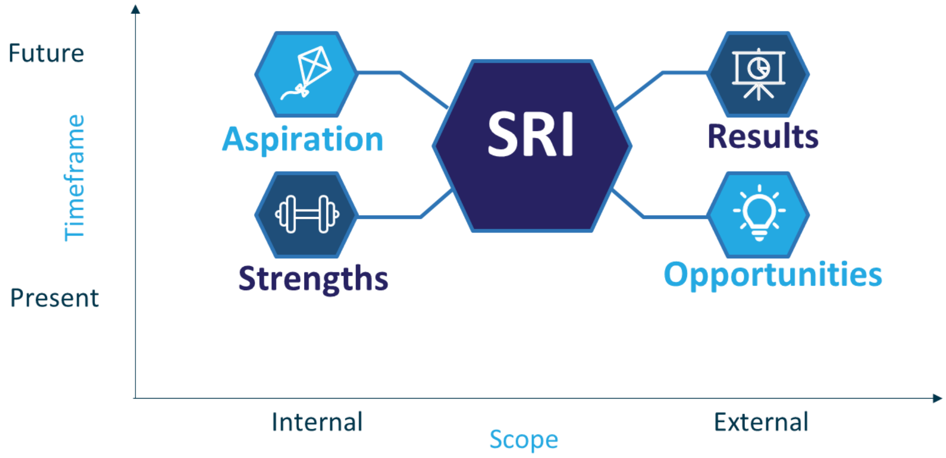

Figure 6 The four sections of SOAR analysis allocated according their scope and timeframe of implementation.

Specifically for the case of SRI, the SOAR analysis aims to answer the questions of **Table 1**, for each of the targeted MSs.

Table 1. The SOAR analysis table of SRI instrument that will be filled for each targeted MS.

Strengths	Opportunities
What makes SRI a valuable tool? What is the greatest benefit form SRI?	What are the current trends and needs that SRI could capitalise on? What is the possibility of collaboration between SRI and other relevant instruments?
Aspirations	**Results**
What are the hopes, visions and missions that SRI could achieve and how?	What results have been obtained so far? How many of the agreed goals have been achieved?

3. The status of smart technologies integration into the building stock from an EU policy perspective

In this section, recent directives, recommendations, and policy documents at the EU level are reviewed, aiming to identify key policy directions and objectives endeavouring to capitalise on smart technologies' integration into the building stock. As mentioned in the introduction chapter of D2.1, SRI was officially introduced to the EU policy framework in the revised EPBD of 2018, with the overall aim of assessing buildings technical capability to interact with to their occupants, the grid and to operate more efficiently. In this context, the aim is to explore how smart buildings concept is defined and has advanced while also to investigate how the SRI key main functionalities (i.e., buildings' energy performance and operation, buildings response to the needs of occupants, buildings response to the needs of the grid) are related and maybe could capitalise on the provisions of a wide range of EU policy directives. At this point it is important to mention that D2.1 is focused on the provisions of the most recent proposals for revisions of these directives which depict the more ambitious energy and environmental targets of the EU as foreseen in the Clean Energy for Europeans Package published in 2019 and the 2022, RepowerEU plan that come as a response to Russian invasion of Ukraine and aims to eliminate EU’s dependence on imported fossil fuels.

3.1 Smart Readiness of Buildings

The concept of smart readiness of buildings is part of the EU's efforts to promote a more sustainable and energy-efficient built environment, as it provides a framework for assessing building readiness to integrate and benefit from the most recent smart technologies and services.

The SRI should be used to assess buildings' ability to use information and communication technologies and electronic systems to adapt building operations to the needs of occupants and the grid, as well as to improve energy efficiency and overall building performance. The SRI should raise awareness among building owners and occupants of the value of building automation and monitoring of technical building systems, as well as provide occupants with confidence in the actual savings of those new enhanced functionalities.

For the purpose of developing the SRI calculation methodology, smartness of a building is referred to its ability to sense, interpret, communicate and actively respond in an efficient manner to changing conditions in relation to the operation of technical building systems or the external environment (including energy grids) and to demands from building occupants (Verbeke *et al.*, 2020).

Even though, there is not a commonly agreed definition of what a smart building is, the proposed definitions do not vary significantly (Al Dakheel *et al.*, 2020). Thus, a smart building could be defined as” a zero-emission building that is able to manage the amount of RES in the building and/or the smart grid, using advanced control systems, smart meter, energy storage and demand-side flexibility. Moreover, it reacts to the users’ and occupants’ needs and is able to diagnose faults in building operations.”

The SRI should encompass extended functionalities to achieve improved indoor climate condition, energy efficiency, performance levels as well as to enable flexibility. Particularly, the SRI methodology should build on the deployment of interconnected self-regulated devices, smart meters, BACS, for controlling and optimising the indoor air temperature, built- in home appliances and recharging points for EVs operation, the energy storage and the interoperability of those features.

In the final report on the technical support for the development of a SRI for buildings that was supervised by the EC, the proposed method expresses a building's or building unit's smart readiness score as a percentage, depicting the ratio of the building's or building unit's smart readiness to the maximum smart readiness that it could achieve. The methodology provides also disaggregated scores for the three main smart readiness capabilities of energy performance and operation, response to the needs of the occupants and energy flexibility, while the reached smart readiness score for each of the seven impact criteria and nine technical domains can be extracted. Namely the smart readiness impact criteria are: energy efficiency, maintenance and fault prediction, comfort, convenience, health and wellbeing, information to occupants and energy flexibility and storage. Accordingly, the nine smart readiness technical domains are: heating, cooling, domestic hot water, controlled ventilation, lightning, dynamic building envelope, electricity, EV charging and monitoring and control.

Nevertheless, it is indicated in (Al Dakheel *et al.*, 2020) that the qualitative nature of SRI calculation methodology that evaluates the presence of the services and technologies without evaluating their performance, is a notable limitation, as quantifying the energy performance of buildings is an essential baseline for exploring the potential savings and validating building renovation interventions. Besides, (Ramezani, Silva and Simões, 2021) point out that the introduced methodological framework of SRI needs more studies and development to consider all possible aspects related to building types and climatic conditions as well as the most effective parameters for evaluating the level of smartness of buildings.

To this end, in the 2021 proposal for the revision of the EPBD, it is acknowledged that the SRI is of particular relevance to large buildings with high energy demand, and thus it is envisaged to make SRI evaluation obligatory for non-residential buildings with an effective rated output for heating systems, or systems for combined space heating and ventilation of over 290 kW by 2026. For other buildings, the implementation of the scheme remains optional for MSs.

3.2 Buildings energy performance and operation

National building renovation plans

In the proposal to revise the EPBD of 2021, MSs are asked to establish National Building Renovation Plans (NBRPs) that should be submitted to EC as parts of their National Energy and Climate Plans (NECPs) and their updates. NBRPs will replace the national Long-Term Renovation Strategies (LTRSs) which, among others must include an overview of national initiatives to promote smart technologies and well-connected buildings and communities. NBRPs indicate the attempt to make the national renovation plans operational and concrete in terms of setting tangible objectives. Its overall aim is to ensure the renovation of their national residential and non-residential building stock, both public and private, towards the overall objective of a zero-emission building stock by 2050[10]. The plans should provide detailed roadmaps with nationally defined objectives and measurable progress indicators, while an outline of the existing building stock and a summary of deployed and planned policies and measures, including for the promotion of smart technologies, as well as the investments needs, and the administrative resources required to facilitate the implementation of the national roadmaps should also be encompassed.

The new EU ETS for the building and transport sector

The "Fit for 55" package envisages the introduction of new EU ETS for buildings and road transport aiming to address growing emissions from these sectors in a cost-effective way and contribute to the achievement of the national emission reduction targets. The new EU ETS along with the new EPBD provisions will support the replacement of inefficient fossil-fuel boilers by systems with no direct GHG emissions, such as heat pumps and other renewable based technologies. Furthermore, the new EU ETS will create economic incentives for building decarbonisation and will yield revenues for public support, focusing on vulnerable households.

The promotion of renewable-based solutions for meeting buildings Heating, Ventilation, and Air Conditioning systems (HVAC) and domestic hot water needs, which will partially contribute to the electrification of occupants' end uses, might serve as a lever for the integration of smart energy services in buildings related to improved comfort and well-being.

Minimum energy performance requirements

Minimum energy performance requirements for existing buildings and building elements were and continue to be a core component of the EPBD. The purpose of minimum energy performance requirements is to guarantee that when a renovation takes place the necessary depth of renovation is achieved while for new building it aims to ensure that they comply with a minimum cost-optimal energy performance level.

The energy performance of a building is defined as the amount of primary energy consumed or measured in kWh/m2 per year. The definition will be complemented by an indicator on operational GHG emissions and renewable energy according to the proposed revision of the EPBD.

For new buildings, the proposed revision of the EPBD places particular emphasis on buildings occupied or owned by public authorities envisaging that they should be zero-emission buildings from 2027. Furthermore, life-cycle Global Warming Potential (GWP) should be calculated for new large buildings (i.e., new buildings with a useful floor area greater than 2000 square metres) beginning in 2027, while all other types of new buildings should be zero-emission and their life-cycle Global Warming Potential (GWP) should be calculated as of 2030.

The proposal for the EPBD revision provisions more ambitious minimum energy performance requirements of existing buildings and it is foreseen that the comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements will be revised by 2026 to be aligned with the new targets and technological developments.

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[10] Zero-emission buildings are considered "buildings with a very high energy performance in line with the energy efficiency first principle, and where the very low amount of energy still required is fully covered by energy from renewable sources at the building or district or community level where technically feasible (notably those generated on-site, from a renewable energy community or from renewable energy or waste heat from a district heating and cooling system)".

Minimum energy performance standards

While minimum energy performance requirements for existing buildings and building elements ensuring the necessary depth of renovation when a renovation takes place, the newly introduced minimum energy performance standards set a threshold for the minimum energy performance of existing buildings and ensure that more emphasis is placed on the renovation of inefficient buildings. The focus on the lowest performing classes of building stock aims to steer efforts towards buildings with the greatest potential for decarbonization and energy poverty alleviation. It is also envisaged that national building renovation plans will define timelines with specific targets of higher minimum energy performance classes by 2040 and 2050, in view of a zero-emission building stock.

Energy Performance Certificates

The EPCs were introduced by the EU 20 years ago and have continuously gained significance. They were first introduced by the EPBD in 2002 (Official Journal of the European Communities, 2003) with the aim to make the energy performance of individual buildings more transparent. The EPBD recast, which took place in 2010 reinforced the legislation by introducing independent quality control of EPCs, penalties for non-compliance, the obligation to display the energy label in advertisements, a mandatory requirement to hand out a copy of the EPC in sale and rent transactions and the improvement of featured recommendations (Official Journal of the European Union, 2010).

EPANACEA project outcomes, indicate that SRI and EPC require bounded common inputs while they address the same technical building systems. However, they argue that a well-coordinated implementation of SRI with EPC, may facilitate the improved quality and reliability of current EPCs beyond just providing extra information.

Regarding SRI, in the new proposed template of the EPC a yes/no indication whether a smart readiness assessment has been implemented is envisaged as an optional indicator to be presented in the next-generation EPCs. Furthermore, there also envisaged the following optional indicators in the proposed new EPC template:

- the presence of fixed sensors that monitor the levels of indoor air quality;
- the presence of fixed controls that respond to the levels of indoor air quality;
- feasibility of adapting the heating system to operate at more efficient temperature settings;
- feasibility of adapting the air-conditioning system to operate at more efficient temperature settings.

Thus, these indicators are overlapping with the information provided under the SRI assessment.

Renovation passports

Renovation passport is a document that provides a tailored roadmap for the renovation of a specific building in several stages that will significantly improve its energy performance. Renovation passport comes as a response to the observed issues of high upfront costs and inconveniences experienced by the occupants during deep renovations. According to the proposed EPBD revision, EC will establish a common European framework for renovation passports by 2023 and subsequently MSs might decide to introduce this voluntary scheme at national level within a year.

Staged renovations might be a useful tool for the introduction of BACS as well as storage systems at late stages of the renovation, in cases that their introduction is not cost efficient at the first place. Thus, the SRI score could be considered as a valuable indicator to assess the smartness upgrade of a building after each stage of renovation.

3.3 Buildings' response to the needs of occupants

Technical building systems

Building automation and electronic monitoring of technical building systems have been demonstrated as effective alternative for inspections, especially for large systems. In particular, the following definition is provided for BACS in 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; 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."*

The EPBD sets precise requirements to ensure that BACS are installed in all large non-residential buildings that are characterised by a high HVAC effective rated output above a specific threshold at a cost-effective manner. The installation of self-regulating devices has a significant potential to contribute to cost-efficient energy savings for citizens and businesses.

On top of that, BACS are crucial tools toward the endeavour to digitalise the building sector and thus facilitate the emergence of smart homes and well-connected communities. Hence, targeted incentives should be provided to promote smart-ready systems and digital solutions in the built environment while SRI could be proven a valuable tool towards this direction through the adoption of tailor-designed business models for the implementation of buildings SRI upgrades.

Data exchange

A new article is foreseen in the proposed revision of the EPBD exclusively referring to the building systems' data. The overall aim is to ensure that building owners, tenants and managers maintain direct access and are eligible for allowing third parties access to these data in accordance with the general data protection regulation (GDPR) for handling personal data. The data should be accessible at no extra costs to building owners, tenants and managers, while MSs shall set the relevant charges for providing access to eligible third parties.

Digital Building Logbook (DBL) proposal aim to serve as national centralised buildings data repositories, encompassing energy performance related data such as EPCs, renovation passports and SRIs. Data regarding energy performance of building services, metering devices and smart charging infrastructure shall also be stored in national databases.

Also, according to the new Article 19 of the proposed revision of the EPBD in 2021, the Building Stock Observatory is foreseen to be a central database at EU level where information from the national databases will be transferred.

3.4 Buildings' response to needs of the grid

Solar energy in buildings

In light of the urgency of decarbonizing and electrifying the energy consumption of buildings in order to reduce their dependence on fossil fuels, the proposal for a revised EED and EPBD stipulates that all new buildings must be "solar-ready". By utilizing solar power on buildings at a large scale, consumers would be protected against rising and unpredictable fossil fuel costs, and disadvantaged populations would experience lower energy bills. The new provision means that buildings should be designed with the intention of optimizing solar generation potential, allowing for the installation of solar technologies without having to make costly structural modifications. That will enable the cost-effective installation of solar technologies at a later stage. In addition, MSs should ensure the deployment of suitable solar installations on new buildings, both residential and non-residential, and on existing non-residential buildings. Specifically, the appropriate solar energy installations should be foreseen for all new public and commercial buildings as of 2027 while all new residential buildings should be solar ready by 2030. Thus, the expected solar power integration increase in the building sector highlights the need to properly manage and dispatch energy at the building/district level (Al Dakheel *et al.*, 2020). That means that buildings should be capable of balancing their own on-site energy generation and consumption through efficient interaction with the grid. SRI tool could serve as a valuable tool providing credible information about the ability of a building to interact with the grid.

Flexibility

The high share of variable energy sources in the production will drastically influence the dynamics of the power system. Currently, conventional thermal generation technologies provide the required flexibility at all timescales and electricity market levels. Replacing these flexibility services in the future energy system whistle ensuring the security of supply appears to be a big challenge. Maintaining the balance between the production and consumption while avoiding RES curtailment, stresses the need for additional flexibility solutions.

In this context, storage solutions and DR could play a key role to ensure that the integration of RES can materialise at the lowest cost, by shifting the consumption to the moment when electricity is available while minimising the need for new conventional generation capacity and grid expansions.

Furthermore, in 14/3/2023 the EC revealed a new proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Regulations (EU) 2019/943 and (EU) 2019/942 as well as Directives (EU) 2018/2001 and (EU) 2019/944 to improve the Union's electricity market design. The proposal aims to overhaul the energy market vulnerabilities that were highlighted during the recent energy crisis and are mainly attributed to the short-term focus of the current design, which distracts from broader, longer-term goals.

One of the main deductions of the directive is that the energy crisis and the consequent price volatility has unveiled the lack of flexibility in the electricity grid, with prices set too often by gas-fired generation and with a general absence of low carbon flexible supply, DR and energy storage. Besides, final consumers empowerment in order to provide them with more control over their energy use and bills, while inducing to the electricity system additional flexibility is a focal aim of the directive.

In particular the directive foresees that transmission system operators (TSO) should be able design a peak shaving product enabling DR to contribute to decreasing peaks of consumption in the electricity system at specific hours of the day. Furthermore, it states that thanks to the recent developments in metering and sub-metering technology and ICT, it is now technically feasible to cover energy needs for a single premises from multiple suppliers. For instance, customers should be capable of choosing a separate supplier exclusively for electricity to power high consumption appliances such as heat pumps and EVs that might be able to automatically shift their electricity consumption in response to price or grid signals. Moreover, with fast-responding dedicated metering devices which are attached to or embedded in appliances with flexible, controllable loads, final customers can participate in other incentive- based DR schemes that provide flexibility services on the electricity market and to TSOs and distribution system operators (DSOs).

Storage in buildings

The Directive 2019/944 encourages MSs to formulate a comprehensive legal framework for active consumers owning energy storage facilities in order to protect them from disproportionate licensing requirements and potential unnecessary fees and double charges (e.g., double network charges for stored electricity or when providing flexibility services to system operators).

The removal of legal and commercial barriers on small-scale storage installations in buildings would give a strong push to the market uptake of the small-scale battery energy storage systems. This, combined with the rollout of rooftop photovoltaic (PV) installations on a remarkable share of buildings, may provide notable part of the necessary flexibility services to the market.

DR market

Explicit Demand-Side Flexibility is dispatchable flexibility that can be traded (similar to generation flexibility) on the different energy markets (wholesale, balancing, system support and reserves markets) (Smart Energy Demand Coalition, 2016) .

The directive encourages MSs to foster participation of DR through aggregation. Final customers, including those offering DR through aggregation, should be able to participate in a non-discriminatory manner in all electricity markets.

To this end the crucial role of TSOs and DSOs as the eligible entities to establish the technical requirements for participation of DR in all electricity markets is highlighted.

Implicit DR, refers to consumers voluntarily adjustment of their consumption according to external price signals (e.g., optimizing load schedule per hourly electricity prices). Compared with explicit DR the entry barriers are significantly smaller, e.g. no definitive need for aggregation. A technical capability to reschedule load and an incentivizing tariff structure are the only requirements for implicit DR (Korkas *et al.*, 2016). The benefits of such active participation are likely to increase over time, as the awareness of otherwise passive consumers is raised about their possibilities as active customers and as the information on the possibilities of active participation becomes more accessible and better known. Customers should therefore have the possibility of benefiting from the full deployment of smart metering systems and, dynamic electricity price contracts such as:(a) time-of-use tariffs; (b) critical peak pricing; (c) real time pricing; and (d) peak time rebates. Appropriate incentives to efficiently engage consumers might be required. Nevertheless, it is also important for customers to be aware of potential price risks when signing dynamic electricity price contracts and thus there should be supportive mechanisms for consumers to make informed decisions on the available options based on the domestic market conditions.

The promotion of DR in buildings requires the development of control mechanisms that can autonomously facilitate changes in electric usage by end-use customers in response to changes in the price of electricity over time or in response to the availability of renewable energy (Korkas *et al.*, 2016). Thus, a robust legislative framework that opens up the opportunity to end customers to participate in the electricity market while protecting them from volatile energy charges might contribute to increased awareness about DR potential benefits and thus the upgrade of the smartness of the buildings, through the installation of self-regulating devices for the automatic control of a variety of end uses. Besides, DR is pivotal to enabling the smart charging of EVs and thereby enabling the efficient integration of EVs into the electricity grid which will be crucial for the process of decarbonising transport.

Infrastructure for sustainable mobility

Innovation and new technology also make it possible for buildings to support the overall decarbonisation of the economy, including the transport sector. For instance, buildings can support the development of the infrastructure necessary for the smart charging of EVs, which can provide a basis for MSs, if they choose to, to use car batteries as a source of power (Official Journal of the European Union, 2019).

EVs 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. The new proposal for a revised EPBD envisages more ambitious targets for incorporating recharging infrastructure in all types of buildings while it also makes provisions for pre-cabling in a certain amount of parking slots that differs for the different building types that will ease the process of installing more recharging points for EVs at a later stage.

4. Exploring the preparedness of the targeted MSs for smart technologies integration into their building stock from a national policy perspective

Even though SRI is envisaged to be a common EU tool for assessing the smart readiness of the buildings in all MSs in a transparent and comparable way, national specificities and policy frameworks should be taken into account in order to ensure that the methodology is in line with the national particularities of the building stock and the energy system and that the appropriate implementation pathway that complies with the national policy context will be followed explicitly for each targeted MS. For this reason, a review of smart readiness and its three functionalities for each of the MSs accompanied by interviews of energy and building stakeholders from the MS are following in this chapter. Before we start the analysis for the SRI2MARKET target countries an overview of the countries partcipating in the SRI cluster projects is presented below in **Figure 7**.

Figure 7. Overview of the SRI cluster related activities in the EU countries.

The analysis in study will concern the SRI2MARKET countries namely: Austria, Croatia, Cyprus, France, Portugal and Spain.

4.1 Austria

4.1.1 Review on national context

Smart Readiness of Buildings

Currently, the smart readiness of buildings is not included at all in the Austrian legislative framework. However, there is an ongoing test phase for the implementation of the SRI, as well as Austria is actively engaged in the EU SRI platform. The Austrian LTRS includes a chapter on existing policies to promote smart technologies and well-connected buildings and communities. The Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) commissioned the Austrian Research Promotion Agency (FFG) to finance a project entitled 'SRI Austria – Smart Readiness Indicator: Evaluation framework and opportunities for intelligent buildings' in 2018 that runed until 2020. The preparation of a national specification of the 'Smart Readiness Indicator' (SRI) for Austria was part of this project. The proposal for an SRI for Austria was being drawn up based on work in the IEA EBC Annex 67 project on Energy-flexible buildings, the responsible individuals at DG Energy, the VITO consortium and national stakeholders. The technology screening and the impact analysis were supplemented by research in studies of smart grids and intelligent heating networks and heating supply in buildings. The main result was a basis for decision-making and support for the national political implementation of an SRI Austria and possible integration into the process of issuing and using energy certificates. The project conceived of an Austria-specific 'Smart Readiness Indicator' as an evaluation framework for intelligent buildings on an EU basis and undertook to produce a rating of the technology according to the requirements of the buildings market.

The Austrian test phase is led by the Austrian Institute of Construction Engineering (OIB) and the Austrian Climate Action Ministry (BMK), with the involvement of AEE INTEC and of the University of Natural

Resources and Life Sciences Vienna (BOKU) who are partners of the SRI2MARKET. The focus of the test phase is to benchmark the SRI methodology against other methods developed in Austria with a focus on energy flexibility. A large number of different building typologies are examined and assessed on the basis of detailed documented buildings from Austrian regions or the federal government. AEE INTEC is coordinating activities with the other LIFE projects (EasySRI, SRIenact), while a new SRI project "SRI Demo" won by AEE INTEC complements national activities. The process is ongoing.

Buildings energy performance and operation

The energy performance requirements and standards for Austrian buildings are described in the national legal OIB Guideline no.6, developed in implementation of Directive 2010/31/EU of the European Parliament (*OIB-Richtlinie 6 Energieeinsparung und Wärmeschutz*, 2019).

Regarding BACS, currently there are not any particular relevant requirements for automation or electronic monitoring and control of technical building systems in Austria. However, there are certain research programs that require building system measurements two years after the start of the operation phase.

Regarding the roll-out of smart meters, a regulatory guideline has been issued according to which, 95% of all consumption meters in Austria must be smart meters by 2022 (Federal Ministry of Sustainability and Tourism, 2019). As a consequence, some regions of Austria, such as Burgenland, in the eastern part of the country, have already achieved 100% smart meter deployment. However, some regions started the roll-out process later, in 2020, and are currently in the middle of smart meter implementation.

Buildings' response to needs of the grid

Austria aims to achieve a climate-neutral energy balance by 2040, thus implementing policies and support schemes for on-site energy generation and storage, such as net-metering, net-billing, and feed-in tariffs that are complex and vary regionally. With nine regional state governments responsible for regulations and policy support, it becomes very difficult to have a clear understanding of what is supported by public funding and the current legislative framework. Consequently, seeking assistance or support is crucial to obtain a comprehensive overview before making any investment in on-site energy generation and storage.

In 2021, Austria implemented the Renewable Energy Community Expansion Act (Erneuerbaren-Ausbau-Gesetzespaket or "EAG-Paket") to promote the establishment of energy communities, including those focused on renewable energy (*Federal Act on the Expansion of Energy from Renewable Sources (Renewable Energy Expansion Act)*, 2023). Numerous initiatives have been launched to support "active customers" whether legal entities or private customer groups. This has put pressure on national utilities to adapt their services and business models, but government's support for these activities is still considered insufficient.

Currently, there is no complete legal framework in Austria regarding **(smart) charging infrastructure** for EVs in buildings, while the **DR** market is still at its early stages of development. For now, only a limited number of companies provide DR services. However, the market is expected to evolve with the implementation of new legislative provisions.

Buildings' response to needs of occupants

The current energy performance of buildings legislation in Austria roughly considers occupants' comfort and well-being. The technical OIB guidelines only include general objectives regarding hygiene, such as protection against moisture, hazardous emissions and hazardous substances (*OIB-Richtlinien 2019 | OIB*, 2019).

Regarding the creation of a DBL, there has not been really any progress in Austria, but the online database ZEUS[11] and the register-based Housing Census of Statistics Austria database[12] are currently operating, collecting detailed information on building and dwelling stock, including building characteristics, type of ownership, construction period, number of dwellings, net floor area and type of heating. However, the majority of these information is not publicly available due to GDPR.

4.1.2 Consultation with national stakeholders

According to national stakeholders from Austria, the SRI in Austria is more about implementing smartness for energy flexibility and energy efficiency, whilst it does not consider users' perception, such as occupants'

[11] https://www.energieausweise.net

[12] https://www.statistik.at/en/statistics/population-and-society/housing

comfort and well-being. They, also, support that building automation and smartness, implemented through measurement and control technologies, are able to assist in the reduction of energy consumption and CO_2 emissions. However, people are sceptic about the reliability of smart technologies in their buildings, because these systems may oversee security issues and are difficult to be understood by occupants.

Regarding the goals of a climate-neutral energy balance by 2040, SRI and EPC could contribute to their achievement if more quantitative indicators were assessed. SRI would be a more reliable instrument, if it was used to assess the usage of certain technologies and not just the readiness of the building for these technologies.

Specifically in Austria, a test phase of the SRI methodology is currently taking place. Around 15 large non-residential modern buildings with the latest automation technology are assessed in the context of this test phase, but they all achieved low ratings, with the highest among them equal to 58%. According to national stakeholders, the main problems that arose during the test phase and affected the reliability of the SRI methodology were (1) the fact that the services and their intensity scales are not well defined, (2) that some weighting factors, such as in the comfort pillar (well-being, health, etc.) are not based on scientific studies, and (3) the fact that methodology is based on assumptions that are not scientifically justified. The credibility of SRI would not be affected when using the same indicators for building of different typology or usage, if the methodology was based more on quantitative indicators. In parallel with the SRI test phase, a three-years project will be launched. This project will include at least 8 buildings where new building automation systems will be installed and their smart readiness will be calculated and assessed.

For the implementation of SRI in Austria, stakeholders consider that among the three functionalities on the performance of which SRI rates the smart readiness of buildings, more emphasis should be placed on energy flexibility. They also foresee practical advantages if integrating SRI into EPC. Regarding the adoption of the common EU DBL framework for storing buildings' data in Austria, they endorse that it will be reliable only if it is really open access to all interested parties, including researchers, and not just to policymakers.

4.2 Croatia

4.2.1 Review on national context

Smart Readiness of Buildings

Currently, the national legislation of Croatia does not include any reference on SRI, but the country has already launched the testing phase of the implementation of SRI. The Croatian LTRS[13] sets out policies and actions to promote smart technologies mostly on a local level by adopting strategies for the development of smart cities. Several Croatian cities have already prepared such strategies in accordance with the European Union initiative European Innovation Partnership on Smart Cities and Communities (EIP-SCC). Smart cities are based on digital infrastructure and encompass the following areas:

- efficient, transparent and smart city administration,
- smart energy and utilities management,
- smart environmental management, including physical planning,
- strengthening the role of citizens,
- smart (circular) economy,
- sustainable urban mobility.

The SRI test phase in Croatia is led by the Ministry of Physical Planning, Construction and State Assets and is supported by the Energy Institute Hrvoje Pozar (EIHP – SRI2MARKET partner). The decision for the test phase was influenced by the funding of the SRI2MARKET. The test phase will be conducted thanks to a recently selected project of the EU Programme for the Environment and Climate Action (LIFE). Other partners from the SRI Cluster projects (REGEA from SRI-ENACT) will contribute to the test phase in different ways. The test phase aims at exploring the potentials and opportunities for SRI in the Croatian context and at contributing to the overall development and refinement of the SRI calculation methodology. Preparatory phase for testing will be finished with the development of SRI calculation tools within LIFE projects in 2023. Small scale testing started in 2023 with 8 pilot buildings aiming to cover the most important types of buildings, to test the tool and to be used for training of trainers. Large-scale testing rollout is foreseen in 2024 and 2025

[13] https://energy.ec.europa.eu/system/files/2021-08/hr_2020_ltrs_en_version_0.pdf

aiming to assess 200 - 250 buildings by the end of 2025 through the two projects. Through SRI2MARKET and SRI-ENACT, trainings to 200-250 assessors will be provided by the end of 2025. The procedure for the establishment of the SRI will probably follow a similar approach with the establishment of the EPC. Firstly, there will be educational procedures according to different building types and usages for professional assessors, and then regular courses every few years to maintain this knowledge. The participants of these educational courses will be provided a relevant certification recognized by the national legislation.

Buildings energy performance and operation

The **energy performance requirements and standards** for the Croatian building stock are described in detail in the Technical Regulation on the Rational Utilization of Energy and Thermal Insulation of Buildings (Official Gazette 102/2020) and are summarised below.

All **new residential and non-residential buildings** heated to a temperature of 18°C or more, with useful floor area over 50 m^2 must be nearly zero-energy buildings. According to the definition in the Technical Regulation, a nearly zero-energy building is a building that has very high energy properties.

Maximum allowed annual primary energy per useful floor area for residential buildings:

1. **Single-family houses**: continental Croatia 45 kWh/(m^2a), littoral Croatia 35 kWh/(m^2a)
2. **Multi-family buildings**: continental Croatia 80 kWh/(m^2a), littoral Croatia 50 kWh/(m^2a)

Maximum allowed annual primary energy per useful floor area for non-residential buildings:

1. **Office buildings**: continental Croatia 35 kWh/(m^2a), littoral Croatia 25 kWh/(m^2a)
2. **Educational institutions**: continental Croatia 55 kWh/(m^2a), littoral Croatia 55 kWh/(m^2a)
3. **Hospitals**: continental Croatia 250 kWh/(m^2a), littoral Croatia 250 kWh/(m^2a)
4. **Hotels and restaurants:** continental Croatia 90 kWh/(m^2a), littoral Croatia 70 kWh/(m^2a)
5. **Sports halls**: continental Croatia 210 kWh/(m^2a), littoral Croatia 150 kWh/(m^2a)
6. **Shops**: continental Croatia 170 kWh/(m^2a), littoral Croatia 150 kWh/(m^2a)

When in an existing **residential or non-residential building**, heated to a temperature higher than 12°C, a floor area greater than or equal to 50 m^2 **is upgraded**, the nearly zero-energy building requirements should be applied to the upgraded part.

In addition to maximum primary energy requirements there are requirements on maximum allowed energy need for heating, maximum requirements for building element transmission coefficient values and RES share.

The **BACS** deployment in Croatia is based on the European standard EN15232. According to this standard, new buildings and those undergoing reconstruction must have BACS and technical building management functions categorized as either A, B, or C efficiency class. Specifically, A class represents a BACS with high performances of energy efficiency and technical building management activity, B class stands for an advanced BACS with some specific building management activities and C class represent a standard BACS, normal control and setting systems equipped also with communication bus but not characterized by particular functional performances from the point of view of energy efficiency.

The implementation of smart meters is currently being implemented in larger companies, as well as in new households and when replacing old meters, mainly for electricity. At the same time, some public buildings have hourly meters for alternative energy sources such as natural gas or water.

Buildings' response to needs of the grid

Considering on-site energy generation in Croatia, the prevalent method is net-metering, which involves the settlement of energy consumption and production on an annual basis for households and a monthly basis for non-households. The current net-metering model promotes energy consumption at the site and does not encourage, although it permits, the feeding of surplus electricity production into the grid. The sharing of excess electricity production is not permitted.

Energy storage is included in the current legislative framework, but its usage is limited to building level. Energy communities, renewable energy communities (RECs) or decentralized smart grids operating at district level are currently not included.

In new buildings, a requirement is set for 10% of parking spaces to be equipped with EV charging infrastructure. Apart from that, there is not any specific legislative framework established and charging infrastructure is treated as just another electricity consumer. Currently, DR market is hardly developed according to a Croatian energy stakeholder.

Buildings' response to needs of occupants

Concerning building data, Croatia has an online land registration and cadastre system that provides publicly accessible information about ownership, geographical location and size of all buildings. Additionally, there is an EPC database, small part of which is accessible to the public. Energy consumption of public buildings is monitored through a separate energy management information system, which is not open to the public but available to individuals responsible for energy management in the public sector.

The existing legislation on the energy performance of buildings does not include any provisions addressing the comfort or the well-being of occupants, except for regulations concerning maximum noise levels and fire safety standards.

4.2.2 Consultation with national stakeholders

According to national stakeholders from Croatia, the concept of smartness of buildings is an innovative instrument for the national efforts towards achieving energy efficiency. Specifically, SRI aims to quantify the savings due to the installation and implementation of smart technologies. Among the three aspects of smartness, an interviewee consider that currently the most important is buildings' efficiency and performance while the least important is interaction with occupants, but in the next ten years, probably this may change making interaction with the grid (flexibility) the most important aspect.

Regarding the goals of zero-emission building stock and ultimately to zero-emission energy systems by 2050, electrification of most of the sectors is considered the main direction in order to achieve them, but puts risks in the reliability of the distribution and transmission networks. For this reason, flexibility of consumption, as an important part of the implementation of smartness in buildings, is considered the main instrument to assist in the achievement of these goals.

According to the interviewees, the provisions of the EPBD, EED, Energy Market Regulation could potentially provide opportunities for the SRI deployment, because the SRI assessment considers the deployment of new technologies and schemes, such as solar-ready buildings, smart-meters rollout, BACS, boosting DR and storage, and active customers. At the same time, the adaptation of all these will be facilitated by SRI. As suggested in the recent proposal for the revision of the EPBD, the interviewees underline that SRI must initially target large non-residential buildings, and include smaller and even residential ones only after the DR market is well-established.

Currently in Croatia, there are building renovation schemes that include smart technology installations or other interventions related to smartness. But as long as there is not any specific framework related with SRI to describe and validate its methodology, it will not be possible to implement it. Regarding the test-phase, it will take place in the framework of SRI2MARKET project and the procedure that will be followed probably will be similar to the one followed for the establishment of the EPC. Firstly, there will be educational procedures according to different building types and usages for professional assessors, and then regular courses every few years to maintain this knowledge. The participants of these educational courses will be provided a relevant certification recognized by the national legislation. According to a Croatian stakeholder, caution should be placed on the formation of the necessary legislation, the choice of the suitable SRI tool and the identification of the goals that SRI should target.

Among the most interested stakeholders in Croatia, there are the companies that trade automation equipment and smart technology, the professionals that will carry out the SRI assessments and implement the relevant calculations and the companies that develop the calculation software. Various stakeholders believe that linking SRI with EPC is the most practical and efficient option, because they are both based on similar data that can be obtained through the energy audit, they provide information relevant to each other and they probably will be both carried out by the same professionals. Also, integrating SRI into the EPC will relieve building owners of any associated additional burden. Regarding the EU DBL, it is a tool that is not necessary in order to successfully implement the SRI assessment.

The current format of the SRI is generally sufficient apart from the fact that the functionality levels in the current service catalog that must be satisfied to reach the maximum SRI are not really economically viable options, yet. This endorses the scepticism of various stakeholders and negatively affects the credibility of SRI instrument. The most important measures that will ensure the successful rollout of SRI as well as the reliable implementation of the SRI assessment in Croatia include a straightforward legislation framework that will also make SRI mandatory, and the proper education of people that will implement SRI.

4.3 Cyprus

4.3.1 Review on national context

Smart Readiness of Buildings

The revised EPBD, along with its subsequent regulations (Delegated Regulation and Implementing Regulation), introduced SRI in 2018. This led to an optional implementation phase for EU countries. As a result, EU countries have the choice to adopt the SRI within their territories, either for all buildings or specifically for certain categories of buildings. Currently, Cyprus lacks specific guidelines for implementing the SRI as stipulated by regulation 2156/2020. Consequently, the national governing body aims to proceed with adopting the SRI methodology and integrating it into the national policy. Furthermore, they seek to create opportunities for tool development and advance towards an SRI testing phase. The Cypriot LTRS[14] states that the bill amending the Regulation of the Energy Performance of Buildings Law enables the Minister of Energy, Commerce and Industry to issue a Decree, with which it will be able to determine issues regarding the common assessment system of the SRI and not covered by the EC delegated act.

In order to introduce SRI methodology to the policymakers, a cluster of four partners (SRI Cyprus Cluster), consisting of the Cyprus Energy Agency, the Frederick University, the CyRIC Ltd and the Euphyia Tech Ltd, all participants in research projects funded by the EC under the topic LIFE-2021-CET-SMARTREADY (Smart Square, easy SRI, and SRI2Market), propose to the Ministry of Energy, Commerce and Industry to undertake the implementation of the SRI Testing Phase in Cyprus. So far, there is no official reply from the authorities with regards to participation in the testing phase, but the discussions are still ongoing. However, there is interest from the energy services of Cyprus, Universities and other market actors to promote the SRI concept.

Buildings energy performance and operation

The regulations regarding buildings' performance requirements and standards currently applied in Cyprus are presented below.

The owner of the building has to ensure the issuance of an **EPC** in case of new buildings, existing buildings for sale or rent and buildings with an area > 250 m^2 used by a public authority and accessible to the public.

New buildings, buildings undergoing major renovation and parts of the building's shell undergoing replacement or installation must meet the minimum **energy efficiency requirements**. Specifically, any new building or building's unit should be A class, have maximum primary energy consumption equal to 100 KWh/m^2 per year and 125 KWh/m^2 per year in case of residential and non-residential building, respectively, 0.4 W/m^2K maximum U-value of masonry and horizontal structural elements and maximum U-value of frames equal to 2.25 W/m^2K. It is allowed to exceed the above U-values provided that the average coefficient of the entire shell does not exceed 0.65 W/m^2K. At the same time, by the end of 2020, new buildings must have almost zero energy consumption.

In order to further improve the energy efficiency of heating and air conditioning systems in existing buildings, legislation has been introduced to regulate and supervise the periodic inspection and operation of these systems. Two guidelines have been issued for each system, describing the tasks and examinations to be conducted by technical system installers. The purpose is to guarantee that proper maintenance measures are implemented, ensuring optimal energy efficiency in the functioning of heating and air conditioning systems.

At the same time, the Energy Regulatory Authority of Cyprus has issued a Regulatory Decision urging the DSO to proceed with the appropriate actions for the widespread installation of smart meters for all electricity consumers. The whole process is expected to be completed within the upcoming years. This initiative establishes the foundation for smart metering in the country, enabling efficient use of electricity and potential cost savings in the competitive electricity market.

[14] https://energy.ec.europa.eu/system/files/2020-07/cyprus_2020_ltrs_en_0.pdf

Buildings' response to needs of the grid

In Cyprus, there is significant potential for on-site energy generation and storage in buildings, which can help reduce the country's reliance on imported energy and promote sustainable development. The dominant policy scheme on on-site energy generation in buildings is net metering.

Net metering is a policy that allows building owners to connect their on-site renewable energy systems to the grid and receive credits for any excess energy they generate. This scheme can incentivize building owners to invest in on-site energy generation systems such as solar PV systems and wind turbines. Currently, there are four different categories of net metering in Cyprus:

- Category A: PV systems connected to the grid using the net-metering method. In this category all electricity consumers are beneficiaries and the maximum power of each PV system is 10.4 kW per electricity bill. Also, PV systems can be installed on the roof of legally erected buildings or on the ground within the same block where the legal building is located and/or adjacent blocks to the building they will serve.
- Category B: RES systems connected to the grid using the net-billing method. In this category all electricity consumers are beneficiaries and the maximum power of each RES system is 8 MW per electricity bill. Also, RES systems can be installed on the roof of legally erected buildings or on the ground within the same lot and/or neighboring lots with the building they will serve.
- Category C: Autonomous RES systems not connected to the grid. In this category, all electricity consumers are beneficiaries and it is possible to install autonomous RES systems according to consumer's needs, without limiting the maximum power of each system.
- Category D: PVs connected to the grid with the virtual net metering method. In this category, only household consumers and professional farmers are beneficiaries, while PV systems are installed in a location other than the serviced property. The produced electricity of the PV system is offset against the imported electricity from the network of a single residential unit or agricultural property, located in a different area from the PV system. The maximum power of each PV system that can be installed is 10.4 kW and 20 kW per electricity consumption bill, for household consumers and professional farmers, respectively.

At the same time, Cyprus has introduced legislation to support the development of citizen energy communities and RECs. In particular, the Ministry of Energy has currently proceeded with the drafting of two law documents, which are expected to be submitted for public consultation. The first document harmonizes the national legal framework with EU Directive 2019/944 on common rules for the internal electricity market, while the second document concerns complete replacement of the Electricity Market Regulation Laws of 2003 with the provisions of the Fourth Energy package (Directive (EU) 2019/944, Regulation (EU) 2019/941, Regulation (EU) 2019/943). Specifically, EU Directive 2019/944 establishes the right of customers to actively participate in the electricity market through a new category of active customers, the "Citizen Energy Communities".

In order to promote the adoption of EVs, the Ministry of Transport, Communications and Works has included specifically targeted measures in the National Recovery and Resilience Plan. These measures include the creation of a regulatory framework for the efficient operation of the EV recharging infrastructures and market, and the replacement of all government vehicles with electric ones by 2030. Furthermore, these measures include incentives for the adoption of EVs, such as a subsidy of 5,000 euros for buying an electric car and a subsidy of 7,000 euros if the purchase of a new electric car is accompanied by the retirement of a vehicle that is over 15 years old. Cyprus aims on having electric cars account for 25% of new vehicle registrations by 2030, with a total of 36,000 EVs on the roads. Currently, there are approximately only 250 electric cars.

In addition, the government has provided a new grant scheme called the "Electrification with 1000" to facilitate the installation of EV charging stations. This grant scheme is included in the National Recovery and Resilience Plan and is financed by the Recovery and Resilience Mechanism (RMM) of the EU. Its main objective is to promote electrification by establishing an extensive network of EV charging points.

Buildings' response to needs of occupants

The Energy Performance of Buildings Law incorporates and aligns relevant European Directives into national legislation, introducing a range of measures to enhance the energy efficiency of both new and existing buildings. These measures consider occupant's comfort requirements, local climate conditions, and the cost-benefit relationship throughout the building's lifecycle.

At the same time, Cyprus has its own building database, based on information from the Statistical Service and some technical reports, such as the "Building Stock in Cyprus and Trends to 2030" of the Joint Research Center (2017), the "An energy efficiency strategy for Cyprus up to 2020, 2030 and 2050" by Deutsche Gesellschaft for International Cooperation (2017) and the "Long-Term Building Renovation Strategy" of the Energy Agency (2020). This publicly accessible database is used for the evaluation of the existing residential and non-residential building stock of Cyprus and provides information regarding the total category/number of the building stock, the number of building permit, the mean area per building, the mean cost per square, the year of construction, the type of building, the percentage of thermal insulation, the energy consumption in residential buildings and the percentage by type of space heating of residential buildings.

4.3.2 Consultation with national stakeholders

According to stakeholders from Cyprus, the concept of smartness of buildings corresponds to the ability of a building to be used and managed in a smart way. Among the three aspects of smartness, it is considered that the most important are buildings efficiency and performance and interaction with occupants, while the least important is interaction with the grid (flexibility). Regarding the goals of zero-emission building stock and ultimately to zero-emission energy systems by 2050, since the SRI is not directly correlated with energy consumption and CO_2 emissions, it is not anticipated to have a major impact on achieving these goals.

Specifically in Cyprus, the Department of Energy Services of the Ministry of Energy, Commerce and Industry has been involved in EU workshops and sessions to get support on specific elements of the SRI, such as the test phase and the methodology. In addition, the Academic Community has been involved in research and pilot projects for the SRI, where these initiatives could support the introduction of the SRI to the policymakers and the market of Cyprus. These entities are currently the most interested among the stakeholders on SRI since other potential stakeholders like market players and building owners are unfamiliar with the SRI. In order to introduce SRI methodology to the policymakers, a cluster of four partners (SRI Cyprus Cluster), consisting of the Cyprus Energy Agency, the Frederick University, the CyRIC Ltd and the Euphyia Tech Ltd, all participants in research projects funded by the EC under the topic LIFE-2021-CET-SMARTREADY, propose to the Ministry of Energy, Commerce and Industry to undertake the implementation of the SRI Testing Phase in Cyprus.

Regarding the integration of SRI into the EPC, an interviewee considered that it could be realized only after optimising the EPC methodology and fixing its existing issues. Regarding the adoption of the common EU DBL framework for storing buildings' data in Cyprus, it is considered to have minimal relation to the roll out of SRI to the market, but it could be useful for providing a clear overview of the current situation of the buildings stock.

Finally, it was suggested that to achieve a successful rollout and the reliable implementation of SRI could be ensured by making it mandatory, training assessors, engineers and the market players about the use of the instrument and by developing a direct connection between SRI and energy consumption and CO_2 emissions.

4.4 France

4.4.1 Review on national context

Smart Readiness of Buildings

France actively participated in the construction of the SRI methodology and is one of the first countries that launched an official SRI test phase. For this reason, the French test phase is strategically designed to pave the way for the widespread rollout of SRI. As part of this process, external assessors are being recruited and trained, to ensure that SRI assessments are conducted by independent third parties. Furthermore, France currently holds the position of chairing the first working group of the SRI platform, focusing on MS' SRI test phase. The French test phase is led by the Ministry for Ecological Transition with the support of CEREMA. SRI assessments are going to be conducted by independent third parties. The target is to assess at least 30 buildings as a first step. Several meetings have been scheduled between the Ministry (Housing Department) and R2M Solution (partner of SRI2MARKET) in order to present the project and areas of assistance. The discussions with the Ministry and other stakeholders are ongoing.

Buildings energy performance and operation

The energy performance requirements and standards for the French building stock are summarised below.

In France, when selling or renting a building, either residential or not, it is obligatory to obtain an EPC (*Diagnostic de performance énergétique*, 2021).

All multi-family buildings with more than 200 dwellings are obliged to obtain an EPC by 2024. For multi-family buildings with more than 50 dwellings this deadline is extended by one year, while for the rest multi-family buildings it extends to 2026 (*Diagnostic de performance énergétique*, 2021).

In the tertiary sector, the acquisition of an EPC is mandatory when selling a property, constructing a new building and for all public buildings that have a surface area of more than 250 m² (*Diagnostic de performance énergétique*, 2021).

In the residential sector, the dwelling owner, in order to be allowed to rent it out, is obliged to ensure that the following minimum energy efficiency requirements are met (*Diagnostic de performance énergétique*, 2021):

- Since 2023, the final energy consumption of the dwelling must be lower than 450 kWh/m²/year;
- From 2025, the EPC class of the dwelling must be at least F (i.e., primary energy consumption < 420 kWh/m²/year);
- From 2028, the EPC class of the dwelling must be at least E (i.e., primary energy consumption < 330 kWh/m²/year);
- From 2034, the EPC class of the dwelling must be at least D (i.e., primary energy consumption < 250 kWh/m²/year);

In addition, single-owner residential (multi- or single-family) buildings are obliged to conduct an energy audit after 2023 for class G and class F buildings, and after 2025 and 2034 for class E and class D buildings, respectively (*Loi n° 2021-1114 - Audit énergétique réglementaire*, 2021).

Furthermore, since 2019, the so-called "Décret Tertiaire" requires tertiary buildings with a floor area larger than 1,000 m² to declare their annual energy consumption on the OPERAT centralized platform[15] and achieve a 40% reduction in final energy consumption by 2030, a 50% reduction by 2040, and a 60% reduction by 2050 compared to the reference year (*Décret n° 2019-771 relatif aux obligations d'actions de réduction de la consommation d'énergie finale dans des bâtiments à usage tertiaire*, 2019).

Since 2020, the Decree No. 2020-887, concerning BACSs for non-residential buildings and automatic heat regulation, requires tertiary buildings with a rated heat capacity of 290 kW or more to be equipped with a BACS by 2025 (*Décret n° 2019-771 relatif aux obligations d'actions de réduction de la consommation d'énergie finale dans des bâtiments à usage tertiaire*, 2019).

At the same time, France has completed the rollout of smart meters. Specifically, at the end of 2021, smart meters had been installed to more than 90% of French electricity consumption points (*Décret n° 2020-887 relatif au système d'automatisation et de contrôle des bâtiments non résidentiels et à la régulation automatique de la chaleur*, 2020).

Buildings' response to needs of the grid

In France, the net metering system for on-site energy generation is not implemented, yet. Instead, the installation of PV panels is encouraged financially through the following measures (*Consommation d'électricité -L'absence de compteur Linky en 2023 pourrait vous coûter près de 50 € par an ! | Service-public.fr*, no date):

- A bonus (€/kW) is offered to incentivize the adoption of self-consumption schemes. The bonus amount varies based on the size of the installation and is revised on a quarterly basis.
- A feed-in tariff (€/kWh) is available for surplus electricity generated in self-consumption schemes. Higher feed-in tariffs are provided for installations that choose to feed-in 100% of the generated electricity to the grid.

However, there is currently no incentive program in place to promote the utilization of building-scale batteries.

Furthermore, the concept of energy communities is still in its early stages of development. Instead, collective self-consumption projects are currently preferred. In such projects, multiple buildings, whether owned by the

[15] https://operat.ademe.fr/

same or different owners, can benefit from shared renewable energy production, provided that they are located in close proximity and their production capacity is below 3 MW. Proximity is generally defined as a maximum distance of 2 km, but it is increased to 20 km for rural areas. These projects offer favourable financial terms to the participants, allowing them to collectively exploit RES.

The operation of distribution grids is exclusively operated by the official DSO, i.e. ENEDIS covers 95% of the French territory, with local operators serving the remaining regions. Numerous demonstration pilots of smart grids at district level have been supported by the energy and environment agency ADEME, the Energy Regulatory Commission and the Ministry of Ecological Transition.

At the same time, the recent Decree No. 2020-1720 grants households (owners and tenants) in apartment buildings the right to install EV charging plugs in their parking spaces. However, this decree does not specifically address the implementation of smart charging. Regarding tertiary buildings, smart charging solutions are offered by some market players, but they are not yet widespread (*Installation de panneaux solaires : vous avez droit à des aides ! | economie.gouv.fr*, 2023).

Regarding DR mechanisms, France is one of the pioneering countries in Europe concerning their development. DR can be offered both on the energy and capacity markets. RTE, the French TSO, is particularly transparent on the procurement and activation of demand-side flexibility, and ENEDIS is also developing flexibility markets at local level. Currently, 3 GW of DR capacities have been achieved only during 2023. According to RTE, this amount needs to be multiplied by 5 by 2050.

Buildings' response to needs of occupants

Considering occupants' comfort and well-being, the updated version of EPC includes an evaluation of the building's summer comfort. This assessment focuses specifically on passive summer comfort, taking into account factors such as insulation and shading, without considering active cooling systems (*Diagnostic de performance énergétique*, 2021).

Considering the need for a building stock database, France has developed its own **national database of buildings** that can be found at https://www.bdnb.eu and maps the existing building stock, counting 20 million residential and tertiary buildings in the country. Specifically, it provides a set of 400 data elements corresponding to the buildings' morphology (surface areas, heights, shapes), buildings' usages, buildings' materials and technical equipment, energy consumptions, energy performance (EPC class), administrative and financial information, address, cadastral references, etc. Amongst the 400 data elements included in the database, only 170 are freely available to the public.

Regarding the **DBL**, France has adopted the "Carnet d'information du logement"(CIL), a concept that focusses on the content of the building logbook rather than the digital format. By January 2023, it is mandatory for all new buildings. It also applies to existing dwellings and buildings that are being deeply renovated with an impact on energy performance (*Carnet d'information du logement (CIL) | Service-public.fr*, no date). Several CILs' commercial offers are being developed, such as CLEA by QUALITEL, and MONHA by EDF and Docaposte.

4.4.2 Consultation with national stakeholders

National stakeholders from France support that the smartness of buildings is necessary in order for more decentralized systems based on RES to exist and operate. Smartness, along with insulation and RES deployment in buildings, are necessary when trying to achieve the goals of zero-emission building stock and ultimately to zero-emission energy systems by 2050. Unlike insulation measures (in the framework of an EPC), that are related to passive energy systems and are able to reduce the total electricity demand, smart technologies and SRI are able to smoothen the curve of electricity demand through the day.

According to an interviewee, all the provisions of the EPBD, EED, Energy Market Regulation could be presented as opportunities for the SRI deployment, because the SRI assessment considers the deployment of new technologies and schemes, such as solar-ready buildings, smart-meters rollout, BACS, boosting DR and storage, active customers, among others. The DR scheme could be considered the most relevant among them, since it makes consumption more flexible in order to decentralize the energy system and achieve the energy transition. Additionally, the implementation of the BACS decree in France will help the upgrade of the smartness of buildings through the activation of the related market, and will enhance the roll out of SRI.

In France, the test phase is based on attracting private assessors, train them on the SRI methodology and choosing a couple of large non-residential buildings of various usages (office buildings, restaurants etc.). In this way, test phase cases simulate real life cases. Large non-residential buildings were chosen for the initial implementation of SRI, because in such buildings either automation systems are already installed or it is easier to implement smartness. In case of successful implementation of SRI in these buildings it must rapidly expand to all other building categories, even to single family apartments. The only adaptation that was made in the SRI methodology during the French test phase is related with the weight factors of the heating technical domain. They were modified to simulate all the different climate zones of France, since the common EU methodology uses the same climate zone for the whole country.

According to a French stakeholder, a lot of issues were presented during the test phase, due to the fact that the functionality levels included in the service catalogue are very complex for the assessors to understand, while there was insufficient guidance (e.g., lack of a portfolio of examples and guidelines for each functionality level) on how to identify the suitable level. Part of this problem is also the fact that training was limited on how to use the complex excel tool of the SRI methodology and conduct the assessment, and it did not include enough training on the service catalogue material. These issues were enhanced by the difficult vocabulary, even for professional assessors. Another issue regarding the service catalogue was that it included functionality levels that do not correspond to current systems. This led the existing buildings to achieve, in general, very low scores.

Apart from SRI, France has an alternative tool that assess the energy performance and smartness of buildings, called Ready2Services label, that comes with complete support and consulting service, it is more thorough and leads to the development of an improvement roadmap for the whole building. This instrument could not be mandatory or widely used, since it requires a significant investment from the building owner.

Regarding the integration of SRI into the EPC, according to an interviewee, it could be considered as an update since SRI fills some gaps that are not covered by EPC. For example, EPC is related to the perfect performance of the heating system, while SRI assesses the performance of the management of the heating system, like central thermostat or thermostats in each room, etc. But, having two different certificates, it will be more complex and expensive for building owners. They, also, endorse that the adoption of the common EU DBL framework for storing buildings' data could help the rollout of SRI, because it integrates information needed for SRI assessment. Additionally, there are several services in the service catalog at EU level that involve having a single interface that provides information, so this single interface could be the DBL.

An interviewee identifies DSOs among the most interested stakeholders. Since they are facing difficulties to accommodate new PV generation, flexibility that is part of the concept of smartness, is important for the reliability of the distribution grid. Also, all other stakeholders engaged in the flexibility of the power systems, such as aggregators and virtual plants, are benefited by the implementation of SRI.

Finally, the methodology framework of SRI is sufficient, but the functionality levels included in the service catalogue must be simplified to be more comprehensive for the professional assessors. The successful rollout of SRI will be ensured by making SRI mandatory for a specific share of the building stock and simplifying the technical parameters of the service catalogue will help the successful rollout of SRI.

4.5 Portugal

4.5.1 Review on national context

Smart Readiness of Buildings

The Portuguese Long-term Strategy (LTS) for the Renovation of Buildings, published and approved in 2021, introduces 7 areas of intervention, one of which is dedicated to smart buildings. It specifically foresees the introduction of the SRI and other measures such as the promotion of smart meters, sensors, building management systems, grid flexibility, smart charging, registry systems for local electricity production systems and information systems on self-consumption and energy communities (Portuguese Government, 2021).

In particular as regards SRI, this indicator is already foreseen in the EPC layout which "may include smart readiness indicator(s)" by law. Although not yet implemented in practice, it already allows this innovation and is being promoted in the new version of the EPC system. In Addition, Portugal, through ADENE, participated in the X-Tendo Horizon 2020 project which evaluated an SRI framework, even though this particular feature was not one of those tested in Portugal. The LTRS also includes a specific measure on smart buildings, outlining the implementation of SRI as one of the key tools. Portugal is currently evaluating the introduction of an official SRI test phase and is participating on the SRI platform working groups alongside the work carried out in SRI2MARKET. ADENE (partner of the SRI2MARKET) established several contacts with the Ministry (National Energy and Geology Directorate) and discussed the possibility of having a formal participation in the testing phase.

Buildings energy performance and operation

The current requirements and standards for new buildings are depicted in Decree-law 101-D/2020, which transposes the EU EPBD and the directive on the internal market for electricity into national legislation. These requirements and standards are divided according to the following main building types: residential, small non-residential buildings with HVAC system's power less than 30 kW, small non-residential buildings with climatization and HVAC system's power more than 30 kW, and large non-residential buildings with over 1000 m^2 (*Decreto-Lei n.º 101-C/2020*).

New buildings, among others such as major renovations, large non-residential buildings, buildings on transaction (rental, sale, leasing, donation, etc.), buildings financed for some energy performance improvements and related tax benefits, must have an EPC. Public owned and occupied buildings that are frequently visited by the general public with an area greater than 250 m^2, are automatically obliged to have an EPC and to display it in their premises. Among private buildings, the display of the EPC is only mandatory for large non-residential buildings. All buildings must display the energy class when advertising any transaction.

New buildings and major renovations must comply with minimum energy performance requirements depending if they are residential or non-residential buildings. Specifically, new residential buildings must be at least of Class A, while new non-residential buildings must be at least Class B. The minimum requirement for major renovation is class C for both residential and non-residential.

Under the aforementioned Decree-law 101-D/2020, BACSs are mandatory when renovating new and large service buildings and for all service buildings when the installed nominal power is greater than 290 kW by December 2025. They should include at least supervision, monitoring, command, control and registry of variables. Moreover, for buildings with nominal power greater than 290 kW, the requirements are stricter and include alarms, events, systems interoperability, detailed total and partial metering, extractable reports in Excel sheets, minimum efficiency classes according to EN 15232, etc.

Regarding smart metering in Portugal, extensive investments have been made for smart meters' roll out. The DSO has installed smart meters in roughly 70% of the consumption points. However, most of these systems are fit for purpose but still do not actively transmitting data. In 2021, ERSE, the national regulator, estimated that only 1.7 million of the 4 million installed smart meters were actually connected to a smart grid (Balanço da implementação das redes inteligentes de distribuição de energia elétrica em 2021, 2022). A number of pilot projects were also developed, most notably that of Évora, which served as a testing ground for further development (*Instalação de contadores Inovgrid*, 2020). According to Decree-law nº 15/2022 defining the organization and operation of the National Electric System, full uptake of smart meters for all 6.3 million consumption points is mandatory by the end of 2024 (Diário da República, 2022).

Buildings' response to needs of the grid

Portugal has a quickly evolving regulatory framework for on-site energy generation and storage. Following a focus on feed-in tariffs for small scale systems, in 2019 Portugal has adopted a new framework, focused on the regulation of self-consumption, collective self-consumption and RECs, that has been further developed in 2022 with the publication of Decree-law nº 15/2022.

This regulatory framework includes the rules for local renewable electricity production and energy storage and promotes them in two ways. On the one hand, licensing procedures for self-consumption schemes are simplified, with minimal to no licensing requirements for small systems below 30 kW and simplified procedures for systems between 30 kW and 1 MW. On the other hand, under certain conditions, tariff exemptions ranging from 50% to 100% are granted when using the public distribution grid outside the site. These exemptions apply to specific configurations and are valid on a temporary basis for a period of 7 years. This applies to the share of the tariff allocated to economic and general interest.

Also, when establishing a collective self-consumption system, there is no need to create a separate legal entity. However, it is required to have an entity responsible for the operational management of the self-consumption activities and the communication with the respective operators. This entity can either be one of the individuals involved in the collective self-consumption or an external entity. The sharing of electricity produced within members and shares of ownership must be communicated to the DSO and are regulated under an internal regulation defined for each collective self-consumption. Smart meters and bidirectional smart meters are mandatory at the generation plant and end-users point which are granted by DSO.

At the same time, RECs operate within a distinct regulatory and legislative framework. This framework provides comprehensive guidelines on how to relate with the electricity system, the structure and agents involved, the procedures for sharing energy production and the incentives available, such as partial tariff exemption under certain conditions and simplified licensing procedures. The existing framework enables citizens, companies, local authorities, and others in close proximity to renewable energy projects to establish RECs. These communities can take the form of any collective legal entity set up specifically for this purpose. Proximity is defined as a maximum distance of 2 km for low voltage networks or when renewable energy production units and end-users are connected to the same transformer station for low voltage transformation. This distance increases to 4 km for medium voltage networks, 10 km for high voltage networks, and 20 km for extra high voltage networks.

The Portuguese NECP for 2030 also places energy communities at the centre of its objectives. Specifically, in Action Strategy 3.2 it states that the aim is to “promote the dissemination of distributed production and self-generation of energy and energy communities” (*PLANO NACIONAL ENERGIA E CLIMA 2021-2030 (PNEC 2030)*, 2020). Energy communities are recognised as a valuable tool in both the LTS for the Renovation of Buildings and in the LTS to Combat Energy Poverty.

Regarding citizen’s energy communities, while they are already defined in the current legislation on the electricity system by Decree-law nº 15/2022, there are still no detailed regulations to boost and govern their implementation. Similarly, smart grids at district level also require detailed and specific regulations, despite the existence of a general definition and regulatory framework for them.

At the same time, financial incentives are offered for projects involving collective self-consumption and energy communities in residential, public, and service buildings. They include non-refundable funding rates from 50% to 100% and maximum funding amounts ranging from €200,000 to €500,000.

Under the aforementioned Decree-law 101-D/2020 for the energy performance of buildings, there are mandatory provisions for EV charging infrastructures, but there is no specific provision regarding smart charging. However, as mentioned, the Portuguese LTS for the Renovation of Buildings has a specific package of measures on smart buildings and foresees the introduction of smart charging infrastructures.

According to the energy stakeholders who responded the survey, the implementation of DR schemes is either at a very early stages or at pilot level, while no relevant national framework exists. The national regulator ERSE has initiated two pilot studies as regulatory sandboxes.

Buildings’ response to needs of occupants

Under the aforementioned Decree-law 101-D/2020, there are provisions on thermal comfort as part of the energy performance evaluation and on indoor air quality with specific requirements on ventilation. All non-residential buildings and new or renovated buildings must comply with requirements for indoor air quality. Additionally, an annual simplified evaluation that covers several air pollutants is required for large non-residential buildings, educational and elderly care units.

In an effort to upgrade the National Building Energy Certification System (SCE), ADENE has developed a strategy that included the development of a new online platform to issue EPCs, a new EPC layout, a new website and the publication of support documentation and guidelines for experts. The main goal was to realign the SCE with the needs of the market. Today, the EPC database is fully functional and accessible. Currently, it holds information on roughly 1.85 million EPCs, while their summary version, as well as, relevant statistics are publicly accessible at https://www.sce.pt website. The significance of the EPC database is highlighted by the fact that specific funding schemes have been developed based on information provided by the national EPC database. Moreover, ADENE offers "Portal casA+" as a national one-stop-shop with DBL features, available at https://portalcasamais.pt/ website that provides various features, including renovation measures tailored to EPC recommendations, building owners and service providers. At the same time, the process of cadastral mapping/registration of all properties in the country, including buildings, is underway for the creation of the National Register of Buildings.

4.5.2 Consultation with national stakeholders

According to stakeholders in Portugal, the practical implementation of smartness in a building can vary according to the building type and usage and the expected impact that can be produced by the installed technology. In the context of Portugal, among the three aspects of smartness, the interaction with the grid seems to be the most important, since there are a lot of new investments and new regulations related with flexibility, followed by interaction with the occupant since there is a gap on this in Portugal.

Also, they add that SRI should be considered an informative tool that can generate conclusions on de facto energy consumption and CO_2 emissions, instead of a regulatory instrument. The contribution of SRI to the goals of zero-emission building stock and ultimately to zero-emission energy systems by 2050 depends on how it is implemented, the type and usage of buildings that are chosen, and the way that its conclusions are correlated with real energy consumption and the CO_2 emissions of the building.

In Portugal, even if SRI has already been included in the regulatory framework, it is not well-addressed enough by the main market actors. There are some test phases implementing SRI and BACS, but they must include more buildings. Currently, SRI is not placed at a high priority by the Portuguese government and the ongoing test phases are not formally approved yet, but it has been identified as an important element of the EPBD transposition process. Also, Portugal will be following closely and officially the developments under Working Group 1 of the SRI Platform. Academia and Industry stakeholders have developed test phases implementing SRI and BACS, but they must include more buildings. These unofficial test phases highlighted several issues in the SRI methodology. Initially, there is a lack of information regarding the relation of real energy consumption and real CO_2 emissions with SRI and how they correlate. Also, SRI methodology could not be considered reliable enough yet, since the final score of an assessment largely depends on the assessor's perspective. SRI Tests in Portugal also revealed that energy eficiency and user's comfort can be sometimes conflicting and this should be subject to further evaluation. Another issue noted is that the service catalogue lacks details for technologies commonly implemented in the South European countries.

According to the interviewees, the most interested stakeholder groups are probably from academia, BACS technology providers, energy companies working on production, distribution and commercialization of energy and RECs. For building owners all around the EU, SRI will seem as an extra burden if it is not integrated in the EPC.

Specifically in Portugal, the national legislation has already integrated SRI into the EPC system for optional implementation. This is considered the only way to implement the mandatory provisions of SRI. An interviewee endorses that SRI has to be mandatorily implemented and developed for large buildings, but at the same time, it can voluntarily be implemented in a different framework on buildings of different kind. At the same time, BACS could help the roll out of SRI, considering also that they are included in the EPC. Considering the adoption of a DBL for storing buildings' data, the aforementioned "Portal casA+" allows for an automatic upload and retrieve of all the information included in the EPC, that is very useful for the roll out of SRI.

Finally, a national stakeholder summarised the main actions for ensuring the successful implementation of SRI. SRI must be integrated into the EPC system for mandatory implementation to large non-residential buildings, interventions regarding smartness must be included in the public fundings for renovation and efforts should be targeted on making the SRI methodology more reliable and correlating its results with real energy consumption and CO_2 emissions.

4.6 Spain

4.6.1 Review on national context

Smart Readiness of Buildings

According to Directive 2018/844/EU, Commission Delegated Regulation (EU) 2020/1477 and Commission Implementing Regulation (EU) 2020/2156, the Ministry for the Ecological Transition and Demographic Challenge has agreed to launch a **non-committal testing phase** for the SRI implementation. Currently, this is under preparation with the support of CENER,https://www.cener.com/en/ within the context of the

SRI2MARKET project. The SRI test phase in Spain is led by the Ministry for the Ecological Transition and the Demographic Challenge with the support of CENER - National Renewable Energy Centre within the context of the LIFE project SRI2MARKET.

The main aspects that would be assessed during the test phase will cover:

- The training needs for EPC assessors to became SRI experts, based on the SRI2MARKET e-learning platform and training program;
- The available web tools, such as the SRI2MARKET assessment tool and the e-learning platform in Spanish language;
- The quality of required input data and their justification;
- The adequacy of the methodology to the Spanish context;
- And the SRI assessment outcomes of the sample (at least 50 case studies across Spain).

The Spanish test phase timeline will be linked to the SRI2MARKET developments that will support each step and scope. Thus, a tentative timeline[16] according to the SRI2MARKET milestones is presented in **Figure 8**.

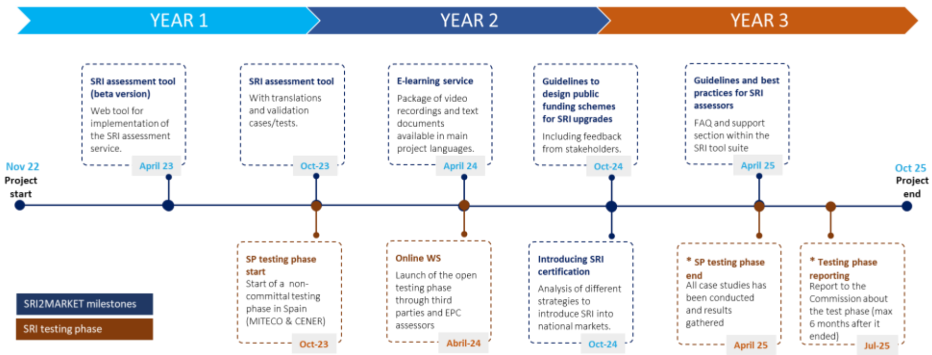

Figure 8. The test phase timeline according to the SRI2MARKET milestones.

Buildings energy performance and operation

All newly constructed buildings or buildings undergoing renovations are required to adhere to the national standard, known as the "Basic Document on Energy Saving." This standard outlines the minimum energy efficiency requirements that must be met for the construction or renovation of a building. This document establishes the limitations based on the climatic zone in which the buildings are situated, covering the following aspects (MINISTERIO DE TRANSPORTES, 2022):

- Minimum energy efficiency of the lighting system (since June 2006);
- Minimum percentage of on-site generated renewable energy consumption in the building (since June 2006);
- Minimum energy efficiency requirements for thermal installations in buildings (since July 2007);
- Maximum energy demand of the building (since June 2013);
- Maximum total non-renewable primary energy consumption of the building (since September 2013).

Although there is not currently any recognised document that directly links the maximum non-renewable primary energy consumption of the energy saving regulation with the minimum letter of the energy rating required for buildings, both indicators are strongly related.

Since April 2013, all new buildings, buildings or parts of buildings for sale or rent and buildings or parts of buildings in which a public authority occupies a total useful floor area of more than 250 m^2 and regularly frequented by the public are obliged to have an EPC (*BOE-A-2013-3904 Real Decreto 235/2013, de 5 de abril, por el que se aprueba el procedimiento básico para la certificación de la eficiencia energética de los edificios.*, 2013).

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[16] Tentative dates that can be adapted (if necessary) according to the requirements established by the approval and publication of the new EPBD in 2023.

Starting from June 2021, the following categories are obliged to have an EPC (*BOE-A-2021-4572 Real Decreto 178/2021, de 23 de marzo, por el que se modifica el Real Decreto 1027/2007, de 20 de julio, por el que se aprueba el Reglamento de Instalaciones Térmicas en los Edificios.*, 2021):

- Buildings or parts of buildings undergoing renovations or expansions that involve the replacement, installation, or renovation of thermal installations;
- Buildings or parts of buildings where intervention on over 25% of the final thermal envelope surface is performed;
- Buildings or parts of buildings with an enlargement exceeding 10% of the surface area or volume built, provided that the total useful surface area enlarged exceeds 50 m².
- Buildings or parts of buildings with a total useful floor area larger than 500 m², used for administrative, sanitary, commercial (e.g., shops, supermarkets, department stores, shopping centers), public residential (e.g., hotels, hostels, residences, pensions, tourist flats), educational, cultural (e.g., theaters, cinemas, museums, auditoriums, conference centers, exhibition halls, libraries), recreational activities (e.g., casinos, amusement arcades, nightclubs, discotheques), catering (e.g., bars, restaurants, cafeterias), passenger transport (e.g., stations, airports), sports (e.g., gyms, sports centers), places of worship, religious, and similar purposes;
- Buildings which must mandatorily undergo the Technical Building Inspection or equivalent inspection mandatory for buildings 50 years old or older.

According to the Basic Document on Energy Saving, lighting installations in buildings should include a BACS enabling the adjustment of lighting based on the actual occupancy of the area (MINISTERIO DE TRANSPORTES, 2022). Additionally, there should be a regulation system in place that optimises the use of natural light in areas that meet certain conditions.

According to the Royal Decree 1027/2007 on thermal installations in buildings, all thermal installations must be equipped with the necessary BACS to be able to maintain the intended design conditions by adapting the energy consumption to changes in the thermal load. In addition, Royal Decree 1027/2007 makes a distinction between residential and non-residential buildings (*Real Decreto 1027/2007 - Reglamento de Instalaciones Térmicas en los Edificios*, 2007). Thus, where technically and economically feasible, non-residential buildings with a useful rated output for heating, cooling, combined heating and ventilation or combined cooling and ventilation of more than 290 kW must be equipped with BACS.

Regarding consumption metering, Royal Decree 1027/2007 requires that any thermal installations serving multiple users must be equipped with a system enabling the allocation of costs for each specific service, such as heating, cooling, and domestic hot water, among the different users. Specifically for domestic hot water, an individual meter must be installed. By the end of 2019, approximately 99.22% of domestic consumers whose contracted power is below 15kW, were equipped with integrated smart electricity meters, totalling around 28.5 million units.

Buildings' response to needs of the grid

The regulations on on-site energy generation, energy storage and shared self-consumption systems are outlined in Royal Decree 244/2019. Currently, there are several self-consumption schemes, each with its own requirements and regulations. These systems can be classified into different models depending on whether they have a surplus or not. In case of having surplus, depending on the characteristics of the installation, the user can choose between options such as compensation through a monthly net billing model or selling the surplus energy directly to the market.

To boost the adaptation of on-site energy generation and storage technologies, subsidies are available for self-consumption installations, including both PV systems and batteries. In addition, some energy companies have started to offer virtual battery services, allowing users to sell their surplus energy through this system instead of opting for the formal surplus compensation model, in exchange for a small commission.

The first legislative framework for energy communities in Spain was a draft Royal Decree published by the Ministry for Energy Transition and Demographic Challenge. This draft Royal Decree presented multiple structures of citizen energy communities and RECs. However, collective self-consumption projects were already funded through various calls for proposals where grants can cover up to 60% of eligible costs (*Programa de Incentivos a proyectos piloto singulares de comunidades energéticas (CE IMPLEMENTA) | Idae*, 2022).

The minimum requirements for EV charging infrastructure in buildings are described in the Basic Document on Energy Saving, while the Royal Degree 1053/2014 specifies the technical guidelines for such infrastructures. According to the CTE DB-HE6, residential buildings, with some exceptions, must have installed power line systems to accommodate future charging stations for 100% of the parking spaces. Additionally, in tertiary buildings, power line systems must be installed to enable the future supply of charging stations for at least 20% of the parking spaces. Furthermore, one charging station should be installed for every 40 parking spaces in these buildings. However, if these buildings are owned by the General State Administration or public bodies, the provision increases to one recharging station for every 20 parking spaces.

Recently, the Royal Decree-Law 17/2022 was approved to regulate active DR for installations with a power equal to or greater than 1 MW. This service is designed to be used during specific periods to ensure continuity of electricity supply in the event of a shortage of manually activated balancing energy in the system, such as the replacement reserve and tertiary regulation.

In the inaugural active DR auction in Spain, 16 participants took part and a total of 497 MW were allocated to the peninsula's power system. The successful bidders will receive a remuneration of 69.97 €/MW per hour for their availability during the established service period, which spans 2,714 hours.

On the other hand, currently in Spain, there is a lack of regulation regarding DR mechanisms for domestic consumers and small companies. Although the concept of the electricity aggregator, which refers to an entity that can offer DR services, was introduced into the electricity system through the Royal Decree-Law 23/2020, the specific aggregation model to be established at the national level has yet to be defined. This is due to the existence of different models with different impacts on all parties involved.

Buildings' response to needs of occupants

Regarding occupant's comfort and well-being, Royal Decree 1027/2007 on thermal installations in buildings includes indoor air quality requirements among others, which establishes the indoor comfort conditions that a building must satisfy in the design of its thermal installation. The parameters defined by this regulation include operating temperature, relative humidity, average air speed and turbulence intensity, radiant asymmetries, vertical temperature gradient and floor temperature (*Real Decreto 1027/2007 - Reglamento de Instalaciones Térmicas en los Edificios*, 2007).

At the same time, Spain has developed several databases where information on buildings can be found. There is the cadastre database[17], a publicly available database where data for the total Spanish building stock (residential and tertiary) regarding the year of construction, address, cadastral reference, usages and buildings' morphology (number of floors, floor areas, heights and shapes) are collected.

Also, there is the EPC database, where registrations are kept in territorial level and are not centralised, and each Autonomous Community has its own database as established by Royal Decree 390/2021.This data base collects data regarding the buildings' materials, technical equipment, energy consumptions, energy performance class, address, cadastral reference of buildings having an EPC (*Ministerio para la Transición Ecológica y el Reto Demográfico - Energía*, no date). The only nation-wide information of the EPC database available to the public is the EPC label of buildings. The accessibility of the rest of the data depends on the legislation of each Autonomous Community.

Regarding the DBL in Spain, it is represented by the "Libro Digital del Edificio". The Ministry of Transport, Mobility and Urban Agenda is responsible for the management of the logbook, although its competences are delegated to the Autonomous Communities. The book is currently being promoted through direct national aid and by including it in a compulsory document for renovation such as Royal Decree 853/2021.

4.6.2 Consultation with national stakeholders

According to Spanish stakeholders, even if it is difficult to quantify the impact of smartness and BACS in energy consumption at the moment, SRI is a useful instrument for the evaluation of the building of stock. It can provide a global picture of the national building stock and give policymakers information to develop specific policies for funding schemes that upgrade buildings mainly in the direction of the energy transition and the better integration of buildings into electricity grids. An interviewee notices that SRI could also be a useful instrument for engineers to make recommendations for new buildings.

[17] https://www.sedecatastro.gob.es/

In Spain, some universities and other associations have started to provide training on SRI tools, in a regular basis. Also, a test phase will start on October 2023 at the framework of SRI2MARKET project. There already have been some SRI assessments in tertiary, public and residential buildings, and the main insights were that SRI methodology is sufficient but it should also include quantitative evaluation of the impact of BACS and smartness on the energy performance of the building, and specifically on energy savings, and estimation of investment costs. Additionally, the SRI methodology needs to be calibrated to the climate and building topology of each country. At the same time in Spain, there is not any other active program specifically related to the upgrade of smartness, but in the national regulations there are some guidelines that oblige the installation of smartness (especially, monitoring and control technology) when a building is been renovated.

The interviewees are in favour of integrating SRI in the EPC, because the SRI assessment can be carried out with only a little additional effort when developing an EPC. But the integration has to be achieved only after the SRI instrument and its methodology have been tested. Also, all stakeholders involved in the EPC schemes consist the group of SRI's most relevant stakeholders. Regarding the adoption of the common EU DBL framework for storing buildings' data in Spain, a DBL could be a useful database for storing the results of SRI assessments, but it could not assist in the SRI assessment of a building because it could not contain all the required information.

Finally, an interviewee recognises the provision for mandatory implementation, the in-depth training of professionals on proper tools to conduct assessments and a methodology calibrated to country's particularities as the main conditions for ensuring the successful rollout of SRI and its reliable implementation.

5. SOAR analysis of the SRI instrument for the targeted MS

The purpose of this chapter is to summarize the analysis of the national policy contexts and their degree of alignment with the EU directives, with regards to their preparedness and progress toward the introduction of SRI to their national legislation. To do that, a SOAR analysis for the SRI instrument in each of the targeted MS will be presented.

5.1 Austria

Table 2. SOAR analysis of SRI instrument for Austria.

Strengths	Opportunities
• No other instrument relevant with smartness. • Valuable regulatory instrument for CO_2 reduction and energy flexibility. • Authorities and industry support SRI's credibility.	• The mandatory smart meters' deployment by 2024. • The promotion of (renewable) energy communities by the EAG-Paket. • The building stock digital databases. • The importance of BACS to increase energy efficiency and achieve the more immediate a climate-neutral goals by 2040.
Aspirations	**Results**
• Expansion of SRI to other building types. • More quantitative indicators to provide a stronger basis for measuring and achieving energy efficiency goals. • Increase SRI's reliability by assessing the usage of smart technologies and not just buildings' readiness and validating energy savings.	• The results of the ongoing test phase indicate that currently SRI methodology is not reliable because assumptions are not well justified and the services are not well defined.

5.2 Croatia

Table 3. SOAR analysis of SRI instrument for Croatia.

Strengths	Opportunities
• Smartness, through flexibility, increases the efficiency and performance. • SRI provides quantification of savings due to the installation and implementation of smart technologies.	• The electrification of the building sector brings risks to the distribution and transmission grids that can be overpassed by the implementation of smartness. • The provisions of the EPBD, EED, Energy Market Regulation and the accompanied deployment of new technologies and schemes. • There are already renovation schemes including smart technology installations.
Aspirations	**Results**
• The establishment of legislation, tools, and certification processes for SRI. • The integration of SRI into the EPC. • Introduction of SRI through an educational process similar to the introduction of EPCs.	• No results have been obtained, since SRI test phase started recently through the SRI2MARKET project.

5.3 Cyprus

Table 4. SOAR analysis of SRI instrument for Cyprus.

Strengths	Opportunities
• Ability to use and manage a building efficiently, with high performance and in order to satisfy occupants' well-being.	• DSO's obligation to proceed with appropriate actions for the widespread installation of smart meters for all electricity consumers. • Ongoing renovation schemes that include smartness or automation technology and the planned SRI test phase. • The introduction of energy communities in the legislation, since active customers may be interested in implementing smartness. • The electrification of the transport sector brings risks to the distribution grids that can be overpassed by the implementation of smartness. • Occupants' comfort requirements integrated in national legislation.
Aspirations	**Results**
• Contribute to zero-emission goals by correlating SRI's results with energy consumption. • The integration of SRI into the EPC.	• There are not any results obtained yet. • The success of the SRI implementation test phase will depend on the assessment of its outcomes and how they can be correlated with energy consumption and CO2 emissions.

5.4 France

Table 5. SOAR analysis of SRI instrument for France.

Strengths	Opportunities
• The smartness of buildings is necessary to decentralize the energy system and the renewable energy production. • The smartness of buildings is able to smoothen the curve of daily electricity demand. • Flexibility through smartness minimizes risks in the distribution grids. • Test phase including buildings of various usage type.	• The DR mechanisms are already significantly developed. • The implementation of the BACS decree will help the upgrade of the smartness of buildings through the activation of the related market. • The completed rollout of smart meters. • The provisions of the EPBD, EED, Energy Market Regulation and the accompanied deployment of new technologies and schemes. • Plethora of demonstration pilots of smart grids at district level supported by the energy and environment agency ADEME, the energy regulator CRE and the Ministry of Ecological Transition. • The electrification of the transport sector brings risks to the distribution grids that can be overpassed by the implementation of smartness. • In large non-residential buildings automation systems are already installed. • Exploitation of information from the common EU DBL.
Aspirations	**Results**
• Participation of SRI in the achievement of goals for zero-emission energy systems by 2050. • Expansion of SRI to all building categories, even to single family apartments. • Update of the EPC by integrating the SRI into it.	• Feedback from test phases that mentions challenges with the complexity of the service catalog, vocabulary, and functionality levels. Assessors face difficulties assigning functionality levels and require more guidance and examples. • Existing buildings achieve, in general, very low scores, indicating that the SRI goes beyond the present technology offers.

5.5 Portugal

Table 6. SOAR analysis of SRI instrument for Portugal.

Strengths	**Opportunities**
• Broad concept of smartness that can have different impacts depending on the type of building and its usage. • An informative tool that can generate conclusions on the de facto energy consumption and CO_2 emissions.	• A lot of new investments and new regulations related with flexibility are going on which means that there is need for flexibility. • SRI is included in key national strategies such as the Long Term Strategy for Builidng renovation, • SRI and BACSs have already been included in the regulatory framework and SRI has been integrated into the EPC legislation for possible implementation.

	• The existence of a platform to upload and retrieve all the information included in the EPC, boosts the roll out of SRI. • Wide rollout of smart meters and mandatory provisions for EV charging infrastructures. • Active customers may be interested in implementing smartness, so the governments boost to energy communities may offer opportunities for smartness.
Aspirations	**Results**
• Participation of SRI in the achievement of zero-emission energy systems goals by 2050, if there is further development to correlate SRI score with real energy consumption. • Wide implementation of SRI also in building types where it is not mandatory. • Inclusion of smartness and smart technologies as requirements into the public fundings for renovation.	• In discussions to implement start official test phase of the SRI. Some thoughts from the feedback from test phases mentions challenges on correlating the SRI score with real energy consumption and CO2 emissions, outcomes that depend on assessor's perspective and that the service catalog could lack details on technologies commonly implemented in South Europe.

5.6 Spain

Table 7. SOAR analysis of SRI instrument for Spain.

Strengths	Opportunities
• SRI can contribute to the energy transition by integrating buildings into the electricity grid, providing flexibility and DR capabilities. • SRI can provide policymakers with an overall picture of the building stock and help develop specific policies for funding and upgrading buildings. • SRI could be used to provide recommendations for new buildings.	• Mandatory requirements for BACS in lighting, heating, cooling, combined heating and ventilation or combined cooling and ventilation. • Obligations for installation of smartness when a building is renovated. • There already have been some SRI assessments in tertiary, public and residential buildings. • EPC stakeholders are also SRI stakeholders. EPC could integrate SRI. • Trainings on SRI tools are already launched by several institutions. • A test phase with at least 50 case studies across Spain will take place within the context of the SRI2MARKET project. • Some requirements regarding occupants' comfort and well-being are already included in the legislation.
Aspirations	**Results**
• Mandatory implementation of the SRI assessment to the whole building sector. • Update of the EPC by integrating the SRI into it. • Update of the SRI methodology to provide direct insights on energy consumptions and quantified	• Feedback from the first SRI assessments mentions that it should include quantitative evaluation of the impact of smartness on the energy performance of the building and estimation of investment costs, and it needs to be calibrated to

recommendations to improve performance and efficiency.	the climate and building topology of each country. • Current assessments conducted, lead to very low scores even for very sophisticated buildings.

5.7 Discussion

After exploring the national specificities and policy frameworks of each targeted MS and identified the context of each structural pillar of SOAR analysis at the national level, this chapter provides a comparison between the SOAR results of all countries to investigate to what extent similar or contrasting SOAR correspond to the targeted MSs and summarises the common SOAR conditions in a cross-country SOAR table (**Table 8**) filled with common conditions found in at least four targeted MSs.

The most common strength of smartness identified through the targeted MSs is the fact that by **increasing buildings' flexibility and performance, can contribute to the energy transition of the building sector without jeopardizing the reliability of distribution grids or increasing peak demand.** Also, the **well-being of occupants is considered a major strength** in Cyprus and Portugal, while in other targeted MSs, such as Croatia and Austria, the interaction with occupants is considered the least important aspect of smartness. At the same time, Cyprus is the only targeted MS that considers interaction with the grid as the least important aspect of smartness.

One of the major strengths of SRI in France is that buildings of various usage types were included in its test phase, allowing a more holistic evaluation of the instrument. Another main strength of SRI reported in Austria is the fact that it is the only tools currently developed to assess the smartness of buildings first tool that assesses the smartness of buildings. This could not be considered in France, where a smartness assessment tool already exists, although it is not widely utilized. A major strength identified for Spain is the fact that **SRI's results could provide an overall picture of the building sector to help policymakers develop specific policies for upgrading buildings**. This strength probably is valid in every targeted MS, but not reported.

Regarding the current trends and needs that SRI could capitalize on, the **widespread deployment of smart meters is considered an opportunity for SRI** in Austria, France, Portugal and Cyprus. Installing smart meters will assist on implementing smartness and evaluating its impact on buildings. In Croatia, Cyprus and Spain, **renovation schemes including smart technology installations** accompanied by relative obligations, already exist, while in France automation systems are already installed in large non-residential buildings. The **increasing appearance of smart technologies and schemes, such as BACS and DR, in all targeted MSs is identified as an opportunity for a smart readiness evaluation tool**, like SRI in order to quantify their impact on the performance of the building.

The **electrification of transportation and heating of buildings is also identified as an opportunity** in Croatia, Cyprus and France. Electrification is considered to be necessary for achieving the zero-emission energy systems goals by 2050, but may put risks in the reliability of the distribution and transmission networks. Interaction with the grid, as implemented in the context of smartness, could harvest these risks and ensure the reliable operation of the grid.

Additionally, **active customers** may be interest to voluntarily implement smartness along with energy production, so the **integration of energy communities** in legislation and governments' boost is identified as an opportunity for SRI in Austria, Cyprus and Portugal.

Regarding the aspirations for SRI, similar ones have been identified through all MSs. Specifically, the common aspiration between all targeted MSs is the **contribution of SRI into the zero-emissions goals** by updating the methodology to provide direct insights on energy consumptions and quantified recommendations to improve performance and efficiency. Moreover, **updating EPC to integrate SRI i**n it, is a common vision in Croatia, Cyprus, France and Spain, while Austria, France, Portugal and Spain aspire to expand SRI to other building types. The ambition of including smartness and smart technologies as requirements into the public fundings for renovation is reported only in Portugal.

Among the six targeted MSs, only Austria and France have already launched an SRI implementation test phase. Also, even though the formal SRI test phase in Spain will start in October 2023, some SRI assessments have already been conducted. Similar feedback was collected from all these countries. This feedback reports challenges with the complexity of the service catalog and its functionality levels, to the point where the outcome depends on assessor's perspective. Specifically in France, **assessors required more guidance and specific examples of the functionality levels**. Also, it is reported that **the service catalog lacks details on technologies implemented in South European countries, and that the methodology needs to be calibrated to the climate characteristics and building typology of each country**.

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Regarding the outcomes of the assessment, several relevant stakeholders mention that SRI schemes should include **quantitative evaluation of the impact of smartness on the energy performance of the building, such as savings on energy consumption and CO_2 emissions, and estimation of investment costs according to the services and functionality levels chosen**.

Finally, **the assessments conducted up to now, have resulted on very low scores even for very sophisticated buildings**, indicating that the SRI methodology is designed to be a forward-looking and futuristic instrument.

Table 8. Cross-country SOAR analysis of SRI instrument. Strengths, opportunities, aspirations and results identified in at least four of the targeted MSs.

Strengths	Opportunities
• Increasing buildings' flexibility and performance through smartness, can facilitate the energy transition of the buildings without compromising the reliability of distribution grids or increasing peak demand.	• The rise of smart technologies presents an opportunity for tools like SRI to assess their impact on building performance.
Aspirations	**Results**
• Increase the contribution of SRI into the zero-emissions goals by updating the SRI methodology to provide direct insights on energy consumptions and quantified recommendations for the improve of performance and efficiency. • EPC update to integrate SRI • Expansion of SRI to other building types.	• The test-phase feedback highlights challenges with the complexity of the service catalog and its functionality levels. • The SRI methodology is not country-tailored since it overlooks the climate characteristics and building typology of each country, and the service catalog lacks technologies implemented in South European countries, such as solar water heating systems.

6. Conclusions and policy recommendations

Smartness of buildings was recently identified as a new approach to enhance buildings' performance, mitigate peak demand, increase demand's flexibility and ultimately decrease the carbon footprint of the building sector. Apart from that, smartness aims to satisfy occupants comfort and well-being by employing active systems consistently throughout the entire year. The overall objective of this study is to investigate how ready and able are the targeted MSs, namely Austria, Croatia, Cyprus, France, Portugal and Spain, to integrate SRI into their national regulation, what actions are taken to this end and what are their future plans for the utilisation of SRI. For this purpose, a multi-method approach that included a preliminary participatory workshop with national stakeholders on "Progress so far and expectations from SRI", desk research on the policy context at the EU and national levels, consultation with national stakeholders and a SOAR analysis of the SRI instrument for the targeted countries, was conducted.

In **Austria**, despite the successful rollout of smart meters in almost all regions, the establishment of smart technologies and schemes, such as BACSs, smart EV charging stations and DR, along with on-site energy generation remains limited. These technologies and schemes are essential for developing smartness in buildings, and especially for satisfying the "response to the grid" and "efficiency and performance" aspects. Therefore, efforts should be made to ensure the rapid rollout and adoption of them. Specifically, national legislative framework regarding buildings' energy efficiency and performance should be updated to include stricter obligations for BACS installation when a building is built or renovated, while new energy efficiency upgrade funding programs should involve smart technologies to their eligible solutions. Information campaigns should be organised to inform citizens on the use of residential smart technologies and their benefits on energy management and consumption, and to eliminate their scepticism. Austria must design targeted initiatives for regions where the smart meters' adoption is limited, in order to achieve their rapid and homogenous uptake and facilitate consumption metering and DR to all building stock. Austria should design a robust DR mechanism and include it to the national legislation. This DR mechanism should be harmonised for all nine regions and involve buildings of a wide use and type variety, not just large company buildings. Smart EV chargers' deployment will be facilitated by the design of a regulatory frameworks for smart charging infrastructure developers, owners, operators and users, as well as the corresponding revenue streams. Additionally, this framework should involve strategies to fit smart charging to the generation mix and to standardize interoperability between EVs and supply equipment. Smart charging should be particularly focused in areas with high share of RES. In order to facilitate the deployment of on-site energy generation, Austria should harmonize the relevant legislation in all nine regions and increase the dissemination of relevant information to citizens. In order to enhance the "respond to the need of occupants" aspect of smartness, Austria should update its national Energy Performance of Buildings regulation to integrate provisions regarding occupants' comfort and well-being. Finally, a rational regulatory framework for the implementation of SRI should be developed to enhance its rollout. This framework should regulate the implementing entity and auditing authority, the type of buildings that are mandatorily or voluntarily included, and it should be based on the experience from the on-going test phases of all EU MSs.

In **Croatia**, there are active regulations on BACS, specific requirements on EV charging infrastructures, and smart technology installations are included in renovation schemes, but these could be intensified within the context of the provisions of the EPBD, EED and Energy Market Regulation. Also, energy storage is regulated but not widely implemented in building sector, therefore technology-push policies must be introduced, simultaneously. These requirements and regulations pave the way for the implementation of smartness, but are not sufficient enough. Grid operators in Croatia should accelerate smart meters' installation, targeting a wide variety of end-use buildings. Additionally, the net-metering schemes for on-site PV energy generation should be revised to enable and encourage feeding surplus electricity to the grid, while expansion measures for the DR market should be designed. The current obligations for EV charging infrastructures should be updated to include smart chargers after designing their legislation framework and their operational models. Considering the "respond to the need of occupants" aspect of smartness, Croatia should update its national legislation on energy performance of buildings in order to include criteria regarding occupants' comfort, well-being and health. Regarding SRI implementation, Croatia should educate professional assessors, design the business models that could implement SRI, initiate a test-phase and identify the suitable building typology for this purpose.

In **Cyprus**, several renovation schemes include the installation of smart technologies and automations while requirements regarding occupants' comfort and well-being are included in the national Energy Performance of Buildings Law. Also, there is extensive on-site RES generation regulated by schemes that permit self-consumption and supplying the grid, while funds are granted for an extensive network of EV charging stations to be developed. Smart meters are at the core of buildings' smartness, but Cyprus has not achieved enough towards this target. It should oblige DSOs to comply with the Energy Regulatory Authority's Decision and intensify their efforts to diffuse smart meters to their electricity consumers. Moreover, Cyprus should enhance the "response to the grid" aspect of building's smartness by establishing a legislative framework for EV smart charging installation and operation and developing targeted mandates for their diffusion in the building sector. Following the proposal of the SRI testing phase in Cyprus, the policymakers could exploit this opportunity to introduce SRI within the national building's legislation.

In **France**, the widespread implementation of smartness in buildings is facilitated by the following factors. The fact that smart meters' rollout is complete, that the DR market and related schemes are well-established, that on-site RES energy generation and consumption are regulated and that there are active requirements for BACS and heating automation systems for large buildings. Actions should be taken on creating incentives for the uptake of building-scale energy storage, because it will increase the flexibility of final consumption and enhance the "response to the grid" aspect of buildings' smartness. For the same purpose, mandates for installing EV smart charging infrastructures on public buildings should be designed, while the current funding schemes for residential EV charging infrastructures should be updated to direct their funds on smart chargers. The needs of occupants are addressed in buildings' performance national policy framework and especially in EPC's criteria, but it is limited just to summer passive comfort. The definition of occupants' comfort and well-being must be expanded to include all year comfort and to refer to active systems. France has gained a lot of experience from the successful launch of its SRI test phase, where the need of a more thorough training of the assessors on both SRI methodology and service catalogue arose as a main issue. Consequently, the educational courses for the certification of professional SRI assessors should be enriched with portfolio examples, guidance on functionality levels and robust mapping of the service catalogue.

In **Portugal**, SRI and smart technologies are already included in national legislation and integrated as as possibility in EPCs but an SRI test phase is not formally approved, and the implementation of smartness is not directly included in any funding scheme. Smart meters are widely installed but, at least until the end of 2021, most of them were not transmitting data, while there is not any regulatory framework for DR schemes or the functioning of smart charging stations for EVs in the national legislation. Towards enhancing flexibility of national building stock, Portugal should consider actions to oblige DSOs to complete the installation of smart meters on all consumption points, such as establishing innovative business models that create revenue streams towards the DSO and include smart chargers in EV charging infrastructures' mandates. Also, Portugal should establish specific legislation for the operation of the national DR market, and at the same time this market should be supported to increase the number of its participants. Regarding the "efficiency and performance" aspect of buildings' smartness, current energy efficiency upgrade funding schemes should be updated to include smart technologies and BACSs. Portugal should approve and initiate an official SRI implementation test phase.

Spain has already done actions that will facilitate the successful uptake of buildings' smartness. These actions include the establishment of BACS mandates in lighting and thermal systems, an almost complete rollout of smart meters, several schemes and fundings for self-consumption and energy storage, the regulation of RECs and their funding, smartness requirements for new or renovated buildings and the regulation of occupants' comfort and well-being requirements. Specifically, regarding SRI, the test phase is already officially planned and training courses on SRI tools are already held by several institutions. In order to support the "response to the grid" aspect of building' smartness, Spain should regulate and support the expansion of DR market to small businesses and residential buildings. Moreover, it should design smart technology funding schemes, including smart EV charging stations, and revise existing building mandates to integrate smart EV chargers.

The interviewed energy stakeholders from all targeted MSs admit that the the provisions of the EPBD, EED, Energy Market Regulation could benefit the deployment of SRI since they regulate the use of smart technologies, such as **solar-ready buildings, smart-meters rollout, BACS, boosting DR and storage, that are essential for developing buildings' smartness**, but at the same time SRI could facilitate the adoption of these smart technologies. Regarding the update of EPC and the integration of SRI into it, they insist that having two different certificates will be more complex and expensive for building owners and will hinder the successful roll-out of SRI. **Updating EPC framework by integrating SRI into it is the most practical and efficient option**, because both are based on information obtained through energy audits, they both provide information relevant to each other and will probably be carried out by the same professionals.

The **smartness of buildings and particularly SRI could assist on the effort to achieve the goals of zero-emission building stock and ultimately to zero-emission energy systems by 2050, but only if the methodology is updated**. **It should integrate more detailed climate information, be tailored to each country's particularities and make the selection of service levels less dependent on assessors' perspective**. Also, in order to ensure the successful implementation of an SRI scheme, each MS has to conduct a **thorough training of the assessors** on how to use the SRI assessment methodology and on the material of the service catalogue and its levels.

References

Apostolopoulos, V. *et al.* (2022) 'Smart readiness indicator evaluation and cost estimation of smart retrofitting scenarios - A comparative case-study in European residential buildings', *Sustainable Cities and Society*, 82(April), p. 103921. Available at: https://doi.org/10.1016/j.scs.2022.103921.

BOE-A-2013-3904 Real Decreto 235/2013, de 5 de abril, por el que se aprueba el procedimiento básico para la certificación de la eficiencia energética de los edificios. (2013). Available at: https://www.boe.es/buscar/act.php?id=BOE-A-2013-3904 (Accessed: 7 July 2023).

BOE-A-2021-4572 Real Decreto 178/2021, de 23 de marzo, por el que se modifica el Real Decreto 1027/2007, de 20 de julio, por el que se aprueba el Reglamento de Instalaciones Térmicas en los Edificios. (2021). Available at: https://www.boe.es/buscar/doc.php?id=BOE-A-2021-4572 (Accessed: 7 July 2023).

Brugger, H. *et al*. (2021) 'Energy Efficiency Vision 2050: How will new societal trends influence future energy demand in the European countries?', *Energy Policy*, 152. Available at: https://doi.org/10.1016/j.enpol.2021.112216.

Canale, L. *et al.* (2021) 'Estimating the smart readiness indicator in the italian residential building stock in different scenarios', *Energies*, 14(20), pp. 1–19. Available at: https://doi.org/10.3390/en14206442.

Cara Carmichael, R.E. and Taylor, E. (2021) *Grid-Interactive Efficient Buildings Made Easy: A GSA Building Manager's Guide to Low-and No-Cost GEB Measures*.

Carnet d'information du logement (CIL) | Service-public.fr (no date). Available at: https://www.service-public.fr/particuliers/vosdroits/F36759 (Accessed: 7 July 2023).

Consommation d'électricité -L'absence de compteur Linky en 2023 pourrait vous coûter près de 50 € par an ! | Service-public.fr (no date). Available at: https://www.service-public.fr/particuliers/actualites/A16180 (Accessed: 6 July 2023).

Al Dakheel, J. *et al*. (2020) 'Smart buildings features and key performance indicators: A review', *Sustainable Cities and Society*, 61, p. 102328. Available at: https://doi.org/10.1016/J.SCS.2020.102328.

Décret n° 2019-771 relatif aux obligations d'actions de réduction de la consommation d'énergie finale dans des bâtiments à usage tertiaire (2019) *Ministère de la Transition écologique et de la Cohésion des territoires*. Available at: https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000038812251 (Accessed: 6 July 2023).

Décret n° 2020-887 relatif au système d'automatisation et de contrôle des bâtiments non résidentiels et à la régulation automatique de la chaleur (2020) *Ministère de la Transition écologique et de la Cohésion des territoires*. Available at: https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000042128488/ (Accessed: 6 July 2023).

Décret n° 2020-1720 pour l'application des articles L. 111-3-8 et L. 111-3-9 du code de la construction et de l'habitation (2020) *Ministère de la Transition écologique et de la Cohésion des territoires*. Available at: https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000042748952 (Accessed: 6 July 2023).

Diagnostic de performance énergétique (2021) *Ministère de la Transition écologique et de la Cohésion des territoires Ministère de la Transition énergétique*. Available at: https://www.ecologie.gouv.fr/diagnostic-performance-energetique-dpe (Accessed: 6 July 2023).

Diário da República (2022) *Decreto-Lei 15/2022*, *Presidência do Conselho de Ministros*. Available at: https://dre.tretas.org/dre/4772926/decreto-lei-15-2022-de-14-de-janeiro (Accessed: 18 October 2023).

DIGITALEUROPE (2022) 'Paving the way towards a sustainable and digitalised European building sector', 32(April), pp. 1–10.

Economidou, M. *et al.* (2020) 'Review of 50 years of EU energy efficiency policies for buildings', *Energy and Buildings*, 225, p. 110322. Available at: https://doi.org/10.1016/j.enbuild.2020.110322.

energy.ec.europa.eu (2023) *What is the SRI?*, *energy.ec.europa.eu - An official website of the European Union*. Available at: https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/smart-readiness-indicator/what-sri_en (Accessed: 18 October 2023).

EuroACE (2022) *Feedback to the EPBD RECAST Proposal*. Available at: https://doi.org/10.1108/ss.2005.11023aab.001.

Europe, S.E. (2023) 'Policy recommendations on the Energy Performance of Buildings Directive trilogue negotiations smartEn comparative analysis of the positions of the 3', 32(April).

European Building Automation Controls Association (2022) *EPBD RECAST PROPOSAL - EU.BAC FEEDBACK*. Available at: https://eubac.org/wp-content/uploads/2022/04/2022.03.31_EPBD-revision_eubac-position-paper.pdf (Accessed: 18 October 2023).

European Commission (2021) 'Proposal for a Directive of the European Parliament and of the Council on the energy performance of buildings (recast)', *Official Journal of the European Union*, 0426, pp. 10–27.

European Parliament (2023a) *Amendments adopted by the European Parliament on 14 March 2023 on the proposal for a directive of the European Parliament and of the Council on the energy performance of buildings (recast)*. Available at: https://doi.org/10.1080/00344897208656356.

European Parliament (2023b) 'Revision of the Energy Performance of Buildings Directive: Fit for 55 package', (February).

European Parliament and Council of the European Union (2018) 'Directive (EU) 2018/2002 of the European Parliament and of the Council of 11 December 2018 amending Directive 2012/27/EU on energy efficiency', *Official Journal of the European Union*, 328(L), pp. 210–230.

Federal Act on the Expansion of Energy from Renewable Sources (Renewable Energy Expansion Act) (2023) *www.ris.bka.gv.at*. Available at: https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20011619 (Accessed: 6 July 2023).

Federal Ministry of Sustainability and Tourism (2019) *Integrated National Energy and Climate Plan for Austria 2021-2030*. Available at: https://energy.ec.europa.eu/system/files/2020-03/at_final_necp_main_en_0.pdf (Accessed: 27 July 2023).

Fokaides, P.A., Panteli, C. and Panayidou, A. (2020) 'How Are the Smart Readiness Indicators Expected to Affect the Energy Performance of Buildings: First Evidence and Perspectives', *Sustainability 2020, Vol. 12, Page 9496*, 12(22), p. 9496. Available at: https://doi.org/10.3390/SU12229496.

Gürel, E. and Tat, M. (2017) 'SWOT ANALYSIS: A THEORETICAL REVIEW Uluslararas Sosyal Araştrmalar Dergisi The Journal of International Social Research'. Cilt.

Instalação de contadores Inovgrid (2020) *E-REDES*. Available at: https://www.e-redes.pt/pt-pt/transicao-energetica/inovacao-e-desenvolvimento/campanha-de-instalacao (Accessed: 6 July 2023).

Installation de panneaux solaires : vous avez droit à des aides ! | economie.gouv.fr (2023). Available at: https://www.economie.gouv.fr/particuliers/aides-installation-photovoltaiques# (Accessed: 6 July 2023).

Janhunen, E. *et al.* (2019) 'Applicability of the smart readiness indicator for cold climate countries', *Buildings*, 9(4). Available at: https://doi.org/10.3390/buildings9040102.

Korkas, C.D. *et al.* (2016) 'Occupancy-based demand response and thermal comfort optimization in microgrids with renewable energy sources and energy storage', *Applied Energy*, 163, pp. 93–104. Available at: https://doi.org/10.1016/J.APENERGY.2015.10.140.

Li, L. (2020) 'The Management Implications of SWOT & SOAR Analysis of Classroom Dynamics A Case Study in China.', *Organization Development Journal*, 38(4).

Litiu, A.V. *et al.* (2021) 'The Smart Readiness Indicator for Buildings: Current Status and Next Steps', *The REHVA European HVAC Journal*, 58(3), pp. 28–33.

Loi n° 2021-1114 - Audit énergétique réglementaire (2021) *Ministère de la Transition écologique et de la Cohésion des territoires*. Available at: https://www.ecologie.gouv.fr/audit-energetique-reglementaire (Accessed: 18 October 2023).

MINISTERIO DE TRANSPORTES, M.Y.A.U. (2022) *Basic Document on Energy Saving*. Available at: https://www.codigotecnico.org/pdf/Documentos/HE/DcmHE.pdf (Accessed: 18 October 2023).

Ministerio para la Transición Ecológica y el Reto Demográfico - Energía (no date). Available at: https://energia.gob.es/es-es/Paginas/index.aspx (Accessed: 7 July 2023).

Official Journal of the European Communities (2003) *DIRECTIVE 2002/91/EC on the energy performance of buildings*.

Official Journal of the European Union (2010) *DIRECTIVE 2010/31/EU on the energy performance of buildings (recast)*.

Official Journal of the European Union (2019) *COMMISSION RECOMMENDATION (EU) 2019/1019 on building modernisation*.

OIB-Richtlinie 6 Energieeinsparung und Wärmeschutz (2019). Available at: https://www.oib.or.at/sites/default/files/richtlinie_6_12.04.19_1.pdf.

OIB-Richtlinien 2019 | OIB (2019) *Austrian Institute of Construction Engineering*. Available at: https://www.oib.or.at/en/oib-richtlinien/richtlinien/2019 (Accessed: 6 July 2023).

PLANO NACIONAL ENERGIA E CLIMA 2021-2030 (PNEC 2030) (2020). Available at: https://diariodarepublica.pt/dr/detalhe/resolucao-conselho-ministros/53-2020-137618093 (Accessed: 7 July 2023).

Portuguese Government (2021) *Ministers Resolution 8-A/2021 - Long-term Strategy for the Renovation of Buildings*.

Programa de Incentivos a proyectos piloto singulares de comunidades energéticas (CE IMPLEMENTA) | Idae (2022) *Ministerio para la Transición Ecológica y el Reto Demográfico*. Available at: https://www.idae.es/en/node/25209 (Accessed: 7 July 2023).

Ramdhani, F.R., Srisusilawati, P. and Ibrahim, M.A. (2020) 'Strategi Pengembangan Pariwisata Syariah di Kota Bandung dengan Menggunakan Pendekatan Analisis SOAR', *Prosiding Hukum Ekonomi Syariah*, 6(2), pp. 226–230.

Ramezani, B., Silva, M.G. da and Simões, N. (2021) 'Application of smart readiness indicator for Mediterranean buildings in retrofitting actions', *Energy and Buildings*, 249, p. 111173. Available at: https://doi.org/10.1016/J.ENBUILD.2021.111173.

Real Decreto 1027/2007 - Reglamento de Instalaciones Térmicas en los Edificios (2007).

Rinaldi, K.S., Bunnen, E. and Rogers, S. (2019) 'Residential Grid-Interactive Efficient Building Technology and Policy: Harnessing the power of homes for a clean, affordable, resilient grid of the future. https://naseo.org/data/sites/1/documents/publications/AnnDyl-NASEO-GEB-Report.pdf';, (October).

Siemens Switzerland and Delta-EE (2021) 'The grid interactive building'.

Smart Energy Demand Coalition (2016) *Explicit and Implicit Demand-Side Flexibility Complementary Approaches for an Efficient Energy System*. September. Available at: https://smarten.eu/wp-content/uploads/2016/09/SEDC-Position-paper-Explicit-and-Implicit-DR-September-2016.pdf (Accessed: 9 October 2023).

Varsami, V. and Burman, E. (2021) 'An Evaluation of the Smart Readiness Indicator proposed for Buildings'.

Verbeke, S. *et al.* (2020) 'Final Report on the Technical Support to the Development of a Smart Readiness Indicator for Buildings.'

Vigna, I. *et al.* (2020) 'Analysis of the Building Smart Readiness Indicator Calculation: A Comparative Case-Study with Two Panels of Experts', *Energies 2020, Vol. 13, Page 2796*, 13(11), p. 2796. Available at: https://doi.org/10.3390/EN13112796.

Vilppu Eloranta (2020) *APPLICABILITY EVALUATION OF SMART READINESS INDICATOR FOR BUILDINGS*. Available at: https://lutpub.lut.fi/bitstream/handle/10024/161468/Master%27s_thesis_Eloranta_Vilppu.pdf?sequence=1&isAllowed=y (Accessed: 18 October 2023).

Appendix A

	No	Questions for the national policy context
SRI	1	How is smartness of buildings considered in the current national legislation? What is the current status of SRI implementation in your country?
Buildings energy performance and operation	2	What are the most up-to-date energy performance requirements and standards for the different building categories (i.e., buildings owned or occupied by public authorities, new and existing buildings)?
	3	Are there any particular requirements for automation and electronic monitoring and control of technical building systems? How is the smart meters rollout progressing in your country?
Buildings' response to needs of the grid	4	What are the active or planned policy schemes for buildings on-site energy generation and storage (e.g., net-metering, net-billing, feed in tariff) and how is the current legislative framework addresses the concept of active customers that own, lease or rent storage and generation facilities and potentially also share excess production?
	5	What is your country's legislative framework for citizen energy communities and renewable energy communities? Are there any provisions in your national energy market legislation related to decentralized smart grids operating at district level?
	6	What is the current status of the legislative framework regarding (smart) charging infrastructure for electric vehicles in buildings?
	7	What is the current situation regarding the demand-response market in your country?
Buildings' response to needs of occupants	8	Is there any active database about building's data in your country? If yes, what kind of data are stored and who has access? How the EU framework on the Digital Building Logbook advances in your country?
	9	Is occupants' comfort and well-being considered in the current energy performance of buildings legislation?

Appendix B

Questions on the new EU regime for SRI.			
	No	Question	Supplementary material
Strengths	1	How do you consider the concept of smartness of buildings? What do you think makes SRI a valuable regulatory instrument? What gap do you see in the current regulatory framework that SRI aims to fulfill?	
Opportunities	2	Which of the new provisions of the EPBD, EED, Energy Market Regulation do you see as opportunities for the SRI instrument deployment and why (e.g. solar-ready buildings, smart-meters rollout, BACS, boosting demand-response and storage, active customers)?	The proposal for a revised EED and EPBD stipulates that all new buildings must be "solar-ready". This means that they should be designed with the intention of optimizing solar generation potential, allowing for the installation of solar technologies without having to make costly structural modifications. That will enable the cost-effective installation of solar technologies at a later stage.

Aspirations	3	To what extent, according to your opinion and experience, can SRI contribute to the goal of zero-emission building stock and ultimately to zero-emission energy systems by 2050?	Zero-emission buildings are considered "buildings with a very high energy performance in line with the energy efficiency first principle, and where the very low amount of energy still required is fully covered by energy from renewable sources at the building or district or community level where technically feasible (notably those generated on-site, from a renewable energy community or from renewable energy or waste heat from a DH and cooling system)". Beyond covering their little energy requirements with renewable energy, zero-emission buildings should be equipped with measuring and control devices for the monitoring and regulation of indoor air quality."
Results	4	Do you think that SRI rollout should be directly related with Building Automation and Control Systems (BACS) deployment? Should SRI be mainly used for the assessment of large non-residential buildings, as suggested in the recent proposal for the revision of the EPBD? If not in what other types of buildings should SRI be expanded/ tested (e.g., buildings owned or occupied by public authorities and residential buildings)?	In the 2021 proposal for the revision of the EPBD, it is acknowledged that the smart readiness indicator is of particular relevance to large buildings with high energy demand, and thus it is envisaged to make SRI evaluation obligatory for non-residential buildings with an effective rated output for heating systems, or systems for combined space heating and ventilation of over 290 kW by 2026. 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 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. Buildings owned or occupied by public authorities are placed at the forefront of the efforts towards a decarbonised building stock by 2050 according to the provisions of the proposal for a revised EED.
Questions on the national regime for SRI.			
Strengths	5	What are the current experiences with SRI in your country? - Have there been any applications, what are you aiming for, etc? How is the test-phase of SRI progressing? Have you evaluated/Do you plan to evaluate specific types of buildings during the test-phase?	Austria, Croatia, France, (Czech Republic, Finland and Denmark) are already proceeding with a test phase.

Opportunities	6	Are there any active or planned programs/initiatives related to the upgrade of the smartness of buildings in your country - that could potentially facilitate the uptake of SRI? Which of the aspects of smartness of buildings do you consider as more relevant, in particular, for your country? Are there any other tools that assess the smartness of buildings in your country?	
	7	Do you think that the current format of SRI calculation methodology is sufficient for assessing the smart readiness of buildings? (considering national particularities and different typologies of buildings). Have you implemented or tested any adaptations to the common EU methodology based on your national particularities and what gaps in the current methodology do you aim to cover?	
	8	Do you believe that integrating the SRI calculation into the EPC assessment methodology would be beneficial for the roll-out? Do you think that the adoption of the common EU Digital Building Logbook framework for storing buildings' data particularly relevant for SRI rollout?	
Aspirations	9	According to your experience, who are the most relevant/interested stakeholder groups about SRI and how SRI may address their needs?	
Results	10	What measures may ensure the successful rollout of SRI as well as the reliable implementation of the SRI assessment in your country?	

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