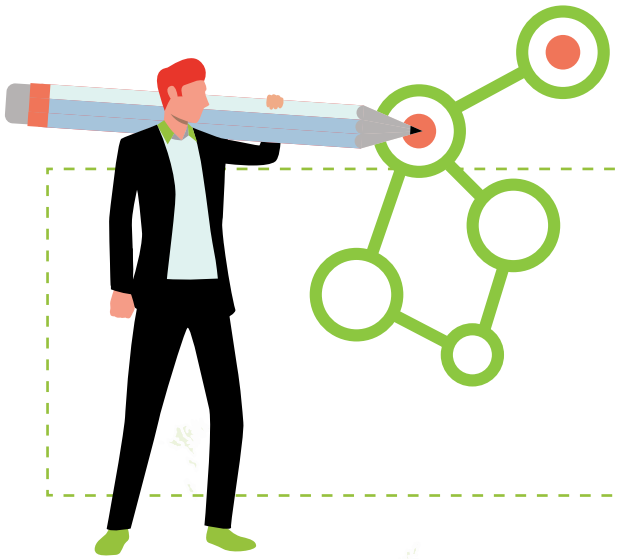

X-tendo

FEATURE 1:

SMART READINESS INDICATOR (SRI)

Implementation guidelines and replicability potential of the innovative features for the next generation EPCs

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 845958.

BPIE

Project Acronym	X-tendo
Project Name	eXTENDing the energy performance assessment and certification schemes via a modular approach
Project Coordinator	Lukas Kranzl (TU WIen)
Project Name	2019 - 2022
Website	https://x-tendo.eu/
Deliverable No.	D5.3
Dissemination Level	Public
Work Package	WP5
Lead beneficiary	BPIE
Contributing beneficiary(ies)	TU WIEN, VITO, E-THINK, BPIE, ADENE, CRES, TREA, AAECR, DEA, EASt, NAPE, ENEA, EST
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Date	31/05/2022

Please note these chapters are extracted from the full report, available at this link:
https://x-tendo.eu/wp-content/uploads/2022/07/x-tendo-Implementation-guidelines-and-replicability-potential_Final.pdf

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 845958.

CONTENTS

EXECUTIVE SUMMARY

Energy performance certificate (EPC) schemes have not evolved much since their first introduction in the Member States to meet the mandatory requirements set out under the Energy Performance of Buildings Directive (EPBD). With the recent revision proposal of the *EPBD* it has become more important to focus on EPCs critically and increase their usability for stakeholders. Stakeholders have questioned their reliability but at the same time, they have been useful for the real estate industry. All the Member States have legislation in place and existing infrastructure or systems to run EPC schemes. These schemes must evolve with the changing needs of the built environment and consider elements such as enhanced indoor comfort, reducing air pollution and financing options. This should occur alongside energy consumption analysis giving impetus to renovation rates of Member States towards achieving EU 2050 decarbonisation goals for the building sector set out under the *European Green Deal.* Public authorities view EPCs as potential instruments to improve the performance of existing building stock and deeper renovation. Extending the functionalities of existing EPC systems will create several pathways to update and manage next-generation EPCs.

This report presents the implementation guidelines and replicability potential of ten innovative features proposed within X-tendo: (i) smart readiness, (ii) comfort, (iii) outdoor air pollution, (iv) real energy consumption, (v) district energy, (vi) *EPC databases*, (vii) *building logbook*, (viii) *enhanced recommendations*, (ix) *financing options*, and (x) *one-stop-shops*. The outcome of this report is a critical presentation of the barriers and drivers for each feature's wide uptake, their impact if implemented by Member States and the necessary next steps in order to implement the innovative features in certification schemes around Europe. The developed features were tested in nine countries: Austria (AT), UK-Scotland (UK), Italy (IT), Denmark (DK), Estonia (EE), Romania (RO), Portugal (PT), Poland (PL) and Greece (GR). Then the experts who tested them provided deeper insights, appropriate directions and policy perspectives which provided a realistic estimation for its implementation and replicability across different Member States. The replicability potential is mainly analysed based on qualitative information collected from previous investigations in the project and extensive focus groups within project implementing countries. However, an estimation of the quantitative effects of the implementation of innovative features into the EPC schemes is also performed for X-tendo countries based on the results of the testing activities together with use of a building stock model.

Some general conclusions derived for all features include:

- New or revised EPCs must not be burdened with a lot of new information for the end-user. Information on the first page must be prioritised for the end-user application. Thus, which information is presented on the EPC (on paper) and which on the digital EPC or digital building logbook (DBL) should be considered.

- Automation and simplification of procedures is necessary in overcoming major issues regarding interoperability and data exchange.

- User-friendliness of features is highlighted as one of the most important drivers during tests of all features and more research is needed in this regard, because so far, the features were tested with experts, not with end users.

- EPCs must be coherently linked to other instruments such as DBL and building renovation passports to increase their impact.

- Training is required for some features to upskill and improve the competence of the workforce responsible for delivering EPCs. Some features do not require training at all, while others have either simple or complex methods that require different training needs.

- All the features are compatible for different building typologies. For some features, X-tendo developed two calculation methods, one is more simple and requires low effort, while the other is complex and more reliable. Each method can fit different building typologies (e.g. a detailed SRI is needed for large commercial buildings whereas CARP and CORP can be used for school, office and residential buildings).

X-tendo features were developed from this perspective to empower the end-user with more information and help them take necessary actions for renovation. All the features have been found to have relevance in the test countries with differences in needs and application. The X-tendo project has identified a series of recommendations for policy uptake and formulation that would be beneficial in the implementation of new features:

- Establish simplified procedures at MS level to update the EPC with new features followed by individual and detailed studies at national level.

- Recognise the strengths of existing EPC best practices and provide necessary resources for the transfer of knowledge from front runner countries. Use this process to adapt new features for EPCs.

- Conduct detailed assessments of existing EPC input data and prioritise new features with significant overlap of data input with EPCs. In addition, prioritise outputs relevant to the end-user on the EPC. Information relevant for public authorities can be made available on the attachment or DBL.

- Promote the implementation of new features using market and non-market mechanisms to raise awareness among the public and other relevant stakeholders.

- Conduct cost-benefit analyses at a national level to determine the feasibility of features and their economic impact to build trust in markets.

- Carry out selective implementation and independent pilot studies in national contexts to support MS individual policy goals.

- Set up more ambitious and rigorous quality check mechanisms in EPCs, the EPC database and check consistencies within and between databases.

- Require businesses to work on creating an environment and enabling conditions to support job creation and increase investments in renovation with features such as DBL and OSS.

1 INTRODUCTION

This report brings together the outputs of the evaluation of the test projects (T5.2) alongside the insight from end-users and stakeholders gathered in WP6 (Communication and Dissemination) and from end-users in WP2 (Exploring the principles of next-generation EPCs), and include estimations of:

1. The barriers and drivers for the wide uptake of each of the 10 features.
2. The effects (in quantitative and qualitative terms) of the wider implementation of the developed innovative features of EPCs in Europe.
3. The necessary next steps in order to implement the innovative features in the certification schemes around Europe, in particular assessing staff and training needs.

The replication potential is mainly analysed based on qualitative information collected from previous activities in the project and extensive focus groups within project implementing countries. However, we have also estimated the quantitative effects of the implementation of innovative features into the EPC schemes, based on the results of testing activities in the previous task (T5.1 and T5.2) together with the use of a building stock model. An assessment has been carried out on the potential future number of EPCs with the innovative features developed throughout the course of this project. It forms the basis for the identification of the capacity-building implications for delivery bodies, particularly staff and training needs.

Table 1 provides an overview of the 10 innovative features developed in the project X-tendo and tested by partners with relevant expertise in 9 countries: Austria (AT), UK-Scotland (UK), Italy (IT), Denmark (DK), Estonia (EE), Romania (RO), Portugal (PT), Poland (PL) and Greece (GR).

Based on the methodologies of the developed features, three different test categories were used:

- **In-building testing:** In existing buildings this involved testing the new features in use by assessing the time required and viability to collect new data points as part of, or in addition to, a conventional EPC assessment. This process also involved the systematic collection of qualitative data from EPC assessors and building owners/managers on their view of the new process/indicator.
- **Systems testing:** This involved development work with EPC database operators or public authorities to assess the technical and practical viability of the new features. It considered time and cost implications, integration with existing systems, access to data and data privacy issues.
- **User testing:** Surveys were carried out with specific end users or stakeholder groups to understand the usability of the new features.

Table 1 - Overview of features and implementing partners

Feature number	Innovative feature	Feature lead	Implementing countries
1	Smart readiness	VITO	AT (IB), EE (IB/expert), GR (IB), RO(IB)
2	Comfort	BPIE	AT(IB), GR (IB/expert), PT(IB), RO(IB)
3	Outdoor air pollution	NAPE	PL (IB expert)
4	Real energy consumption	VITO	AT(IB), EE(IB), IT(IB), RO (IB/expert)
5	District energy	E-think	DK (expert), IT(IB), PL(IB), RO(IB)
6	EPC databases	TU Wien	DK (S), GR (S), IT(S), UK (expert)
7	Building logbook	BPIE	EE (U/S) , GR(U/S) , PT (expert)
8	Enhanced recommendations	TU Wien	AT (expert), DK (IB), PL (IB/S), UK (IB)
9	Financing options	ADENE	DK (U/S), PL (expert), PT (U), RO (U/S)
10	One-Stop-Shops	ADENE	DK (U/S), PT(U/S/expert), RO (U) , UK (U)

IB: In-building test; S: System test; U: User test, expert: supporting partner with existing expertise

2

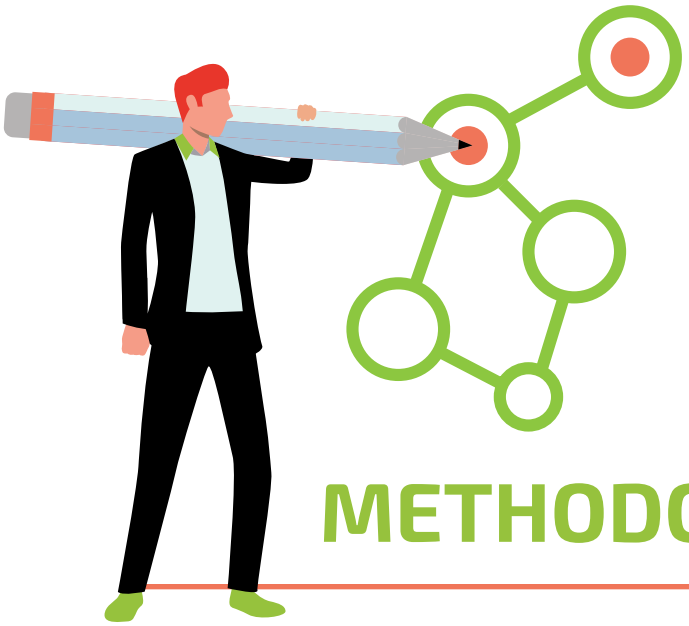
OBJECTIVE OF THE REPORT

This report on the implementation guidelines and replicability potential of the 10 innovative features has been prepared to consolidate useful information to guide public authorities, energy agencies and other relevant stakeholders in the enhancement of EPCs. The report supports the project results' replicability and implementation in different Member States of the EU.

Therefore, the objective of the report is twofold:

1. Provide implementation guidelines for public authorities for the 10 X-tendo features.
2. Estimate the replicability potential in quantitative and qualitative terms.

The implementation guidelines are mainly structured as barriers and drivers for each feature. The identification of the replicability potential is based on qualitative information and quantitative estimations of the potential number of EPCs that will – in future – incorporate the innovative features. Finally, we identify the necessary next steps to implement the innovative features in certification schemes across Europe.



3 METHODOLOGY

Implementation guidelines and replicability potential in this report were prepared through an iterative process of filtering and refining the information and data collected through different project activities. This includes findings from the viewpoints of all relevant stakeholders.

These are briefly described below:

1. **Methodologies and concepts for all features:** Approaches and methods used for the development of the ten features in the X-tendo project [1][2].

2. **End-users needs and perspectives:** A stakeholder survey comprising homeowners, buyers, tenants, sellers and landlords was conducted in 5 European countries (Poland, Portugal, Greece, Romania and Denmark) with 2,563 participants to investigate their needs and identify the relevance of the new features [3]. Interviews and focus groups were also conducted with relevant stakeholder groups for some features to collect their preferences during testing.

3. **Cross-cutting criteria:** The principles used to guide the development and testing of the features for next-generation energy performance certification ensure (i) Quality and reliability, (ii) User-friendliness, (iii) Economic feasibility, and (iv) Consistency with ISO/EN standards [4].

4. **Introductory reports for 10 innovative EPC features:** Brief reports describing the basic concepts, highlight existing cases or best practices, and outline the first steps for implementation [5]–[14].

5. **Evaluation and documentation of test projects:** Monitoring and results reports to assess the practical viability and impact of the ten features. This includes detailed evaluations of the features after testing conducted in nine test countries [15]–[24].

6. **Experience sharing web-calls:** Views gathered from stakeholder representatives within the consortium and from the advisory board.

7. **Workshops and webinars at EU level:** Stakeholder engagements conducted by the test countries with local and national stakeholders to evaluate and receive feedback on the features during their development at EU level.

8. **Online meetings between partners for each feature:** Review of evidence and data collected in the project relevant to each feature with extensive discussion on the replicability potential of each feature.

9. **Estimation of quantitative impact for wider implementation:** Analysis using a building stock model to study the impact on renovation rates of the ten features in Member States. A detailed methodology is described further in this section.

The inputs were analysed to identify drivers and barriers that impact the uptake of each feature. The effects (in quantitative and qualitative terms) of the wider implementation were also analysed for the developed features of EPCs in Europe. Based on these, the necessary next steps were outlined in order to enable their implementation in certification schemes around Europe. To ensure an impartial assessment for replicability, the findings for each feature were triangulated using feedback from testing partners, feature developers and stakeholders.

Methodology for estimation of quantitative impact due to wider implementation

To estimate the quantitative impact of a wider implementation of the 10 features an assessment was conducted for the 10 X-tendo countries using the building stock model. To estimate the impact several trigger points were identified when EPCs can or need to be issued in the X-tendo countries. These trigger points are:

- New building construction
- Major building renovation
- Building sales (if no valid EPC available)
- Renting out (if no valid EPC available)
- Other (e.g. the interest of the building owner in improving the energy performance of the building)

The reference for the above trigger points is drawn from Art 12/1 of the EPBD (2018/844) [25] which states that 'Member States shall ensure that an energy performance certificate is issued for: (a) buildings or building units which are constructed, sold or rented out to a new tenant; and (b) large public buildings'. In Art 17 of the proposed recast EPBD, this is extended to "building units which are constructed, have undergone a major renovation, are sold or rented out to a new tenant or for which a rental contract is renewed".

The different EPC features developed in the X-tendo project will have a different response to the identified trigger points in each Member State. This is due to factors such as public acceptance, real estate needs, market interests, investments, existing state of EPC system etc. The relevance of each trigger point for each feature mentioned above are presented in detail in Table 13 of Annex 1. These trigger points are used to calculate the number of annually issued EPCs until 2030 using historical data of issued EPCs (2014-2019) in the 10 X-tendo countries. The number of EPC end-users potentially interested in a certain feature was determined by estimating the share of interested end-users per trigger point and feature. For the 2030 projection, it was assumed that the number of tenants, real estate transactions and new building constructions follow the same linear trends as in the past 10 years.

More details on calculation method are presented in *Annex 1*.

4

FEATURE 1: SMART READINESS INDICATOR (SRI)

4.1 Overview

The smart readiness indicator (SRI) was first introduced by the 2018 EPBD recast and is reinforced as a voluntary European scheme for rating the smart readiness of buildings, by the 2021 EPBD recast proposal [25]. The SRI measures the capacity of buildings to use information and communication technologies and electronic systems to better suit the needs of occupants and the grid, as well as improve energy efficiency and overall building performance. The SRI was officially adopted by Delegated Regulation (EU) 2020/2155 (European Union; 2020a) and Implementing Regulation (EU) 2020/2156 (European Union; 2020b), both published in 2020 and came into force in January 2021. The SRI is intended to raise awareness about the benefits of smart buildings, including energy efficiency, an optimised mix of various energy sources, user occupancy experience and grid flexibility. In addition, its implementation is expected to stimulate investments in smart building technologies and support the uptake of technology innovation in the building sector.

Two parallel methodologies have been developed and tested so far to speed up SRI evaluation capabilities. These methodologies vary in the amount of information required and the skills needed by the assessor to quantify the level of smartness.

- **Abbreviated method A** is composed of a simplified checklist that can be self-assessed online or by an assessor in 15 minutes. This makes it ideal for assessing single and multi-family dwellings, small commercial and office buildings.
- **Extended method B** relies on an on-site inspection and includes more detailed information about the building smartness components. Its specificity makes it suitable for assessing large private (residential, offices) and public (schools, hospitals, etc.) buildings.

The SRI score of a building is a percentage that expresses how close (or far) the building is from maximal smart readiness. A high score indicates a high smart readiness of the building. The total SRI score is based on a weighted average of scores allocated on seven impact criteria, each evaluated within nine domains (this generates a 7x9 evaluation matrix), which include:

- The **seven impact criteria**: Energy Efficiency, Maintenance and Fault Prediction, Comfort, Convenience, Health and Well-being, Information to Occupants and Energy Flexibility and Storage.
- The **nine domains**: Heating, Cooling, Domestic Hot Water, Ventilation, Lighting, Dynamic Building Envelope, Electricity, Electric Vehicle Charging, and Monitoring and Control.

The final SRI score is provided as a percentage and subdivided into three key smart readiness functionalities:

1. Energy performance and operation
2. Response to user needs
3. Energy flexibility

4.2 Key insights from testing

Table 2 - Test projects summary in implementing countries for SRI

Country	ROMANIA	GREECE	ESTONIA
Type of Testing	In-building Testing	In-building Testing	In-building Testing
Number of testing cases	1 SFH, 1MFH, 1 Office, 1 Kindergarten / school	2 Offices and 2 Apartments.	10 MFH
Tool	In-situ visits and technical documents, calculation tool based on assessment method A		
Testing Period	02/2021 – 10/2021	07/2021 – 09/2021	08/2021 – 10/2021

The evaluation methodology obliges the assessor to go over a checklist of possible smart solutions, while the same list provides recommendations for the end-user.
Some key findings derived from the testing in three countries are given below:

- The assessment tool provides clear and straightforward use while being relevant for smartness assessment and improvement.
- In apartment buildings that were built more than 40-50 years ago a low score was calculated and the same applies to non-residential buildings. However, recently built buildings, less than 15-20 years old, were found to have a higher score due to the installation of more smart control or other technologies.
- Calculation of smartness is more reasonable at the whole building level compared to individual dwellings or zones.
- The effort involved in assessing and documenting complex buildings (e.g. office buildings) was much higher than for simpler buildings like SFH with regard to aspects like time, access to data and its collection on-site.

4.3 Drivers and barriers for a wide uptake of the feature

4.3.1 Calculation method and quality assurance

Different building typologies may require different calculation methods, depending on their smartness capacity. The abbreviated method A is more suitable for single and multi-family dwellings, small commercial and office buildings. The extended method B is most suited for assessing large private buildings, such as offices, or public (schools, hospitals, etc.). Non-residential buildings have overall better SRI scores, often as a result of their management systems. Further testing is needed for commercial buildings, for which method B would be initially more appropriate.

The main driver of this feature is the 2018 and 2021 EPBD recast proposal [25] and the eventual requirement for it to be implemented by the MS as a voluntary assessment scheme within the EPC scheme, or within the digital building logbook and building passport at a later stage.

According to experts, the simplified method is the most suitable to be implemented in the EPC scheme. Testing showed that method A is suitable for both residential, non-residential and public buildings. It is a simple method, which is easily implemented and calculated by the EPC assessor. A complex method could be avoided by the EPC assessors if the tool is voluntary, while some inputs for heating and cooling of method A are already covered by the EPC calculation.

Experts within the consortium from different countries showed different opinions regarding the harmonisation of the method in different MS. Experts in Portugal propose different calculation methods adapted to specific climates, the experts from Romania advocate the same calculation method and – for example - to keep the assessment of cooling as a requirement in all MS. A compromise proposed by the Austrian partner would be to provide the same calculation method of the IAQ, the same wellbeing and health standards while allowing different weighting due to climatic differences.

The existing calculation methods have the following limitations, which could act as barriers to implementation:

- Buildings have different theoretical maximums. Parameters such as type or characteristics will determine the criteria according to which a building will be evaluated. For example, a building without space to integrate an electric vehicle (EV) charging point will not be evaluated on this service, and thus has a lower theoretical maximum.
- Potential divergences in the calculation of SRI for large buildings: some buildings may not have the same smartness capacity although some can have similar SRI scores (methodological limitation).
- One challenge of the SRI scheme will be to deliver a significant volume of assessments in the first years of implementation.
- Smart controls are available in public and in non-residential buildings, especially for maintenance purposes. However, their potential implementation in residential apartment blocks is more difficult because of multiple ownership.

4.3.2 Social drivers and barriers (occupants/owners' perspective)

SRI scores need to be easily shared with the general public, not only experts. For this purpose, the SRI should be communicated using a logo to immediately visually brand it in users' minds and create an identity for the scheme. The logo will be accompanied by numbers indicating the SRI score. In addition, the SRI should be subdivided into three subcomponents indicating in more detail the building smart readiness for (1) energy savings and maintenance, (2) comfort, ease and wellbeing, and (3) grid flexibility.

However, currently, the SRI is a concept that can be hard to communicate and understand for the general public. Furthermore, according to experts from Austria, the SRI concept is less relevant for the end-user compared to the grid supplier. Experts from Romania stated that the concept of a smart home is not yet developed in Romania, thus the indicator's implementation may be too early. Perhaps, though, an early introduction of the tool in the EPC scheme could raise awareness.

To increase the relevance for the end-user, the benefits of SRI must be communicated very clearly. According to stakeholders of the Workshop in Greece (see Methodology section), 66.6% consider smart homes to have the potential to improve an occupant's comfort, 55.5% think smart homes can save energy, 77.7% believe that smart homes can improve the efficiency of grids and 77.7% think smart technologies will increase the property value.

Important aspects to be considered during the implementation are data protection, GDPR compliance and citizen security (i.e. cybersecurity risks).

4.3.3 Construction sector (upskilling, construction industry, investors, developers etc.)

The two calculation methods require different degrees of skills and knowledge, thus, different types of training. Method B requires an expert degree of knowledge and can be only performed by SRI certified assessors.

Potential barriers to delivering a validated accreditation include training costs and the lack of trained assessors during the first stages of implementation. The costs associated with establishing a pool of qualified assessors would be reduced if training programmes first target experts already certified through other schemes in Member States.

Smart utility solutions are a fast-developing market. The SRI method should be updated when needed to include new technologies, and therefore, also the training.

The implementing partners underlined that Method B could be too complicated and time-consuming for the EPC assessors. If the tool is voluntary in the EPC certification, assessors could avoid using it. On the other hand, implementing partners find the simplified method A rather easy to implement in the existing EPC scheme. Additionally, only limited training is required since many inputs are already covered by the existing calculation methods. According to experts from Austria and Romania, simplicity is key, and an easy implementation should be the main goal.

4.3.4 Economic and market drivers and barriers

While the methodology is ready, some further aspects regarding economic and political feasibility, such as the assessment costs or the different EU Member States' maturity levels on smartness, still need to be evaluated and decided by the implementing authorities.

For residential buildings, abbreviated method A is as effective as extended method B (which is longer and more expensive) to estimate SRI levels

Implementing partners expressed their concern regarding Method B, which could add an additional burden on EPC certifiers. In Denmark they already have a complex and lengthy procedure for the EPC assessment, thus the inclusion of the SRI will add further time, and cost burdens. The implementing partners and stakeholders expressed concern that the increase in cost would be borne by the client, so there is a need for cost-effective business models. Experts from Austria suggested optimisation processes and automation in data collection, achieved by integrating with the building logbook, and the use of smart metering and benchmarking. Those from Romania proposed a collaborative business model with utilities, which would compete for clients and could offer the SRI assessment for free.

The SRI could also be more relevant for large buildings, and its implementation is easier for non-residential ones. Therefore, a targeted implementation of the SRI to specific building typologies could be considered. An impact on the market of the SRI implementation could be an increase in the real estate value of new buildings compared to existing ones.

4.3.5 Consistency with existing policies and standards

The EPBD recast proposal of 2021 [25] foresees the integration of the SRI into the EPC as a voluntary scheme. The smart readiness indicator is particularly beneficial for large buildings with high energy demand; thus Article 13 reinforces the SRI for large non-residential buildings as of 2026. For other building typologies, the SRI rating should be optional. According to the proposal, the goals of the SRI indicator are multiple: the measurement of the buildings capacity to use ICT technologies, adjust to the needs of the occupants and the grid which improves energy performance. It also serves to raise awareness amongst building owners regarding the advantages of building automation.

The differences between country-specific legislation and the market maturity of smart utilities demand a high degree of flexibility when it comes to implementation rules. Differential implementation might increase the technological gap between the Member States. 55.6% of Greek stakeholders of the Workshop consider that some EU countries are better positioned to benefit from the SRI implementation than others.

The identification and analysis of possible options for implementing the SRI at the EU level and at the MS level involved the examination of equivalent frameworks as possible templates. Some models of other initiatives which are instructive for the SRI's governance include the Ecolabelling scheme and CEN/CENELEC standardisation bodies.

Compatibility with the EPC scheme

In contrast to other quantification schemes used in existing EPCs, the SRI calculation is intended to follow the same general methodology across all MS. If well-coordinated with EPC assessment, the SRI scheme might provide not only new information, but help improve current EPC evaluation quality and reliability. This is because some of the input data needed to assess both are the same or come from the same source. An important provision of the EPBD recast proposal [25] is the requirement for MS to set up EPC databases and a 'digital building logbook' which would gather information about the smartness of the building.

The Annex of the EPBD recast proposes the following indicators to be integrated into the EPC, which are relevant for the SRI:

- A yes/no indication whether a smart readiness assessment has been carried out for the building.
- The value of the smart readiness assessment (if available).
- Number and type of charging points for electric vehicles.
- Presence, type and size of energy storage systems.

The X-tendo tool recommends the display of a comprehensive SRI score, subdivided into three subcomponents (1) energy savings and maintenance, (2) comfort, ease and wellbeing, and (3) grid flexibility. Experts agree this is a good strategy because different end-users could be interested in different aspects of the SRI. However, some of them warn that EPC should display information regarding energy performance, and additional features may contribute to information overload with an increase in cost, as well as loss of the goal of the policy tool. Thus, they do not recommend the display of the SRI indicators on the first page. Greek stakeholders had divided opinions regarding the integration of SRI in the EPC assessment, with 44.4% in favour and 55.5% expressing doubts. Some experts advised compulsory implementation only for specific building typologies. However, they admitted that residential buildings, even though displaying low SRI scores, could raise awareness among homeowners. At the same time, Austrian stakeholders expressed the concern that SRI is relevant mainly for energy suppliers, public authorities and funding authorities, and less for homeowners, who would have to pay for it.

4.4 Estimation of the quantitative replicability potential

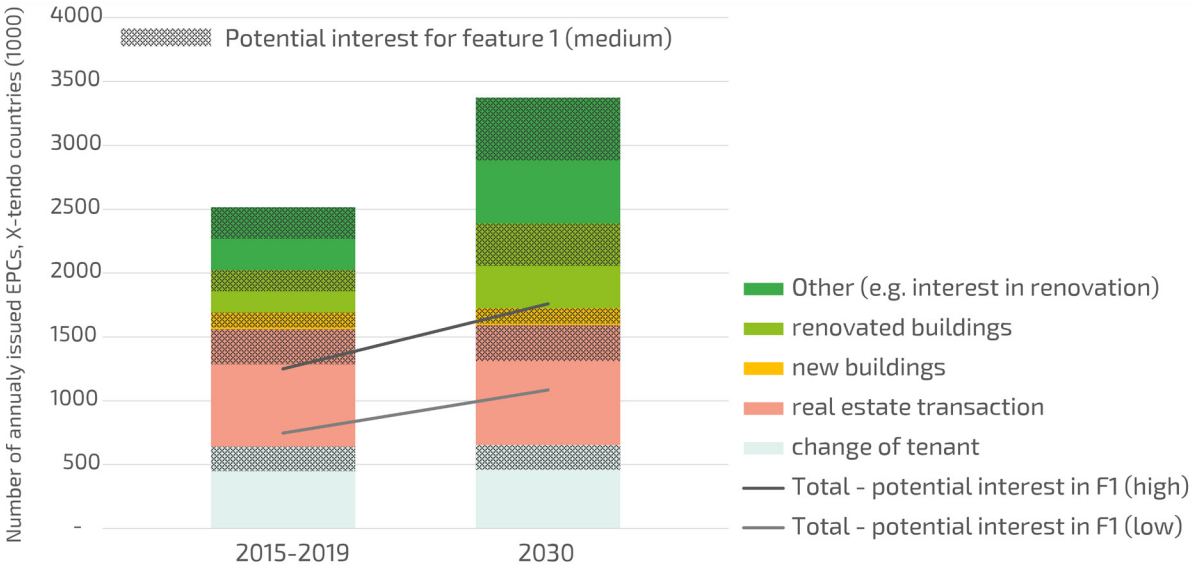
In this chapter, an estimation of the quantitative replicability potential of this feature is provided in the X-tendo countries. This follows the methodology described in section 3.

Figure 1 shows the number of annually issued EPCs, with the different trigger points in the X-tendo countries. In the period 2015-2019, about 2.5 million EPCs were issued annually. The largest part resulted from real estate transactions, followed by new building construction, while EPCs due to the change of tenant and building renovation, according to our data and the chosen assumptions, have lower relevance. In shaded colours, the figure shows the share of EPC end-users which potentially show special interest in this feature, according to the factors determined in *Table 13* and *Table 14*[1] in *Annex 1*. A high relevance is assumed in particular for new buildings and building renovation, leading to a range of 30%-50% of all EPC end-users showing potential interest in the results of the SRI feature. The total number of interested EPC-end-users for all trigger points is estimated to be around 0.75 to 1.25 million in the base year which may increase to 1.09 to 1.76 million EPC end-users in the year 2030, which is indicated by the grey lines. The bandwidth (low-high) results from two factors: (1) The potential interest of EPC end-users was categorised, each representing a range, such as 20-40% of EPC end-users are estimated to be interested. (2) The interest may differ significantly between the buyer and the seller, in particular when a building does not perform very well according to a certain indicator. Therefore, for the "lower" case a lower value of interest (typically the interest of the seller) is assumed whereas for the "higher" case a higher value (typically representing the interest of the buyer) is considered. For Feature 1 no strong difference in interest in the SRI is given for the buyer vs. the seller is estimated. Thus, the difference in results is only from the bandwidth of the estimation.

The share of various trigger points is quite different in the X-tendo countries, with a very different share of rented buildings or real estate transactions. This leads to a different weighting of the number of potentially interested EPC end-users in each country. This is reflected in the results in Table 15 of Annex 1. Since Poland and Romania have the highest share of new building construction as a trigger for EPC issuing, the relevance of this feature is particularly high in these countries (in a range of about 50-70% of all EPCs, while the average in X-tendo countries is 30-50%).

[1] The shaded areas (labelled as medium) in Figure 1 were derived as the average of the low/high range depicted in Table 14.

Figure 1 – Number of annually issued EPCs by trigger points and the estimated share of potentially interested EPC end-users, total of X-tendo countries (Feature 1). Historical data 2015-2019, projection until 2030.



4.5 Next steps for implementation

4.5.1 Calculation method and quality assurance

One of the biggest challenges of the SRI scheme will be to deliver a significant volume of assessments within the first years of implementation. The best way to ensure good market penetration would be to combine the scheme, on a mandatory basis, with other existing schemes such as the EPC. Linking the SRI to new building development and major renovations could also accelerate its deployment. A third promising approach is to develop a market-based voluntary scheme in which self-assessment is supported by online tools or in which certified professionals are hired to perform the evaluation (remunerated by owners and/or state agencies). Additional pilot studies to certify the validity of the method developed may be needed. Hence, the next step would be the selection and testing of the scheme in some targeted areas within the EU territory with a large piloting approach.

Another aspect of realising quality assurance is to provide training in some categories for the EPC assessors, who lack the required technical background. A recommended strategy from the experts is to start with the implementation of the simplified method, which requires less or no training and to implement more complex calculation methods at a later stage. The steps of implementation would be firstly, a voluntary certification which can be applied to all buildings and secondly, an initial mandatory implementation, for office buildings which would be required to meet specific SRI goals.

4.5.2 Capacity building for delivery bodies and training needs for assessors

The training and skills required for SRI assessment depend on the type of method used and the type and size of the building. While an intermediate level of awareness is sufficient to assess SRI levels through method A, method B requires an expert degree of knowledge and can be only performed by SRI certified assessors.

Training needs can therefore be divided between guidance and training to support local self-assessment and training of third-party assessors. Training costs are not yet appropriately estimated and will vary across Member States. Potential barriers to delivering a validated accreditation include training costs and the lack of trained assessors during the initial stages. The costs associated with establishing a pool of qualified assessors would be reduced if training programmes first target experts already certified through other schemes in Member States.

4.5.3 Political discourse/market or end-user awareness

The main strategy for implementation is integrating the SRI with other existing schemes such as the EPC or DBL to reduce costs and provide complementary information. Creating a common assessment framework within the EPC would lead to new market opportunities and the creation of business models for existing and future stakeholders. The next step is to elaborate on further tools to solve the main implementation issues: assessment costs, national divergence, market value, etc. Experts recommend the simplified method for residential buildings.

An important aspect in the development of the common methodology is increasing the accessibility of information through digitalisation of the services. The development of SRI will run in parallel to the development of DBL and the quality assurance of the EPC databases. When Member States implement SRI, the calculation method should be in line with the respective current EPC calculations, ensuring the maximisation of any overlap in inputs. The next steps in implementation are to include it in the EPC software and test beta versions.

The overall SRI score and the three subcomponents (1) energy savings and maintenance, (2) comfort, ease and wellbeing, and (3) grid flexibility are expressed in percentages. This choice of unit is motivated by the difficulty for the end-users to grasp the concept of smartness, as well as of technical units such as kWh/m^2. The experts agree that the choice of percentages and the subdivision of information into three sub-indicators may contribute to the user-friendliness of the tool. However, some concepts such as a percentage of grid flexibility could still be difficult to interpret, thus an additional verbal explanation when the EPC is handed over to the homeowner is advised. Another strategy to make SRI relevant to the homeowners would be to formulate EPC recommendations based on it, ideally tailored and containing cost/benefit analysis.

4.6 Conclusion

The 2021 EPBD recast [25] proposed the mandatory introduction of SRI as a voluntary rating and reinforces the Smart Readiness Indicator for large non-residential buildings as of 2026. To facilitate development of new services related to buildings, a new Article 14 specific to building data ensures that the building owner, tenant and manager or third parties can have access to building systems' data. New rules on data interoperability and access to data are to be laid down by the Commission by means of an implementing act.

Regarding replicability, end-users indicated a high interest in this feature during earlier investigations. This has been affirmed by the quantified impact, based on trigger points, indicated in **Annex 1**. A high relevance is assumed in particular for new buildings and building renovation, leading to a range of 30%-50% of all EPC end-users showing potential interest in the results of the SRI feature. Thus, the total number of interested EPC end-users for all trigger points is estimated to about 0.746-1.25 million during the base year. This may increase to 1.085-1.76 million EPC end-users in the year 2030. Since Poland and Romania have the highest share of new building construction as a trigger for EPC issuing, the relevance of this feature is particularly high in these countries.

Key takeways:

- The simplified method appears to be best suited for the first stage of the implementation of SRI since it does not require too much additional training and costs.
- Specific building typologies such as large-scale non-residential buildings with high energy demand might require a more detailed method and minimum requirements to be set at later stages.
- If included in the EPC scheme, the overall SRI indicator should be complemented with three sub-indicators, which should not be placed on the first page of the certificate.
- End-users might have difficulties grasping concepts such as smartness or grid flexibility, thus a link between the SRI and EPC recommendations would make these concepts more relevant for the homeowners.
- For residential buildings, the simplified method would contribute to raising awareness among building owners and help them understand the value of automation in saving energy while increasing comfort.

Key action points:

- Define national strategies for implementation as voluntary or mandatory schemes of the two methods depending on the building typology.
- Test communications strategies of the indicators, to make them relevant for the end user.

5

CONCLUSIONS AND POLICY RECOMMENDATIONS

Overall, the ten features developed and tested in the X-tendo project provide a promising direction to advance the existing EPC schemes. It would not only support taking necessary measures for enhancing the energy performance but extend it beyond that as well. Provision of information to owners and tenants as well as relevant market actors is necessary to give a push to renovation rates and depths across the EU. Each feature aims to enrich the EPCs with such information that enables decision-making by stakeholders. The features developed in the project were tested in X-tendo countries and then the experts who tested them provided deeper insights and appropriate directions, drivers and barriers investigated from social, economic, market and policy perspectives which provided a realistic estimation for its implementation and replicability across the different Member States. Quantitative impact assessments using the trigger points for each feature were conducted to evaluate the impact of feature implementation in terms of increase in share of EPCs. While it is clear that most of the features are directly useful to the end-user, others are meant for quality assurance such as EPC database, tracking progress by public authorities such as district heating, and planning and setting targets for environmental policies using the outdoor air pollution feature.

Each feature is distinct in its application and entails careful planning for its implementation across the Member States. Findings stated thereof in this report from the X-tendo countries are promising and could be replicated in other Member States after careful evaluation in the context of their existing EPC regime. The developed features are provided in the form of a toolbox for public authorities so that it enables effective implementation of more than one feature in the update of the EPC system. All the features build on existing EPC data with additional data inputs that may entail additional training for EPC assessors.

Some key general conclusions derived for all the features are:

- An underlying need for all the features is the establishment of the right conditions and quality assurance of EPC databases at national level giving access to public and other relevant stakeholders.

- New or revised EPCs must not be burdened with a lot of new information for the end-user. Information on the first page must be prioritised for the end-user application. Thus, it should be considered which information is presented on the EPC (on paper) and which on the digital EPC or DBL.

- New features must not overload the assessor's work because it risks the quality, cost and reliability of EPCs.

- Automation and simplification of procedures are necessary for overcoming major issues regarding interoperability and data exchange.

- User-friendliness of features is highlighted as one of the most important drivers during tests of all features and more research is needed in this regard, because so far, most features were tested with experts, not with end users.

- EPCs must be coherently linked with other instruments such as DBL and building renovation passports to increase their impact.

- Training is required for some features to upskill and improve the competence of the workforce responsible for delivering EPCs. Some features do not require training at all, while others have methods, either simple or complex, with different training needs.

- New features must be voluntary in the initial stages of implementation and should be integrated once they showcase acceptance and demand in the building sector.

- All the features are compatible for different building typologies and construction periods. Some features have two calculation methods, one more simple and less reliable, while the other is more complex and reliable. Each method can fit different building typologies (e.g. a detailed SRI is needed for large commercial buildings, CARP and CORP of the comfort tool can be used for school, office and residential buildings).

- Calculation methods were adjusted for individual test countries. However, this presented challenges in different aspects such as missing databases to complete calculations, measurement issues, regional restrictions due to Covid-19, etc.

- All the features have the potential to increase the uptake of renovation if implemented, however, this varies for features that are more directed toward public authorities.

- Stakeholders consider GDPR to be a major barrier for many of the features. Therefore, it requires careful evaluation at Member State level for successful implementation, since it can be shown that the understanding of GDPR issues in the context of EPC data is very different in different EU Member States.

- It is important to establish partnerships and alliances between public and private stakeholders to overcome the market barriers and enable affordable solutions for the implementation of the features.

- Some features demonstrate a marginal increase in cost burden for the end-users of EPC, while some need specific mechanisms to be set up to function (e.g. enhanced recommendations, EPC databases).

Achieving a balance between targets, standards and support measures is necessary to achieve the decarbonisation of the building sector and EPC is a promising policy instrument capable of advancing the EU in this direction. The revised EPBD emphasises that better coverage of the building stock with EPCs is a precondition for its improvement, but at the same time Member States would need to ensure that they are affordable. It also mentions that the EPC should provide additional information to the owner or tenant to foster renovation of the building sector. This would provide a necessary push to unlock private and public funding and subsidies.

X-tendo features were developed from this perspective to empower the end-user with more information and help them take necessary actions for renovation. All the features have been found to have relevance in the test countries with differences in needs and application. Experts found that all the data gathered by the new features is highly relevant for public authorities, but not all outputs are relevant to the end-user. They stressed the importance that the EPC should not lose its main focus and purpose (energy performance) and other outputs can be provided in the DBL.

National policies are framed under the regulations set out in EPBD, thus the X-tendo project has identified a series of recommendations for policy uptake and formulation that would be beneficial in the implementation of new features. These have been compiled below after rigorous development and testing of features in the X-tendo countries.

Next steps for a successful implementation

Plan and prepare mechanisms to link EPCs with new instruments such as Building Renovation Passports, DBL and SRI.

Revise EPC calculation methodologies with a vision to integrate new features developed following the European Standards.

Set up independent control systems to ensure data for EPCs is of high quality.

Ensure that the EPC schemes are in line with more ambitious EU and national goals and targets.

Promote the implementation of new features using market and non-market mechanisms to raise awareness among the public and other relevant stakeholders.

The new features can help to track the progress on policies and support in enforcing mandatory standards by using EPCs for compliance.

Conduct cost-benefit analysis at national level to determine the feasibility of features and their economic impact to build trust in markets.

Selective implementation and independent pilot studies in national contexts would support in meeting MS individual policy goals.

Evaluate national or regional building stock characteristics and estimate the need for new developed features.

Incorporate medium and long-term horizons for the upgradation of the EPC system and on-set of new features.

Advancing comparability and consistency

Promote comparability of features across Member States by following harmonised approaches at EU level.

Consistency with regional policy and standards must be maintained to promote acceptability and reliability of new features.

Set up more ambitious and rigorous quality check mechanisms in EPCs, EPC databases, and check consistencies within and between databases.

Phase-out redundant EPC systems and provide continuous access to interoperable databases, thus increasing transparency and trust.

Adopt standards, methods and tools that promote transparency and accountability in the EPC system.

Market, business models and training needs

Encourage an integrated approach to renovation using the new features and promoting wider benefits such as health and environmental benefits.

Foster collaboration between private and public actors in creating an environment and enabling conditions for supporting job creation and increase investments in renovation with features such as DBL and OSS.

Consider GDPR in data handling of the new features, ensure that data is owned by the homeowner and avoid business models based on trading data.

Promote more collaborative and open-source knowledge systems for EPCs.

Promote the implementation of new features using market and non-market mechanisms to raise awareness among the public and other relevant stakeholders.

Support the implementation of additional features with a more complex methodology including the training and upskilling of EPC assessors.

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ANNEX 1

7.1 Methods and data for estimation of the quantitative impact of implementation of new EPC features

For each country and considered year the following equations were applied to estimate the number of annually issued EPCs (E).

$$E = E_{tenant} + E_{sales} + E_{new} + E_{reno} + E_{other}$$

with

E	Number of annually issued EPCs
E_{tenant}	Number of annually issued EPCs triggered through the change of a tenant
E_{sales}	Number of annually issued EPCs triggered through the sale of a property
E_{renov}	Number of annually issued EPCs triggered through building renovation
E_{other}	Number of annually issued EPCs triggered through other occasions, e.g. the need for advice for renovating the building

In case of rented single family houses or in case that in a certain country an EPC needs to be issued for each apartment of an apartment buildings, E_{tenant_1} applies:

Under the assumption that

$$T_{contract} > T_{EPC}, E_{tenant\_1} = \frac{n_{tenant}}{T_{contract}}$$

Whereas, for apartment buildings in countries where for these buildings only one EPC needs to be issued, E_{tenant_2} applies:

Under the assumption that

$$T_{contract} > T_{EPC}, E_{tenant\_2} = \frac{n_{tenant}}{n_{dwell}(T_{EPC} + \varepsilon)}$$

with

$T_{contract}$	Average duration of Tenancy contracts
T_{EPC}	Validity period of EPCs
n_{tenant}	Total number of rented dwellings and non-residential buildings
n_{dwell}	Average number of dwellings per building
ε	Factor, considering the deviation of changing tenants and the validity of EPCs over time; assumed to be 20% of the validity period of EPCs

For the other trigger points j, the following equation is applied:

$$E_j = \sum_i n_{j,i} \cdot f_{j,i}$$

with

$n_{j,i}$ Number of trigger point (i.e. number of dwellings and non-residential buildings being sold (excluding new buildings, being constructed, being renovated or other) in building category i.

$f_{j,i}$ Correction factor, considering e.g. that some non-residential buildings might not need an EPC, or that for apartment buildings in some countries only one EPC per building needs to be issued.

The number of EPC end users potentially interested in a certain feature k (E_k^*) was determined by estimating the share of interested end-users per trigger point j and feature k ($S_{j,k}$)[12] in certain ranges and partly distinguishing whether the interest refers to the buyer or the seller (or the tenant/landlord) of property. Subsequently, the number of potentially interested EPC end-users is estimated by following equation:

$$E_k^* = \sum E_{j,k} \cdot S_{j,k}$$

As described in *Table 13* and *Table 14*, the factors $S_{j,k}$ were estimated by project partners leading the development of the feature in the project. Thus, there is some subjectivity in the assessment and comparison between features is possible only to a limited extent.

For the 2030 projection, it was assumed that the number of tenants, real estate transactions and new building constructions follows the same linear trend as in the past 10 years, while all the factors specified above remain the same. For the number of renovated buildings, we assumed a doubling of the number from the period 2015-2019. In addition to the renovated buildings, it is assumed that another 50% of building owners is interested in receiving advice for building renovation (i.e. the trigger point "other"). Overall, a strong increase in building renovation activities, moving towards the targets of the fit-for-55 package is assumed.

According to the approach described in *chapter 3*, the number of EPCs issued for each trigger point are estimated. For this purpose, historical data is used on the trigger points, i.e. on the number or real estate transactions, number of rented dwellings and building permits, if available by type of building according to sources in *Table 12*.

[12] See Table 13 and Table 14

Table 12 – Data sources of trigger points

Country	Data sources
Austria	European Central Bank - Statistical Data Warehouse. *https://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=430.RESH.A.AT._T.N._TR.NTRA.AT2._Z.N._Z*. 22 Feb 2022; Österreichische Nationalbank. *https://www.oenb.at/Publikationen/Volkswirtschaft/immobilien-aktuell.html.* 09 Feb 2022; Statistics Austria. *http://www.statistik.at/web_en/statistics/PeopleSociety/housing/housing_conditions/index.html.* 09 Feb 2022; Statistics Austria. *https://statcube.at/statistik.at/ext/statcube/jsf/tableView/tableView.xhtml.* 09 Feb 2022; Statistics Austria. *https://www.statistik.at/web_de/statistiken/menschen_und_gesellschaft/wohnen/wohnungs_und_gebaeudeerrichtung/fertigstellungen/026021.html.* 03 March 2022;
Belgium	Eurostat. *http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do.* 02 March 2022; Statbel (Directorate General Statistics - Statistics Belgium). *https://statbel.fgov.be/en/open-data/sales-real-estate-belgium-according-nature-property-land-register.* 01 Feb 2022; Statbel (Directorate General Statistics - Statistics Belgium). *https://statbel.fgov.be/en/themes/housing/building-stock#figures.* 03 Feb 2022; Statbel (Directorate General Statistics - Statistics Belgium). *https://statbel.fgov.be/en/themes/housing/building-permits#figures.* 14 Feb 2022;
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Estonia	European Central Bank - Statistical Data Warehouse. *https://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=430.RESH.A.EE._T.N._TR.TOOT.EE2._Z.N.RO.* 24 Feb 2022; Republic of Estonia Land Board. *https://www.maaamet.ee/kinnisvara/htraru/Result.aspx.* 03 Feb 2022; Statistics Estonia. *https://andmed.stat.ee/en/stat/majandus__ehitus__ehitus-ja-kasutusload/EH045/table/tableViewLayout2.* 14 Feb 2022; Statistics Estonia. *http://andmebaas.stat.ee/Index.aspx?lang=en&DataSetCode=KVE01#. 24* March 2022; Statistics Estonia. *https://andmed.stat.ee/en/stat/majandus__ehitus__ehitus-ja-kasutusload/EH046/table/tableViewLayout2.* 15 Feb 2022;

Country	Data sources
Greece	European Central Bank - Statistical Data Warehouse. *https://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=430.RESH.A.GR._T.N._TR.NTRA.GR2._Z.N._Z*; 21 Feb 2022; European Central Bank - Statistical Data Warehouse. *https://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=430.RESH.A.GR._T.N._TR.NPRO.GR2._Z.N._Z.* 21 Feb 2022; European Central Bank - Statistical Data Warehouse. *https://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=381.SHI.A.GR.TOOT.P.* 21 Feb 2022; European Central Bank - Statistical Data Warehouse. *https://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=381.SHI.A.GR.TRAT.P.* 21 Feb 2022; Hellenic Statistical Authority. *https://www.statistics.gr/en/statistics/-/publication/SOP03/2021-M10.* 17 Feb 2022;
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Poland	European Central Bank - Statistical Data Warehouse. *https://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=430.RESH.A.PL._T.N._TR.NPRO.PL2._Z.N._Z*. 16 Feb 2022; European Central Bank - Statistical Data Warehouse. *https://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=430.RESH.A.PL._T.N._TR.TRAT.PL2._Z.N.RO.* 16 Feb 2022. Statistics Poland. *https://stat.gov.pl/en/topics/municipal-infrastructure/municipal-infrastructure/real-estate-sales-in-2020,2,13.html.* 08 Feb 2022; Statistics Poland. *https://stat.gov.pl/en/topics/industry-construction-fixed-assets/construction/construction-results-in-2020,1,14.html.* 28 Feb 2022;

Country	Data sources
Portugal	Eurostat. *http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do.* 07 March 2022; Statistics Portugal. *https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_indicadores&indOcorrCod=0008330&contexto=pi&selTab=tab0&xlang=en.* 10 Feb 2022; Statistics Portugal. *https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_indicadores&indOcorrCod=0007838&contexto=bd&selTab=tab2.* 10 Feb 2022; Statistics Portugal. *https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_publicacoes&PUBLICACOESpagenumber=1&PUBLICACOEStema=55534.* 10 Feb 2022; Statistics Portugal. *https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_indicadores&indOcorrCod=0009632&contexto=bd&selTab=tab2.* 10 Feb 2022; Statistics Portugal. *https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_indicadores&indOcorrCod=0008329&contexto=bd&selTab=tab2.* 10 Feb 2022; Statistics Portugal. *https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_indicadores&indOcorrCod=0008320&contexto=bd&selTab=tab2.* 17 Feb 2022; Statistics Portugal. *https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_indicadores&indOcorrCod=0008335&contexto=bd&selTab=tab2.* 17 Feb 2022; Statistics Portugal. *https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_indicadores&indOcorrCod=0008334&contexto=bd&selTab=tab2.* 17 Feb 2022; Statistics Portugal. *https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_indicadores&indOcorrCod=0008330&contexto=bd&selTab=tab2&xlang=en.* 17 Feb 2022;
Romania	European Central Bank - Statistical Data Warehouse. *https://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=430.RESH.A.RO._T.N._TR.NPRO.RO2._Z.N._Z.* 15 Feb 2022; European Central Bank - Statistical Data Warehouse. *https://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=381.SHI.A.RO.TOOT.P.* 15 Feb 2022; European Central Bank - Statistical Data Warehouse. *https://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=430.RESH.A.RO._T.N._TR.TRAT.RO2._Z.N.RO.* 15 Feb 2022; National Institute for Statistics – ROMANIA. *http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table.* 22 Feb 2022; Paul Cosmin Alin ENACHESCU & Genifera Claudia BANICA, 2019. "Analysis Of The Real Estate Market In Romania From The Point Of View Of The Number Of Transactions During 2009-2018," Scientific Bulletin - Economic Sciences, University of Pitesti, vol. 18(3), pages 39-46. *https://ideas.repec.org/a/pts/journl/y2019i3p39-46.html.* 08 Feb 2022;
Scotland	Registers of Scotland. *https://www.ros.gov.uk/data-and-statistics/house-price-statistics.* 07 Feb 2022; Scottish Government. *https://www.gov.scot/publications/housing-statistics-stock-by-tenure/.* 07 Feb 2022; Scottish Government. *https://www.gov.scot/publications/housing-statistics-for-scotland-new-house-building/.* 07 Feb 2022;

For the countries AT, DK, EE, PL, and PT it is considered that in case of apartment buildings, in most cases there is only one EPC issued for the whole building, not for each apartment. For the countries BE, GR, IT, RO and the UK (Scotland) it is considered that EPCs need to be issued for each apartment.

The resulting historical time series for the issued EPCs were then compared to the total number of issued EPCs according to reports [27][28] and selected sources from Table 12. The deviations were calibrated using the approach to the historical and observed data. Subsequently, the relevance of trigger points for each feature is estimated. For this purpose, the share of EPC end-users is estimated, for which the feature might be interesting along the various trigger points. As the tables below indicate, the relevance might differ between the buyer and seller perspectives. This was taken into account by considering both perspectives, where relevant and adding this to the range of results (high/low).

Table 13 – Relevance of trigger points for each feature: Share of EPC end-users for which the feature might be interesting in different trigger points

	New building construction	**Building retrofitting (mandatory or not)**	**Real estate transaction**	**Other (e.g. interest in the improvement of building's energy performance)**
SRI F1	High; insight in impact is relevant for the owner of the new building for the 3 key functionalities; 1) comfort; 2) energy efficiency and operational performance; 3) interaction with the grid.	Medium; insight in impact is relevant for the owner of the building for retrofitting for the 3 key functionalities; 1) comfort; 2) energy efficiency and operational performance; 3) interaction with the grid.	Medium-Low for the seller; unless it shows good results as a selling argument. For the buyer, insight in impact is relevant for the 3 key functionalities; 1) comfort; 2) energy efficiency and operational performance; 3) interaction with the grid.	Medium; SRI scores SRI in 3 key functionalities; 1) comfort; 2) energy efficiency and operational performance; 3) interaction with the grid; not all relate directly to energy performance.
Comfort F2	High; because Comfort (thermal, IAQ, acoustic, visual) has a direct relevance to the end-user especially in the residential sector.	Medium-High; if retrofitting is not mandatory and High if retrofitting is mandatory. Comfort assessment would be preferred by owners.	Medium-High; for buyers, High for sellers and Medium-high for renters. The interest would vary based on the type of transaction.	Low; co-relation of energy performance and comfort not very clear to the end-user.

	New building construction	Building retrofitting (mandatory or not)	Real estate transaction	Other (e.g. interest in the improvement of building's energy performance)
Outdoor air pollution F3	High; in terms of Indoor Air Purity Index, as the quality of internal environment is important for the users. Medium-Low; in terms of Local Air Pollution Contributor Index. The pollutant emissions from the building are less important for the users.	Medium; in terms of Indoor Air Purity Index, as the retrofitting measures might increase the quality (purity) of internal air. Medium; in terms of Local Air Pollution Contributor Index. The index can be used by the users to verify the environmental results of the modernisation.	Medium-Low; in terms of Indoor Air Purity Index, the value of the property can be higher if a better indoor environment is assured. In terms of Local Low, air Pollution Contributor Index. The pollutant emission for the building are not the most important parameters considered in real estate transaction.	High; both indexes can be used in verification of the building modernization results. In this case the Local Air Pollution Contributor Index has a higher value as the goal of the modernisation is to decrease emission.
Real energy consumption F4	Low; similar to EPC, but the indicator will only be available after a one-year operational period. May be implemented for commissioning and as such have indirect influence.	High; indication of actual energy performance forms the best basis for energy retrofitting decisions.	Medium-High for the buyer; is very relevant for indication of actual energy performance and cost. Medium-low for the seller; unless it shows good results as a selling argument.	High; indication of actual energy performance forms the best basis for energy retrofitting decisions.
District energy F5	Low; the main benefit of the feature for building owners / user is to a) compare performance of own system with nearby DH, or b) see if other decentral low-temperature supply options are interesting; both not relevant in case of new construction.	Medium-Low; benefit is as described in column new construction; in case of renovation this can be a bit more relevant; however, potentially other aspects will play a more important role.	Low; for rental will probably not be relevant, for buying most probably other factor more important.	Medium-Low for building owners/user; the feature is more relevant for public dministrations and their urban planning. Thus, the more data is available from issued EPCs, the better.

	New building construction	Building retrofitting (mandatory or not)	Real estate transaction	Other (e.g. interest in the improvement of building's energy performance)
EPC databases F6	Medium-High; the quality of the EPC and trust in the information is important and can influence the decision of buyers of a new building.	Low; the quality of the EPC may be less relevant in the cases where the building is occupied by the owner because they may assess the building's performance more based on their own behaviour.	Medium-High; the quality of the EPC and trust of the information is important and can influence the decision of buyers of existing buildings.	High; In general. many actors have high quality EPCs and trustworthy information on that document.
Logbook F7	Medium; the construction phase is key to collect detailed information about the building, material and embodied carbon levels. Registering this data in a logbook can be linked to various private certifications, which can be valuable to the building owner.	Medium-High; logbooks enable better decision-making throughout the building lifecycle, including for energy renovations. Having all the information in one place is something building owners have been requested and something that can simplify the renovation process.	Medium; the construction phase is key to collect detailed information about the building, material and embodied carbon levels. Registering this data in a logbook can be linked to various private certifications, which can be valuable to the building owner (i.e. increase the financial value of the asset).	Medium-High; logbooks enable better decision-making throughout the building lifecycle, including for energy renovations. Having all the information in one place is something building owners have requested and something that can simplify the renovation process.
Enhanced recommendations F8	Low; the main benefit of the feature for building owners / user is to a) compare performance of own system with nearby DH, or b) see if other decentral low-temperature supply options are interesting; both not relevant in case of new construction.	Medium-Low; benefit is as described in column new construction; in case of renovation this can be a bit more relevant; however, potentially other aspects will play a more important role.	Low; for rental will probably not be relevant, for buying most probably other factor more important.	Medium-Low for building owners/user; the feature is more relevant for public dministrations and their urban planning. Thus, the more data is available from issued EPCs, the better.

	New building construction	Building retrofitting (mandatory or not)	Real estate transaction	Other (e.g. interest in the improvement of building's energy performance)
Financing schemes F9	Low; since usually financing schemes are given for energy efficiency improvement of existing buildings.	High; since usually financing mechanisms are related to the building renovation, namely the improvements related to energy efficiency.	High; EPCs are usually mandatory to be issued during the buy or rental of buildings, and therefore there might be some specific mechanisms that use the EPC as eligibility criteria. This can also be relevant to buyers to advise if there are financing mechanisms available to improve their future house.	High; the interest in improving the building energy performance of a house can be the trigger point for looking for funding.
One Stop Shop F10	Low; since usually one-stop-shops have information about the existing building and provide technical assistance to improve the existing house.	High; since usually one-stop-shops have information about the existing building and provide technical assistance to improve the existing house.	Low; since usually it is necessary to be a homeowner to have access to the information/ technical assistance available in the one-stop-shop. A potential buyer does not have access to the information of the house available in the OSS unless they are the owner.	High; the interest in improving the building energy performance of a house can be the trigger point for using the OSS to search for funding opportunities, technical assistance and get closer to the construction market.

Note

Rating	Percentage range
High	100-80%
Medium-High	80%-60%
Medium	60%-40%
Medium-Low	40%-20%
Low	20%-0%

The qualitative arguments, the rating table and discussion points were transferred into the following table, which was then used for the calculation of the share of EPC end-users for which the feature might be interesting, considering upper and lower boundaries as "high" and "low".

Table 14 – Quantitative summary - Relevance of trigger points for each feature: Share of EPC end-users for which the feature might be interesting in different trigger points

	Change of tenant	Real estate transaction (buyer)	Real estate transaction (seller)	New building construction	Building retrofitting (mandatory or not)	Other, in particular: general interest in the potential improvement of building energy performance
F1	20%-40%	20%-40%	20%-40%	80%-100%	40%-60%	40%-60%
F2	60%-80%	80%-100%	60%-80%	80%-100%	60%-80%	0%-20%
F3 (indoor)	20%-40%	20%-40%	20%-40%	80%-100%	40%-60%	80%-100%
F3 (outdoor)	0%-20%	0%-20%	0%-20%	20%-40%	40%-60%	80%-100%
F4	60%-80%	60%-80%	20%-40%	0%-20%	80%-100%	80%-100%
F5 (low-temp)	0%-20%	60%-80%	0%-20%	80%-100%	60%-80%	60%-80%
F5 (DH-PEF)	0%-20%	40%-60%	0%-20%	60%-80%	20%-40%	20%-40%
F6	60%-80%	60%-80%	60%-80%	60%-80%	0%-20%	20%-40%
F7	40%-60%	60%-80%	20%-40%	40%-60%	60%-80%	60%-80%
F8	0%-20%	80%-100%	0%-20%	0%-20%	60%-80%	80%-100%
F9	0%-20%	80%-100%	0%-20%	0%-20%	60%-80%	80%-100%
F10	0%-20%	0%-20%	0%-20%	0%-20%	60%-80%	80%-100%

With $n_{t,i}$, the number of EPCs issued in year t due to trigger point i, the number of potentially interested EPC end-users in feature j is calculated as $\sum_i n_{t,i} f_{i,j}$, while the values in *Table 14* represent the shares $f_{i,j}$, where the lower and the upper range from *Table 14* is considered as the "low" and "high" result in the quantitative assessment of each feature.

Table 15 – Share of potentially interested EPC end-users by feature and country, 2030

		F1	F2	F3 (indoor)	F3 (outdoor)	F4	F5 (low-temp)	F5 (DH-PEF)	F6	F7	F8	F9	F10
LOW(+)	AUSTRIA	40%	66%	40%	12%	40%	32%	20%	50%	40%	10%	10%	10%
	BELGIUM	34%	46%	44%	30%	51%	33%	14%	39%	42%	31%	31%	31%
	DENMARK	41%	56%	47%	22%	42%	37%	21%	47%	42%	19%	19%	19%
	ESTONIA	38%	41%	53%	38%	49%	42%	18%	36%	44%	38%	38%	38%
	GREECE	28%	46%	38%	26%	64%	24%	8%	41%	46%	29%	29%	29%
	ITALY	34%	39%	48%	39%	60%	39%	14%	32%	47%	43%	43%	43%
	POLAND	46%	63%	49%	16%	24%	39%	26%	54%	35%	10%	10%	10%
	PORTUGAL	24%	61%	24%	2%	33%	6%	4%	59%	29%	1%	1%	1%
	ROMANIA	48%	56%	55%	27%	32%	47%	28%	45%	40%	22%	22%	22%
	SCOTLAND	40%	63%	42%	11%	23%	30%	20%	56%	32%	6%	6%	6%
HIGH (*)	AUSTRIA	60%	89%	60%	32%	66%	62%	47%	70%	67%	43%	43%	30%
	BELGIUM	54%	73%	64%	50%	84%	73%	47%	59%	75%	78%	78%	51%
	DENMARK	61%	80%	67%	42%	69%	68%	48%	67%	69%	53%	53%	39%
	ESTONIA	58%	67%	73%	58%	83%	81%	51%	56%	77%	85%	85%	58%
	GREECE	48%	68%	58%	46%	88%	50%	32%	61%	70%	57%	57%	49%
	ITALY	54%	64%	68%	59%	90%	72%	43%	52%	76%	81%	81%	63%
	POLAND	66%	91%	69%	36%	59%	82%	61%	74%	70%	60%	60%	30%
	PORTUGAL	44%	92%	44%	22%	76%	61%	47%	79%	72%	68%	68%	21%
	ROMANIA	68%	83%	75%	47%	65%	86%	60%	65%	73%	68%	68%	42%
	SCOTLAND	60%	93%	62%	31%	63%	80%	60%	76%	72%	66%	66%	26%

(*) Low and High shares result from the ranges indicated in *Table 14*.

GLOSSARY OF TERMS

AQI	Air Quality Index
BIM	Building Information Modelling
BREEAM	Building Research Establishment Environmental Assessment Method
CARP	Comfort Assessment Rating Procedure
CHP	Combined Heat and Power
CO_2	Carbon Dioxide
CORP	Comfort Operational Rating Procedure
Covid-19	Infectious disease caused by SARS-CoV-2 virus
DBL	Digital Building Logbook
DGNB	Deutsche Gesellschaft für Nachhaltiges Bauen
DH	District Heating
DHW	Domestic Hot Water
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificate
GDPR	General Data Protection Regulation
GHG	Greenhouse gas
HVAC	Heating, Ventilation and Air-Conditioning
IAPI	Indoor Air Purity Index
IAQ	Indoor Air Quality
IEQ	Indoor Environmental Quality
LAPCI	Local Air Pollution Contributor Index
LEED	Leadership in Energy and Environmental Design
LTRS	Long-term Renovation Strategies
MEPS	Minimum Energy Performance Standards
MFH	Multi-Family House
MS	Member State
MVHR	Mechanical Ventilation and Heat Recovery
nZEB	Nearly Zero-Energy Building
OSS	One-Stop Shop
PA	Public Administration
PEF	Primary Energy Factor
RH	Relative Humidity
ROI	Return On Investment
SFH	Single-Family House
SRI	Smart Readiness Indicator
T	Temperature

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AAECR Asociația Auditorilor Energetici pentru Clădiri din România

ENEA

BPIE

КАПЕ CRES

Danish Energy Agency

adene Agência para a Energia

ENERGIE AGENTUR Steiermark

energy saving trust

ethink ENERGY RESEARCH

NAPE NATIONAL ENERGY CONSERVATION AGENCY

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 845958.