Bridging the Gap: A Comprehensive Review of EPC and SRI Calculation Tools in Europe

Theoklitos Klitou
Euphyia-Tech Ltd,
Nicosia, 2408,,
Cyprus

Nicky Pavlou
Euphyia-Tech Ltd
Nicosia, 2408,
Cyprus

Cécile Barrère
R2M Solution SAS
Roquefort les Pins, 06330,
France

Sophie Dourlens-Quanranta
R2M Solution SAS
Roquefort les Pins, 06330,
France

Sara Momi
R2M Solution SRL
Pavia, 27100,
Italy

Thomas B. Messervey
R2M Solution SRL
Pavia, 27100,
Italy

Aleksi Vuorenmaa
Caverion
Vantaa, 01650,
Finland

Siiri Lapila
Caverion
Vantaa, 01650,
Finland

Despina Elisabeth Filippidou
OPSIS Research
Bucharest, 51083,
Romania

Paris A. Fokaides
Euphyia-Tech Ltd,
Nicosia, 2408,
Cyprus

***Abstract*—This study provides an in-depth analysis of the landscape of Energy Performance Certificates (EPC) and Smart Readiness Indicator (SRI) calculation tools within the European Union, addressing critical gaps and deficiencies in current methodologies and systems. Through field research, literature review, and extensive engagement with stakeholders, this research offers a comprehensive assessment of existing tools based on a range of criteria, including data collection practices, backend methodologies, user experience, and interoperability among others. Particular emphasis is placed on the emerging generation of tools developed through the NextGenEPC projects, highlighting innovations and advancements in the field. A key output of this research is the introduction of a European atlas of EPC and SRI tools, offering a panoramic view and comparative analysis of the tools available across EU member states. This atlas is envisioned as a pivotal resource for technical partners, market participants, and policymakers, providing critical insights into prevailing practices and fostering the adoption of harmonized, efficient tools for smarter and more sustainable buildings. The study aims to identify areas for improvement and potential pathways for the development of more efficient, user-friendly, and interoperable tools, thereby contributing to the enhancement of building energy performance and smart readiness assessments across Europe.**

Keywords: Smart Readiness Indicator (SRI), Energy Performance Certificates (EPC), EPC EU Atlas, SRI EU Atlas.

I. Introduction

The urgency of preventing climate change necessitates sustainable development within the built environment, a sector responsible for a significant portion of global energy consumption and carbon emissions [1]. The European Union (EU) has been proactive in addressing these challenges, implementing innovative policies aimed at enhancing energy efficiency and intelligent building management [2]. Central to these efforts are Energy Performance Certificates (EPC) and the Smart Readiness Indicator (SRI), tools designed to evaluate and improve the energy performance and smart technology integration in buildings [3][4].

One of the "Smarter EPC" project actions is to examine the landscape of EPC and SRI calculation tools across the EU. This initiative is vital considering the EU's ambitious goal to reduce greenhouse gas emissions by at least 55% by 2030, paving the way for climate neutrality by 2050 [5]. Given that buildings are among the largest energy consumers in the EU, there is a significant opportunity for sustainability and efficiency improvements through the adoption of advanced EPC and SRI tools [6].

However, for these tools to successfully transform the building sector, they must be accurate, easy to use, and consistently applied across all member states. Existing challenges, including data inconsistency, complexity of use, and limited interoperability with other digital platforms, have impeded their full potential [7][8]. This project seeks to tackle these challenges by performing a comprehensive evaluation of the existing Energy Performance Certificates (EPC) and Smart Readiness Indicator (SRI) tools throughout the European Union.

This project's goal is to compile its findings into a European atlas of EPC and SRI tools, aiming to standardize building assessments, promote best practices, and foster the adoption of smart, energy-efficient solutions. By employing this comprehensive strategy, the project aims not only to improve the existing set of tools but also to initiate a transition towards buildings that are more sustainable and efficient, thereby positively impacting the European Union's environmental and energy targets.

II. Theoretical Background

The fundamental theories behind Energy Performance Certificates (EPC) and Smart Readiness Indicators (SRI) within the European Union (EU) context are essential for comprehending the path towards buildings that are both sustainable and intelligent. Instituted by the Energy Performance of Buildings Directive (EPBD) and refined through subsequent legislative updates, these tools encapsulate the EU’s concerted efforts to diminish building sector emissions and energy consumption, pivotal to achieving its climate neutrality goals by 2050.

Energy Performance Certificates (EPC)

EPCs are vital to the EU's strategy for enhancing building energy efficiency, offering a measurable indicator of a building’s energy performance. Since their inception, EPCs have evolved, with updates aimed at improving accuracy and user comprehensibility, facilitating informed decisions on property investment, rental, and energy efficiency improvements [9][10]. However, challenges in standardization across member states and the dynamic nature of building usage emphasize the need for continuous refinement of EPC methodologies.

Smart Readiness Indicator (SRI)

The introduction of the SRI signifies the EU's forward-looking approach to integrate smart building technologies, emphasizing the importance of buildings' capacity to adapt their operations to improve energy efficiency, occupant comfort, and grid responsiveness [11]. The SRI is poised to play a crucial role in the digitalization of the building sector, encouraging the adoption of smart technologies that contribute to the EU's energy and climate goals. Yet, the nascent stage of SRI implementation calls for a unified framework that addresses diverse national contexts and promotes widespread uptake.

Interconnected Challenges and Prospects

The deployment of EPC and SRI faces interconnected challenges, including the need for enhanced data collection methodologies, greater interoperability between assessment tools and building management systems, and broader stakeholder engagement. Addressing these challenges is critical for leveraging the full potential of EPC and SRI in driving the transition towards more sustainable and intelligent buildings in the EU.

Notwithstanding, the evolution of EPC and SRI presents substantial opportunities. Advances in information and communication technology (ICT), artificial intelligence (AI), and the Internet of Things (IoT) offer promising avenues for enhancing these tools' effectiveness. These technologies enable more granular, real-time assessment of building performance and smart readiness, paving the way for adaptive and responsive building operations that align with energy efficiency and sustainability objectives.

Towards a Harmonized and Future-Oriented Framework

Efforts to harmonize EPC and SRI methodologies across the EU are underway, aiming to ensure consistency, reliability, and comparability of assessments. This harmonization is essential for building trust among stakeholders, facilitating informed decision-making, and fostering a competitive market for energy-efficient and smart buildings. Furthermore, the integration of EPC and SRI into a cohesive assessment framework can provide a comprehensive view of a building's performance, offering a strategic tool for policymakers, developers, and occupants to meet the EU's ambitious environmental and energy targets.

The theoretical exploration of EPC and SRI tools within the EU's regulatory framework underscores their pivotal role in the bloc's climate and energy strategy. While challenges remain in standardization and adoption, the opportunities presented by technological advancements and policy developments suggest a bright future for these tools in achieving sustainable and smart buildings.

III. Methodology

The methodology of the "Smarter EPC" project was meticulously designed to ensure a thorough and systematic review of Energy Performance Certificate (EPC) and Smart Readiness Indicator (SRI) tools across the European Union. This multifaceted approach allowed the project team to capture a holistic view of the landscape, evaluate the tools critically, and document the findings comprehensively. The methodology unfolded in several key phases:

Country Selection and Tool Discovery

The project commenced with an organized process of country selection, where project partners were assigned specific EU member states to focus their research efforts on. This strategic allocation ensured a wide coverage and diversity in the review process, taking into account the unique regulatory and market environments across the EU. Partners engaged in rigorous research within their allocated countries to identify all available EPC tools, leveraging public databases, industry networks, and direct outreach to tool providers. This exhaustive search aimed to compile a comprehensive inventory of tools for subsequent evaluation.

Tool Evaluation

With the inventory of EPC tools established, partners proceeded to the evaluation phase. Utilizing a standardized evaluation questionnaire, each partner assessed the EPC tools identified within their assigned countries. The questionnaire covered a broad spectrum of criteria, including data collection practices, backend methodologies, user experience, interoperability with other systems, and alignment with national and European EPC calculation methodologies. Partners meticulously completed this evaluation for each tool, gathering detailed insights into their functionalities, strengths, and limitations.

SRI Tools Research

Parallel to the EPC tool evaluation, the project also embarked on an exploration of Smart Readiness Indicator (SRI) tools. This segment of the research focused on identifying and assessing tools designed to measure buildings' smart readiness, a key component of the project's broader objective. The research into SRI tools was informed by a similar methodological approach, involving the identification of tools, evaluation against specific criteria, and documentation of findings. The results of this research were detailed in a dedicated section, highlighting innovative digital platforms and methodologies for SRI assessment, as previously described in the documents provided.

IV. Results

Comprehensive Evaluation of EPC Tools

The evaluation of Energy Performance Certificate (EPC) tools across the European Union yielded extensive data, underscoring the diversity and variability in tool functionality, user interface design, and alignment with both national and EU-wide standards. Partners, through meticulous research and evaluation, have compiled an extensive table listing the EPC tools identified, alongside key metrics derived from the standardized evaluation questionnaire. This detailed analysis revealed several critical insights:

- Tool Accessibility and Usability: A significant variance was noted in the accessibility and usability of EPC tools across different member states. While some tools offer comprehensive guides and user-friendly interfaces, others pose challenges, particularly to users without technical expertise.
- Interoperability with Other Systems: The evaluation highlighted a mixed landscape in terms of interoperability. A subset of the tools demonstrated seamless integration capabilities with Building Information Modeling (BIM) systems and digital building logbooks, enhancing their utility and efficiency.
- Alignment with Calculation Methodologies: The adherence to national and European calculation methodologies varied among the tools evaluated.

Tools that closely align with these methodologies were identified as more reliable in producing accurate and comparable EPCs.

- Innovation in Data Collection Practices: Innovations in automated data collection, including the use of smart meters and IoT devices, were noted in several tools, indicating a trend towards more dynamic and real-time energy performance assessment.

The table below represents a snapshot of the evaluated EPC tools, encapsulating the diversity and breadth of solutions available across the EU:

TABLE 1 EUROPEAN EPC TOOLS

Country	EPC Tool Name	Website
Austria	ArchiPHYSIK	Link
	AX3000	Link
	GEQ	Link
	Grüner pitCAD	Link
	Gebäudeprofi	Link
Belgium	PEB	Link
Bulgaria	ENSI EAB	Link
Croatia	MGIPU_EC	Link
	KI EXPERT PLUS	Link
	Cjenik	Link
	ENCERT-HR3	Link
Czech Republic	EC780 - Lombardy Region	Link
Cyprus	iSBEM-CY	Link
	ECO-engine	Link
Denmark	Be18	Link
	Energy10	Link
Estonia	PHPP	Link
Finland	IDA ICE	Link
	Lamitor	Link
	RIUSKA	Link
France	AnalysImmo	Link
	CLIMAWIN 2020	Link
	DPEWIN	Link
	EXPERTEC	Link
	LICIEL	Link
	Pleiades	Link
	WINDPE	Link
	DjeserDiag	Link
Germany	GEG / EnEV	Link
	GEG2023 XLSM tool	Link
	DÄMMWERK	Link
	BBSR GEG	Link
Greece	3DR-KENAK	Link
	4M-KENAK	Link
	Ecoline	Link
	TEE KENAK	Link
Hungary	Auricon Energetic	Link
	Bausoft WinWatt	Link
Ireland	DEAP4 Tool	Link
	NEAP	Link
Italy	Blumatica Energy	Link
	EC 780	Link
	Energetika 2000	Link
	Euclide Certificazione Energetica	Link
	Mc4 Suite 2023	Link
	Namirial Termo	Link
	TermiPlan	Link
	Termiko One	Link
	Termolog 14	Link
	TerMus	Link
Latvia	PassiveHaus	Link
	IDA ICE	Link
Lithuania	NRG	Link
Luxembourg	LUXEEB-F (IBP)	Link
	LuxEeB-H	Link
	Lesosai	Link
Malta	SBEMmt. v4.2c	Link
	EPRDM	Link
Netherlands	Vabi	Link
	Uniec	Link
	BouwConnect	Link
	Susteen	Link
Poland	ArCADia-Thermocad	Link
	Audytor OZC	Link
	Certo	Link
Portugal	casA+	Link
	CYPETHERM SCE-CS Plus	Link
	Hab DL 101-D/2020	Link
	C&S DL 101-D/2020	Link
Romania	AllEnergy	Link
	TermicG software	Link
	Doset-PEC	Link
Slovakia		Link
Slovenia	Calculation tool + national EPC	Link
Spain	CE3	Link
	CE3X	Link
	CERMA	Link
	CYPETHERM HE Plus	Link
	LIDER-CALENER (HULC)	Link
	SG SAVE	Link
	TeKton3D TK-CEEP	Link
Sweden	BIM Energy	Link
	EnergyCalc	Link
	TMF Energi	Link
	VIP-Energy	Link

SRI Tools Research

The comprehensive evaluation of Smart Readiness Indicator (SRI) tools constitutes a pivotal component of our research, conducted in tandem with the assessment of Energy Performance Certificates (EPC). This investigation aimed to delineate the current spectrum of digital tools available for assessing the smart readiness of buildings, a cornerstone in advancing the European Union's goals for energy efficiency and sustainability.

Innovative Digital Tools Transforming Building Assessments

Our research identified a spectrum of cutting-edge digital tools, each designed to revolutionize the assessment and enhancement of buildings' smart capabilities. These tools are pivotal in promoting smart building practices across Europe, catering to a diverse array of stakeholders, including assessors, building owners, facility managers, and occupants.

SRI Tools and Their Contributions:

1. *D^2EPC Building Performance Module:* Integrates SRI assessments with asset and operational rating tools, offering a comprehensive evaluation of building performance. This tool is instrumental in identifying opportunities for targeted enhancements in energy performance and smart readiness.
2. *EPC-RECAST BIM Supported SRI:* Employs Building Information Modelling (BIM) models to streamline SRI assessments. Its innovative use of semantic models and visualization tools facilitates efficient and insightful analysis by assessors.
3. *Smart-Ready-Go!®:* A cloud-based platform that delivers real-time insights into a building's smart performance, suggesting actionable upgrades based on smart technologies. It plays a critical role in supporting informed decision-making for enhancing building intelligence.

4. *SPA&A:* Provides data-driven insights and actionable recommendations aimed at improving a building's smartness, with a focus on energy efficiency and meeting occupant needs.
5. *SRI2MARKET:* An under-development, multilingual platform designed for adaptable SRI assessments across different markets, facilitating the broader integration of smart technologies.
6. *IsZEB SRI Calculator:* Part of the IsZEB Certify software package, simplifying the SRI assessment process and supporting stakeholders in implementing smart technology upgrades.
7. *U-CERT SRI Digital Tool:* Enhances the user experience by transitioning traditional SRI assessment spreadsheets to a cloud environment, simplifying data input and results visualization.

Key Findings from the SRI Tools Research:

- *Diverse Platforms:* The research unveiled SRI tools that span a broad spectrum of platforms, from cloud-based solutions providing real-time building performance insights to comprehensive software integrating SRI assessments with other performance metrics.
- *User-Centric Design:* A pronounced emphasis on user experience was evident across the SRI tools, featuring intuitive interfaces and multilingual support to enhance accessibility for a wide range of users.
- *Technological Innovation:* The tools exhibited a significant level of technological innovation, leveraging advanced data analytics, semantic models, and BIM integration to ensure more accurate and efficient assessments.

These findings highlight the critical role of technological innovation in the advancement of smart building assessments within the EU. The SRI tools not only facilitate a more integrated and intelligent approach to building performance evaluation but also empower stakeholders to make informed decisions regarding smart technology investments and optimizations. This shift towards more sophisticated, user-friendly tools underscores the EU's commitment to achieving its ambitious energy efficiency and sustainability targets.

Implications of Findings

The comprehensive evaluation of EPC tools and the synthesis of SRI tools research provide invaluable insights into the current state and future direction of building performance and smart readiness assessments within the EU. The findings highlight the need for continued innovation, standardization, and user education to enhance the effectiveness and adoption of these tools. As the EU moves towards more ambitious energy efficiency and sustainability targets, the role of advanced EPC and SRI tools in achieving these goals becomes increasingly paramount.

V. Discussion

The "Smarter EPC" project's findings illuminate both the progress and the challenges in the domain of building energy performance and smart readiness assessment tools. Innovations in digital technology and data analytics have led to the development of advanced EPC and SRI tools, offering detailed insights into building performance and facilitating the adoption of energy-efficient and smart solutions. However, the analysis also identifies critical gaps, such as the need for greater standardization, improved interoperability between tools, and enhanced user interfaces to accommodate non-technical users.

VI. Implications for Policy and Practice

The insights garnered from this project have significant implications for policy development, tool improvement, and the promotion of sustainable building practices across the EU. By highlighting the strengths and weaknesses of current EPC and SRI tools, the project provides a roadmap for future enhancements, advocating for a more harmonized and user-friendly approach to building assessment.

VII. Conclusions

The "Smarter EPC" project, through its comprehensive review and assessment of Energy Performance Certificates (EPC) and Smart Readiness Indicator (SRI) calculation tools across the European Union, has illuminated the current landscape and underscored the critical gaps and areas for improvement within these essential mechanisms. This endeavor has not only cataloged the existing tools but has also evaluated their efficacy, user experience, and interoperability, with a particular focus on the incorporation of smart technologies and methodologies developed from the NextGenEPC projects.

Our findings reveal a diverse ecosystem of EPC and SRI tools, each with varying degrees of complexity, accessibility, and alignment with the overarching goals of the EU's energy efficiency and building intelligence initiatives. While some tools exemplify best practices in user interface design, data integration capabilities, and the adoption of advanced analytical methodologies, others highlight the persistent challenges in standardization, user accessibility, and the harmonization of methodologies across member states.

The project's ambition to create a European atlas of EPC and SRI tools represents a significant stride towards enhancing the transparency, accessibility, and utility of these tools for stakeholders across the spectrum, from policymakers and developers to building owners and occupants. This atlas not only facilitates a deeper understanding of the available tools but also serves as a foundational step towards the harmonization of energy performance assessment practices across the EU.

Moving forward, it is imperative that the insights garnered from this project inform the continuous evolution of EPC and SRI tools. The development of more intuitive, user-friendly interfaces, alongside the integration of interoperable data formats and methodologies, will be crucial in enhancing the efficacy and adoption of these tools. Moreover, fostering a collaborative ecosystem that encourages the sharing of best practices, innovations, and lessons learned among developers, users, and policymakers will be key to advancing the EU's ambitions for energy efficiency and smart building capabilities.

In conclusion, the "Smarter EPC" project not only sheds light on the current state of EPC and SRI calculation tools but also charts a path forward for their development and enhancement. By addressing the identified gaps and capitalizing on the opportunities for improvement, there is a clear and attainable vision for a future where these tools play a pivotal role in achieving the EU's energy efficiency and sustainability goals. The collaborative efforts of all

stakeholders involved in this project underscore a shared commitment to advancing the smart readiness and energy performance of buildings across the EU, a critical endeavour in the face of global environmental challenges.

VIII. Acknowledgement

This study is part of the dissemination activities of the research project 'Smarter Energy Performance Certificates; Integrating smart readiness aspects into buildings energy certification and tools for market up-take (Smarter EPC)' (Grant ID Number 101121034), funded under the Horizon Europe call LIFE-2022-CET-BUILDPERFORM.

References

[1] International Energy Agency. (2020). Energy Efficiency 2020. IEA Publications.

[2] European Commission. (2019). The European Green Deal. COM (2019) 640 final.

[3] European Parliament & Council. (2010). Directive 2010/31/EU on the energy performance of buildings. Official Journal of the European Union.

[4] European Commission. (2018). Clean energy for all Europeans. Publications Office of the European Union.

[5] European Union. (2021). "EU climate action and the European Green Deal." [Online]. Available: https://ec.europa.eu/clima/policies/eu-climate-action_en

[6] Buildings Performance Institute Europe. (2020). Europe's buildings under the microscope. BPIE.

[7] Smith, L., & Roberts, N. (2019). "Integrating smart technology in the European retrofitting industry: An emergent system." Journal of Cleaner Production, 212, 1398-1408.

[8] Johnson, P., & Robinson, A. (2021). "Challenges and opportunities for improving the energy efficiency of buildings: A European perspective." Energy Policy, 148, 111965.

[9] European Parliament & Council. (2010). Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings. Retrieved from EUR-Lex.

[10] Economidou, M., et al. (2020). "Review of 50 years of EU energy efficiency policies for buildings." Energy and Buildings, 225, 110322.

[11] European Commission. (2018). "Smart Readiness Indicator: Making the EU's buildings smarter." Retrieved from European Commission website.