# Towards Integrated Building Assessment: A Unified Certificate for Energy Performance and Smart Readiness

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# Towards Integrated Building Assessment: A Unified Certificate for Energy Performance and Smart Readiness

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**Abstract.** The increasing complexity of the European Union's building performance regulations, particularly following the recast Energy Performance of Buildings Directive (EPBD 2024), underscores the necessity of harmonizing parallel certification schemes. In this context, the Smart Readiness Indicator (SRI), designed to assess the capacity of technical building systems to optimize energy use, adapt to occupants' needs, and interact with the grid, is progressively being introduced across Member States. Simultaneously, the Energy Performance Certificate (EPC), a long-established tool, continues to evolve towards greater granularity and utility. Despite their complementary scope, these instruments have historically been developed and implemented in isolation.

This study presents a unified certification approach developed within the framework of the SmarterEPC project [1], aiming to visually and functionally integrate EPC and SRI results into a single, modular document. The proposed joint certificate consolidates mandatory and optional indicators from both schemes and is fully aligned with the EPBD 2024 and SRI Delegated Regulation requirements. Emphasis is placed on user-centric design principles, modularity for national adaptability, and visual clarity to enhance stakeholder engagement.

The work introduces the conceptual design of the joint certificate, elaborating on the standardised metrics, classification schemes, and data visualisation techniques employed to support both compliance and informed decision-making. Through this integration, the joint certificate not only reduces administrative complexity but also provides a holistic view of building performance, facilitating investment, renovation planning, and policy enforcement. The proposed approach reflects a forward-looking shift toward digital, interoperable, and action-oriented assessment tools, ultimately fostering the decarbonisation and digitalisation of the EU building stock.

## 1. Introduction

As Europe advances its climate and energy goals, the regulatory framework governing building performance has become increasingly complex. Key among the existing instruments is the Energy Performance Certificate (EPC), which has long served as the standard tool for assessing and disclosing the energy efficiency of buildings under the Energy Performance of Buildings Directive (EPBD). More recently, the introduction of the Smart Readiness Indicator (SRI) through Commission Delegated Regulation (EU) 2020/2155 [2] has expanded the scope of assessment by evaluating a building's capacity to respond dynamically to user needs and external signals such as energy grid fluctuations.

While both instruments contribute valuable insights, their parallel and often separate implementation has led to overlaps, inefficiencies, and a fragmented user experience. Building owners, occupants, and professionals are frequently required to interpret two distinct certificates, often issued at different times, using different formats, and with limited interoperability. This fragmentation complicates compliance and hinders the broader uptake of smart and sustainable building practices.

With the adoption of the recast EPBD (Directive (EU) 2024/1275) [3], there is now a clear policy direction toward greater digitalisation, improved user accessibility, and the integration of performance data across systems. This evolving context has created a strong rationale for bringing the EPC and SRI into a unified format that better serves both regulatory and market needs.

The SmarterEPC project [1], supported by the LIFE Programme, responds to this challenge by developing and testing a joint certificate that integrates EPC and SRI assessments into a single, modular, and digitally compatible document. This paper presents the conceptual foundation, design process, and validation of the proposed certificate. Particular attention is given to regulatory alignment, stakeholder input, visual communication strategies, and the broader implications for future certification practice and building data governance in the EU.

## 2. Methodology

### *2.1 Conceptual Approach*

Developing a joint EPC-SRI certificate required reconciling differences in regulatory context, calculation methodologies, and end-user expectations. To guide this process, the design approach was built around three core principles: (i) regulatory alignment with EPBD 2024 (Annex V) [3] and the SRI Delegated Regulation (Annex IX) [2]; (ii) functional integration of overlapping and unique indicators; and (iii) structural and visual coherence within a single, user-friendly format.

At the heart of this conceptual foundation was the recognition that while EPCs and SRIs assess different aspects of building performance (energy efficiency and technological adaptability, respectively) they often rely on shared data inputs. For example, details about HVAC systems, control mechanisms, or energy sources are relevant to both. This overlap created an opportunity to develop a consolidated architecture that minimises redundancy while maximising clarity.

The broader policy context also informed this approach. With the European Green Deal and the Renovation Wave [5] pushing for smarter, more integrated building performance tools, there was a strong rationale for convergence, not only in terms of metrics and data, but also in how the information is presented and used by building professionals, policymakers, and occupants.

*2.2 Data Framework Alignment*

To translate the concept into practice, structured data templates were developed and circulated among project partners. The EPC template focused on building geometry, system configuration, operational energy use, and on-site renewable energy. The SRI template was centred on system functionalities, automation capabilities, control strategies, and responsiveness to external signals.

Once completed, the templates were analysed comparatively to identify common data points, mismatches, and dependencies. Several key parameters, such as heat generation type, control interface, and storage presence, emerged as areas of overlap. These were mapped into a unified data model that could feed both the EPC and SRI calculation engines, with minimal duplication of effort.

A scoring equivalence model was introduced to address differences in assessment logic. While EPC scores reflect energy demand and emissions, SRI scores measure the potential for smart optimisation. The model helped ensure consistency in data handling, even when the two frameworks required different outputs from the same input fields.

*2.3 Iterative Design*

Two structured roundtable discussions played a pivotal role in shaping the final design of the joint certificate. These sessions focused on evaluating the inclusion of data fields commonly used in national EPCs, assessing the visibility and interpretability of SRI components, and reviewing early-stage visual layout prototypes. Particular attention was given to user-centric features, including colour-coded performance scores, layout modularity, and the clarity of actionable recommendations.

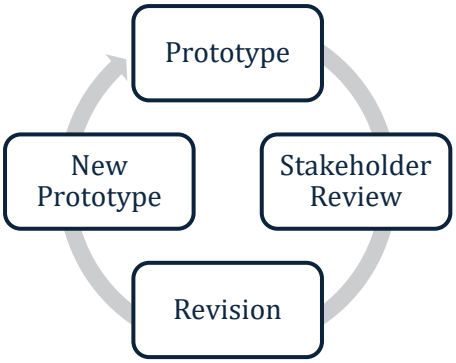



**Figure 1** Iterative Design process

Insights gathered from these discussions prompted a significant redesign. High-level indicators and mandatory elements were repositioned on the front page to enhance immediate readability, while detailed tables, voluntary indicators, and explanatory content were relocated to a secondary, supporting page. Furthermore, several stakeholders highlighted the need for alignment with the evolving structure of the Digital Building Logbook, which was subsequently incorporated into the design roadmap.

*2.4 Visual Integration and Technical Design*

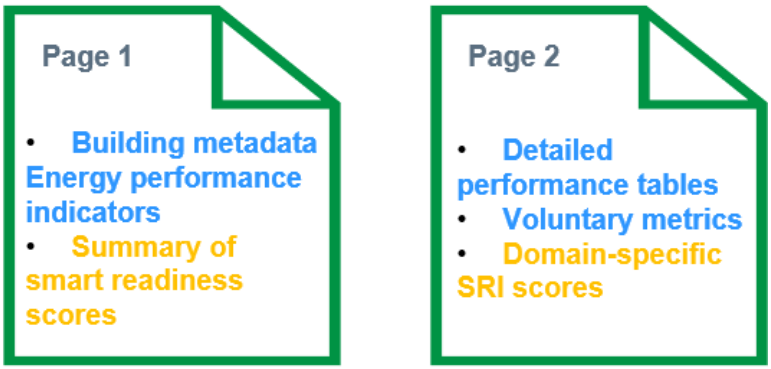



**Figure 2** Two-page modular certificate

The final certificate was designed as a two-page document, with a modular layout that supports clarity and adaptability. The first page presents building metadata, energy performance indicators, and a summary of smart readiness scores. The second page contains detailed performance tables, voluntary metrics, and domain-specific SRI scores.

Technical mock-ups were developed in Adobe Illustrator and evaluated through user experience (UX) testing, including eye-tracking studies. These tests informed improvements to visual hierarchy, text legibility, and colour use. The final layout adheres to WCAG accessibility standards, ensuring that it remains inclusive across a range of user profiles.

## 3. Results: Structure of the Joint Certificate

### *3.1 Overview*

The Joint EPC-SRI Certificate has been developed as a harmonised, two-page document that consolidates both energy performance and smart readiness indicators in accordance with the recast Energy Performance of Buildings Directive (EPBD 2024) Annex V [1] and the Smart Readiness Indicator (SRI) Delegated Regulation Annex IX [2]. The design ensures compliance with regulatory requirements while supporting a high degree of visual interpretability and user engagement.

The EPC section of the certificate encompasses all mandatory indicators as defined by the EPBD, including calculated primary and final energy use (kWh/$m^2$·year), metered consumption, renewable energy share, operational greenhouse gas emissions ($kgCO_2/m^2$·year), and the assigned energy performance class (A–G). Voluntary EPC indicators include the building envelope U-values, theoretical energy needs, availability of renovation passports, digital building logbook status, reactivity to external signals, and the presence of energy storage and electric vehicle (EV) charging infrastructure.

In parallel, the SRI portion presents the total smart readiness score and class, disaggregated domain scores across nine technical systems, and performance metrics aligned with the three core functionalities: (i) optimisation of energy efficiency, (ii) adaptation to occupant needs, and (iii) responsiveness to grid signals. Mandatory fields include system-level recommendations and the scoring methodology, while voluntary data may comprise cybersecurity features, interoperability readiness, broadband infrastructure, and high-speed connectivity.

The final design of the joint certificate is shown in **Figures 3** and **4**. The certificate layout comprises the following structural elements:

- A left-hand column for traditional EPC metrics
- A right-hand column for SRI metrics
- Icons and infographics to aid interpretation
- Clear segmentation for visual usability

This design framework supports a modular and scalable approach that is adaptable to both national implementation and evolving regulatory landscapes.

### *3.2 Metric Harmonisation and Indicator Integration*

The integration of EPC and SRI indicators required the alignment of underlying data models, scoring systems, and presentation formats. The energy performance section reports calculated and metered consumption values, primary and final energy demand, and the proportion of renewable energy generated on-site. Greenhouse gas emissions are quantified both operationally and, where available, on a life-cycle basis.

Smart readiness is categorised into three impact functionalities and supported by nine technical domains including heating, cooling, ventilation, domestic hot water (DHW), lighting, dynamic envelope elements, electricity, EV charging, and monitoring and control systems. Each domain is assessed for automation capabilities, user interaction, and system responsiveness.

Additional harmonised indicators integrated across both EPC and SRI components include:

- Carbon dioxide intensity ($kgCO_2/m^2/year$)
- Annual energy carrier loads by end-use (heating, cooling)
- Indoor Environmental Quality (IEQ) controls (e.g., $CO_2$ monitoring, humidity sensors)
- Availability of a digital building logbook and renovation passport
- System response features, including load flexibility and reactivity to external grid signals

This consolidation minimises data duplication and streamlines input procedures for energy auditors and building professionals.

*3.3 Visual Composition and Accessibility Enhancements*

To maximise interpretability and cross-stakeholder usability, the certificate incorporates a range of visual communication strategies:

- Vertical bar graphs representing energy performance classes (A to G)
- Radar charts and horizontal bars to convey domain-level SRI scores
- Visual distinction between mandatory and voluntary fields using shading and iconography
- Functional icons representing EV charging, energy storage, logbook integration, and smart sensors
- Highlighted alerts (e.g., exclamation symbols) to indicate underperformance and encourage remedial action

The presentation of EPC and SRI metrics side-by-side was validated during user workshops as a preferred format, enhancing comparative analysis and behavioural insights. These design elements collectively foster user trust, improve accessibility, and support informed decision-making.

## List of Acronyms

| Acronym | Definition |
|---|---|
| API | Application Programming Interface |
| BAC | Building Automation and Control |
| BACS | Building Automation and Control Systems |
| DHW | Domestic Hot Water |
| EPC | Energy Performance Certificate |
| EPBD | Energy Performance of Buildings Directive |
| EU | European Union |
| GDPR | General Data Protection Regulation |
| IEQ | Indoor Environmental Quality |
| JSON | JavaScript Object Notation |
| PV | Photovoltaic |
| RES | Renewable Energy Sources |
| SRI | Smart Readiness Indicator |
| UX | User Experience |
| XML | Extensible Markup Language |

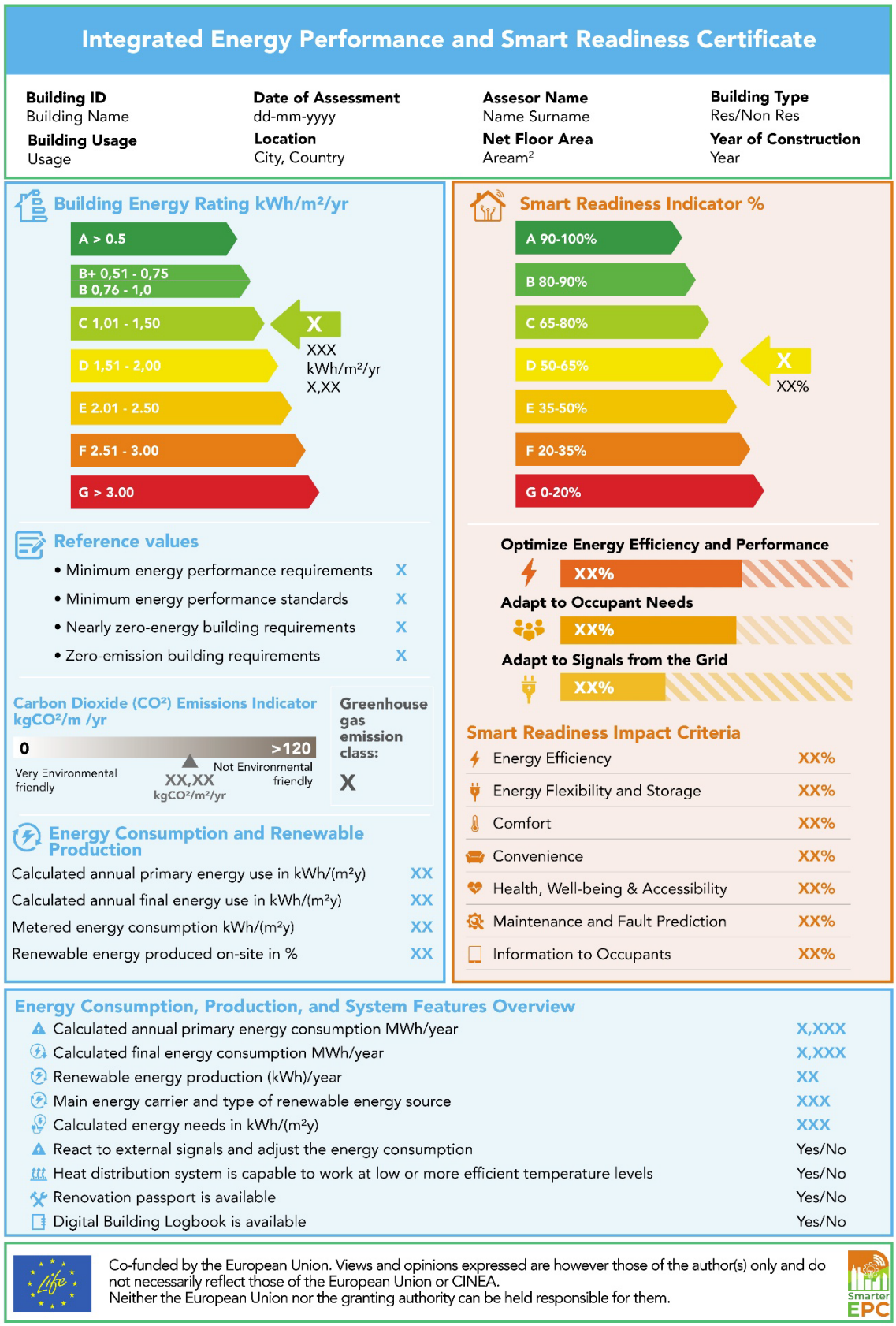
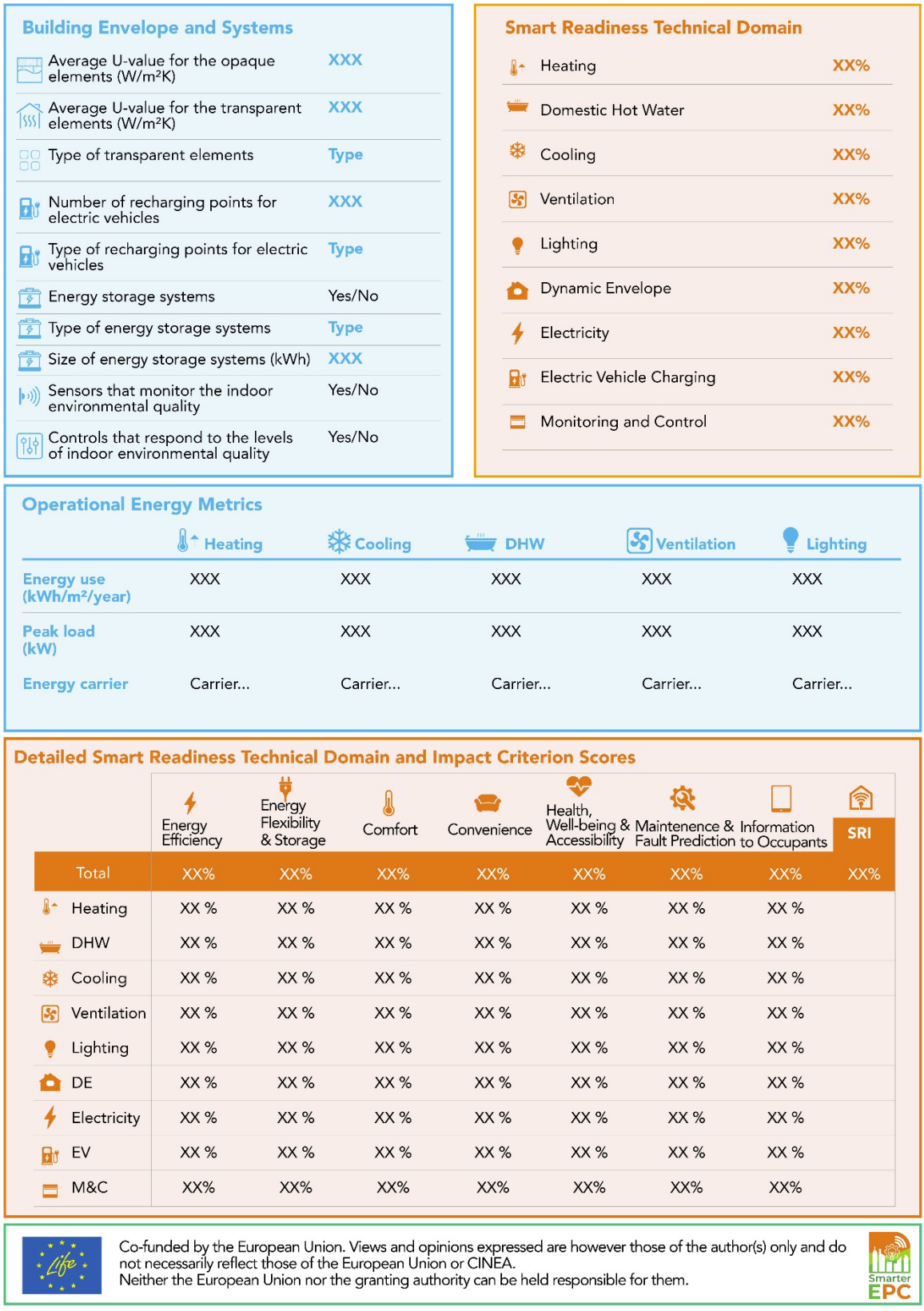



**Figure 3** Front page of the Joint EPC-SRI Certificate



**Building Envelope and Systems**

| | |
|---|---|
| Average U-value for the opaque elements (W/m²K) | XXX |
| Average U-value for the transparent elements (W/m²K) | XXX |
| Type of transparent elements | Type |
| Number of recharging points for electric vehicles | XXX |
| Type of recharging points for electric vehicles | Type |
| Energy storage systems | Yes/No |
| Type of energy storage systems | Type |
| Size of energy storage systems (kWh) | XXX |
| Sensors that monitor the indoor environmental quality | Yes/No |
| Controls that respond to the levels of indoor environmental quality | Yes/No |

**Smart Readiness Technical Domain**

| | |
|---|---|
| Heating | XX% |
| Domestic Hot Water | XX% |
| Cooling | XX% |
| Ventilation | XX% |
| Lighting | XX% |
| Dynamic Envelope | XX% |
| Electricity | XX% |
| Electric Vehicle Charging | XX% |
| Monitoring and Control | XX% |

**Operational Energy Metrics**

| | Heating | Cooling | DHW | Ventilation | Lighting |
|---|---|---|---|---|---|
| Energy use (kWh/m²/year) | XXX | XXX | XXX | XXX | XXX |
| Peak load (kW) | XXX | XXX | XXX | XXX | XXX |
| Energy carrier | Carrier... | Carrier... | Carrier... | Carrier... | Carrier... |

**Detailed Smart Readiness Technical Domain and Impact Criterion Scores**

| | Energy Efficiency | Energy Flexibility & Storage | Comfort | Convenience | Health, Well-being & Accessibility | Maintenence & Fault Prediction | Information to Occupants | SRI |
|---|---|---|---|---|---|---|---|---|
| Total | XX% | XX% | XX% | XX% | XX% | XX% | XX% | XX% |
| Heating | XX % | XX % | XX % | XX % | XX % | XX % | XX % | |
| DHW | XX % | XX % | XX % | XX % | XX % | XX % | XX % | |
| Cooling | XX % | XX % | XX % | XX % | XX % | XX % | XX % | |
| Ventilation | XX % | XX % | XX % | XX % | XX % | XX % | XX % | |
| Lighting | XX % | XX % | XX % | XX % | XX % | XX % | XX % | |
| DE | XX % | XX % | XX % | XX % | XX % | XX % | XX % | |
| Electricity | XX % | XX % | XX % | XX % | XX % | XX % | XX % | |
| EV | XX % | XX % | XX % | XX % | XX % | XX % | XX % | |
| M&C | XX% | XX% | XX% | XX% | XX% | XX% | XX% | |

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**Figure 4** Second page of the Joint EPC-SRI Certificate

## 4. Discussion

Bringing together the EPC and SRI into a single certificate marks an important step toward simplifying how we assess and communicate building performance in Europe. Instead of requiring stakeholders to interpret two separate documents, the integrated certificate offers a unified view that combines energy efficiency and smart readiness in a format that's both informative and easier to use.

For building owners and tenants, this means less confusion and more actionable information. They can see not only how energy-efficient a building is, but also how responsive and adaptable its systems are to user needs and external signals. The use of colour-coded indicators, clear layout structure, and tailored recommendations makes the information more accessible, even to non-technical users.

Public authorities also benefit from the integration. The joint certificate helps them track compliance more efficiently and supports national and EU-level goals related to renovation and digitalisation. By presenting key indicators side by side, the certificate aligns directly with the goals set out in Articles 16 and 17 of the recast EPBD [3], especially the push toward more transparent, user-friendly certification systems.

At the policy level, the joint approach is well-timed. It fits into broader efforts like the Digital Building Logbook, the Renovation Wave, and the EU Taxonomy Regulation [5][6], offering a tool that is flexible enough to serve multiple regulatory and financial functions. For example, by combining data on energy use and smart features, the certificate could serve as a supporting document when applying for green financing or assessing a building's sustainability profile.

On the technical side, the project team has paid close attention to ensuring that the certificate is ready for digital integration. With structured formats like XML and JSON, and an API already in development, the certificate can interface with facility management tools, databases, and potentially even smart meters or dashboards. It's designed not just as a static PDF, but as a living digital asset that can support real-time updates, future services, and customised user experiences.

That said, several challenges remain. EPC and SRI assessments rely on different data inputs and calculation rules, which can make harmonisation difficult in practice. Not all Member States have the same level of readiness for SRI implementation, and in some cases, national frameworks may need to evolve before a joint certificate can be deployed effectively. There are also open questions about how to manage certificate updates, especially when systems or scores change over time. Data privacy and cybersecurity will be important issues as digital certification becomes more widespread.

Even so, the joint certificate represents a promising step forward. It shows that it's possible to streamline existing tools, improve the user experience, and meet the growing demands for digitalisation and sustainability. The SmarterEPC project has demonstrated that with the right mix of stakeholder input, regulatory alignment, and design thinking, we can build certification systems that are both technically robust and genuinely useful.

## 5. Conclusion

This paper has outlined the development of a unified EPC-SRI certificate, designed and tested within the framework of the SmarterEPC project. By combining legal analysis, technical integration, stakeholder consultation, and iterative design, the project has delivered a practical and policy-aligned solution that responds to the evolving needs of building performance certification in the EU.

The joint certificate offers clear added value: it improves usability for end-users, reduces administrative complexity for professionals, and reinforces the coherence of European building policy. Presenting energy efficiency and smart readiness indicators side by side allows for a more comprehensive understanding of building performance, one that reflects not only current energy use but also future adaptability and digital potential.

As the EU moves toward a more connected, decarbonised, and user-centric building stock, tools like this certificate can play a central role. By supporting interoperability with digital building logbooks, renovation passports, and smart service platforms, the certificate lays the groundwork for deeper integration into national and European data infrastructures.

Looking ahead, the focus will shift to pilot deployment, stakeholder feedback, and ongoing refinement. The longer-term ambition is to evolve the certificate from a static document into a dynamic digital resource, capable of supporting real-time performance monitoring, personalised renovation guidance, and alignment with broader policy and financial instruments.

## Acknowledgment

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AI was used to edit the manuscript for language clarity. All outputs were reviewed, validated, and, where necessary, revised prior to submission; responsibility for the manuscript's content and results remains with the authors.

## References

[1] SmarterEPC – Smarter Energy Performance Certificates: Integrating smart readiness aspects into buildings' energy certification and tools for market uptake, LIFE22-CET-SMARTER-EPC, Project ID: 101121034, LIFE Programme, European Commission. Available at: https://webgate.ec.europa.eu/life/publicWebsite/project/LIFE22-CET-Smarter-EPC-101121034

[2] Commission Delegated Regulation (EU) 2020/2155 of 14 October 2020 supplementing Directive (EU) 2010/31/EU of the European Parliament and of the Council by establishing an optional common European Union scheme for rating the smart readiness of buildings, recital (7).

[3] DIRECTIVE (EU) 2024/1275 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 24 April 2024 on the energy performance of buildings (EPBD), article 15.

[4] European Commission. The European Green Deal, COM(2019) 640 final, Brussels, 11 December 2019. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52019DC0640

[5] European Commission, 'Renovation Wave for Europe – greening our buildings, creating jobs, improving lives', COM(2020) 662 final

[6] European Commission. (2023). 'EU Taxonomy for sustainable activities: Technical screening criteria for buildings'