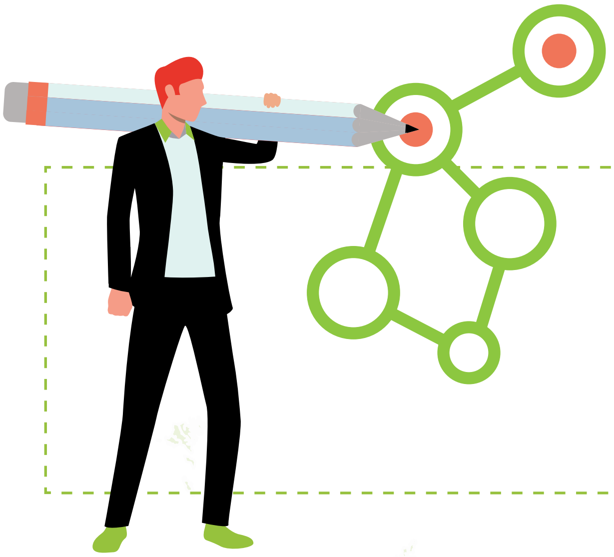

X-tendo

FEATURE 7:

BUILDING LOGBOOKS

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

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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

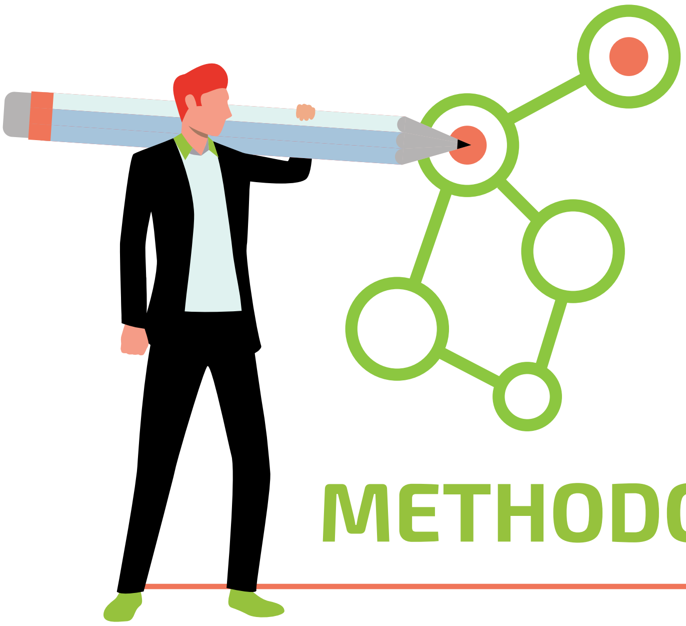
2 OBJECTIVE OF THE REPORT

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 7: BUILDING LOGBOOKS

4.1 Overview

Digital Building Logbooks (DBLs) enable better decision-making throughout the building lifecycle, including management of technical and functional aspects, safety, conservation of economic value, certification, improved energy and environmental performance. DBLs are repositories for detailed building information. They act as a single point of input, access and visualisation of all the information associated with a building unit throughout its lifecycle.

Over the lifespan of buildings, data is routinely collected by multiple stakeholders for various reasons as many decisions rely on data availability. However, there is a lack of a common approach and structure among stakeholders which would make this wealth of information widely available, organised and easily accessible. Much of the data collected goes unused as it gets discarded, forgotten or is not compatible with other stakeholders' systems. The lack of an overarching structure shared across the built environment leads to information asymmetry, lack of transparency and higher risk for investment and renovation decisions.

Organised and shared data reduces uncertainty but also the time and cost needed for collecting missing information. Availability of granular performance and maintenance data in addition to the energy performance certificate (EPC) could provide a more robust and reliable indication of energy performance and reduce data gaps about the building's performance. Logbooks can enhance the overview of the entire building stock at all levels, allow public authorities to better tailor various measures, set benchmarks and strategies, as well as monitor progress toward climate goals (including through the national long-term renovation strategies). Equally, EPC data and databases are considered to be one of the most important sources of data for the initial population of logbooks. Establishing close links between EPC databases and building logbooks, could therefore mutually reinforce both tools.

The current feature developed three core aspects relevant to the building logbook: (1) a data template, (2) functionalities and benefits, and (3) data governance:

- Development of the logbook data model, including protocols for data capturing and data sharing (e.g. via a common web service).
- Stakeholder engagement over the use of data and access by third parties such as mapping of DBL-related benefits, costs, drivers and potential challenges, mapping of information flows, i.e. who needs what data, when, from what sources and in what form?
- Clarifications of data governance requirements (both legal and technical, such as GDPR, intellectual property rights, data access and storage).

4.2 Key insights from testing

Table 8 - Test projects summary in implementing countries for building logbooks

Country	PORTUGAL	GREECE	ESTONIA
Type of Testing	System & User Testing	System & User Testing	System Testing
Number of testing cases	2 functionalities and 15 beneficiaries	1 application and 10 stakeholders	1 application
Tool	Functionalities Development & User Questionnaire	Design of a Logbook Messaging Protocol - Development of a prototype of a logbook software system – User questionnaire	Desktop application test
Testing Period	06/2021 - 12/2021	07/2021 - 11/2021	08/2021 - 12/2022

System testing

System testing in evaluated different aspects of the DBL methodology developed in X-tendo. Portugal tested the two new functionalities within the casA+ platform and web service: (1) building components dashboard and (2) water & energy consumption monitoring. Estonia calculated and analysed renovation costs based on parameters derived from their building logbook application (Energiamonitor). In Greece a logbook messaging protocol was designed, and an application prototype was developed for the exchange of data between the EPC registry and a logbook:

- A building dashboard allowed the user to consult and edit some information about their home (e.g. walls, window glazing, lighting, appliances, equipment and renewable electricity).
- Water and energy consumption functionality allowed the user to monitor their consumption and compare them with others. It also gives their monthly bill for energy (€/kWh) and water (€/m^3).

User-testing

During the user testing in Portugal, the beneficiaries of the casA+ were invited to evaluate the new functionalities with the goal of collecting the homeowner's user experience. A questionnaire was prepared for this evaluation and completed by 15 registered homeowners in the casA+ portal. Most of the respondents were not aware of the building's dashboard functionality (79%). Considering the water and energy consumption functionality, 86% of the respondents were not aware of its availability in the DBL. They indicated that these functionalities will be very useful in both the context of the building logbook and a one-stop-shop. Most homeowners provided positive feedback and felt that the functionalities are fundamental to knowing more about their house and water/energy consumption. The tested DBL functionalities were considered to improve homeowners' understanding of the required improvement measures and behavioural change.

In the user testing in Greece, web meetings were held with the stakeholders in which the design elements of logbook and the design of a standard web-service providing interoperability between a building logbook and an EPC registry were discussed. The stakeholders were EPC registry administrators, energy experts, and engineering software developers. The respondents understood very well and were interested in the feature. They found that the feature would provide useful functionality for building owners and interoperability between relevant public sector applications. They also proposed that a central logbook should be implemented by a governmental agency but extensible by others; the RESTful-JSON architecture is best for the communication between the different logbook components. Thus, there is need for relevant legislation to enable these aspects at national level.

4.3 Drivers and barriers for a wide uptake of the feature

4.3.1 Calculation method and quality assurance

The DBL relies on existing databases, thus its quality assurance is highly linked to the trustworthiness of their data, as well as processes to enable interoperability, data consistency and information exchange. The member states are currently at different stages of digitalisation of the EPC database and the development of the DBL. A lack of digitalised EPC databases is a key barrier for automatised data transfer. The low quality of the EPCs, and thus of the EPC database is another important issue to be tackled. Experts consider that there are inconsistencies of the data within databases and between databases. The quality checks similar to those implemented by Feature 6 are being foreseen by the EPBD recast [25] and will continuously improve the quality and consistencies within the EPC database. It is not only an issue of errors but also of outdated data since the EPC is valid for 10 years and homeowners in this time can undertake light renovation measures, for example, changing windows. This data cannot be updated and overwritten unless a new EPC is issued. The DBL can further contribute to quality assurance if algorithms are set up to check the consistency between the databases. This can contribute to more frequent updates of the data compared to the EPC. Experts advise additional checks of the data by the PA before the information is introduced into the DBL.

The credibility of DBL is closely related to the quality of data and the reliability of sources. Data from public sources (e.g. EPC registries) is generally considered to be more reliable than information submitted by the owner for example. The data enclosed in the logbook will indicate the source and reliability of data, which can include:

- EPC data.
- General and administrative documentation for the identification of the building.
- Official documents related to building construction/renovation permits and real estate transaction contracts.
- Building plans and studies.
- Documentation on renovation works (invoices, materials certificates).
- Further documentation on energy performance, such as energy bills, as well as financial information on taxation, loans, market value etc. are considered to be of minor importance.

The mapping of different data sources will provide an overview of the different quality levels of the data.

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

The logbook is designed to bring a wide range of benefits to different actors involved in the building value chain, including non-professional users such as homeowners, tenants, public authorities or financial institutions. As such, the logbook must be user-friendly and easily accessible. Furthermore, the data should be linked to benefits and functionalities which enhances the value of the logbook and the buy-in from the homeowners (plus all other involved stakeholders).

Public awareness of DBLs is still relatively low due to the novelty of the scheme. Portuguese homeowners are not aware of the DBL as a standalone tool, they rather perceive it as part of the online services of the OSS. Similarly, the Greek public is not aware of the existence of the DBL, however, the associations of homeowners are. Some experts question the need for the general public to be aware of the DBL as a separate policy or that it is enough to be part of wider public services. Other experts consider it as a digital extension of the paper EPC, which can be consulted online for historical data. The divergence of views about the role of DBLs will hopefully be clarified in time as the tool becomes mainstream and additional (non-energy) modules and features will be incrementally added and enabled by logbooks.

Homeowners need to be incentivised to contribute data to the DBL (e.g. by uploading information from the building permit, project plans, BIM models, etc). They can be motivated by the convenience of having historical data on energy consumption in one place and easily at hand, instead of having different paper-based documents and bills laying around. This information can be presented in an attractive, user-friendly way. Digital logbooks can also provide alerts and reminders. However, split incentives concerning the collection and handling of data between tenants and owners will need to be addressed in due course.

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

Once the logbook platform is properly set up and operational, the end users will not require upskilling and training. By linking the logbook with other existing databases and tools such as building registries, environmental certification systems and BIM models, the logbook can act as a digital OSS and bring together building sector stakeholders, overcome value chain fragmentation and enable new/streamlined services. The data transfers and quality checks should be automatised. However, coordination between different departments of the public authorities will be necessary to set them up, as well as capacity to build IT public services.

4.3.4 Economic drivers and barriers

The main economic drivers for both public authorities and end users are cost savings and reduced red tape in accessing financial incentives. Attention must be paid to avoid potential confusion between various policies and public services, such as EPC, DBL, building passports, energy advice platforms or OSS. In Portugal, building experts play an important role as they are responsible for informing homeowners about the improvement measures recommended in the EPC and AQUA+ (Classificação de Eficiência Hídrica de Edifícios). Energy and Water efficiency companies are able to access parts of the DBL data (for example envelope or technical systems) and propose commercial offers on the execution of the improvement works. The DBL stores EPCs and will also store the AQUA+ data, making a historic overview of data from expired EPCs or retrofitted building components available.

The advancement of ICT technologies in the built environment opens up new opportunities to collect data (e.g. sensors, real-time energy use, IoT) but also brings further data privacy and security constraints: the DBL should be able to accommodate these to fully reap the benefits.

Even though business models based on data sharing are possible, experts consider that member states and the EU should implement DBLs based on the principle that data belongs to the homeowner. Currently, in Portugal and Greece, the DBL is managed by public authorities, however, the data is owned by the owner, who grants access to market actors. Besides a general consent on data handling, the homeowner is informed and has to provide consent every time a private actor needs to access a specific data. The PA does not own nor trade data, it is for DBL and OSS only a contact point between the homeowners and the private market actors.

Because of the new EU taxonomy framework, there is interest from financial institutions to access EPC data. The DBL, as well as the OSS, could provide additional information to homeowners compared to the EPC, such as financial products and tailored proposals for financing.

4.3.5 Consistency with existing policies and standards

The 2021 EPBD recast proposal introduces the definition of the 'digital building logbook' as 'a common repository for all relevant building data, including data related to energy performance such as energy performance certificates, renovation passports and smart readiness indicators, which facilitates informed decision making and information sharing within the construction sector, among building owners and occupants, financial institutions and public authorities;' [25]. **This definition is in line with the concept of the X-tendo feature.** At an early stage of implementation of several policies including DBL, building passport, renovation roadmap and SRI, clarity is needed to reduce market confusion. The DBL could be the common denominator and an information repository for the other tools introduced by the EPBD proposal.

The interoperability of the DBL with the EPC database and digital OSS depends on the maturity level of each member state. Digital EPC databases with quality checks are preconditions for the DBLs, which are required by the EPBD recast proposal but not yet implemented across Europe. Experts see the DBL as a first step in the implementation of building renovation passports, which will provide information on the phased renovation, such as the renovation roadmap. Given the overlap in the implementation of the DBL and building passports, there is an opportunity for Member States to implement them together in a way that the tools reinforce and complement each other.

In the context of the Renovation Wave and Long-term renovation strategies (LTRS), there is high interest from policymakers for the DBL, with nearly 20 private and public initiatives in the EU. In some member states, the DBL is conceived as an extension of existing databases. For example, in Estonia, the existing National Building Registry includes mainly technical data on a building – permits, design drawings, technical and physical data, etc. It is planned to expand the database to include ownership (linked to real estate database), administrative and energy consumption data. This development aims to create a 'digital twin' of the building stock in Estonia, which would significantly reduce the administrative burden of the concerned agencies and the general public.

Another example of implementation of the DBL is linking it with the digital OSS, such as the casA+ portal in Portugal. The goal of casA+ is to act as a property ID, facilitating the access of the homeowner to building-related information while encouraging energy efficient home improvements. The portal also facilitates communication between the homeowner, the building expert and companies/service suppliers. The DBL is the digital repository on which the casA+ portal is based. Currently, the data can be uploaded into the portal in 2 different ways:

1. By the homeowner when the building does not have any EPC or when additional information - not available in the EPC - is required.
2. By the Portuguese EPC Registry Database - SCE (Sistema de Certificação Energética dos Edifícios) to upload energy related information. The homeowners can access the portal via their EPCs.

The information stored in the DBL is organised across 8 categories: Building Identification (EPC code, INSPIRE ID, etc.), Building Characterization (construction period, type of building, etc.), Envelope (walls, roof, etc.), Lighting & Appliances (light bulbs, washing machine, fridge, etc.), Technical Systems (heating, cooling, DHW, etc.), Energy Balance Indicators (heating, cooling, DHW energy needs), Improvement Measures (type of measure, cost, payback period, etc.) and Energy/Water Consumption.

The functionalities enabled by the building logbook which are currently available in casA+ are the following:

- Access to the building-related information and available financial incentives.
- Registration with associated EPC (not mandatory).
- Registration, use and interaction with both consumers and companies.
- Improvement measures proposals and access to a list of service suppliers to simplify the energy and water renovation of buildings.
- Energy and water efficiency guides and recommendations.
- Housing energy efficiency simulator.

Compatibility with the EPC scheme

Given that most data transfer processes are foreseen to be automatised, the impact of the DBL on EPC cost would be minimal and will not pose extended requirements and additional costs to the certification process. However, considerable effort from public authorities is required to upgrade the existing EPC databases and to link these with other databases. For example, in Greece the 'Electronic Identity of the building', a recently developed platform, can be linked with the EPC database for the purposes of facilitating the DBL roll out. Besides the Electronic Identity of the building and EPC, other databases such as Land Registry and the Taxisnet (tax authority) can provide other relevant information. Thus, the setup of DBLs require effective collaboration between various public agencies, otherwise it can cause legal and management challenges.

It is necessary to foresee a link between the paper EPC and the digital EPC and thus, the DBL. A QR code is already being implemented on the paper EPC in Norway, while in Portugal the DBL/OSS is advertised on the EPC platform. The PA should evaluate what information should be static, on paper, and what should be digital and dynamic. It should determine which online services could encourage the homeowners to access the DBL for example, simulations on financing information.

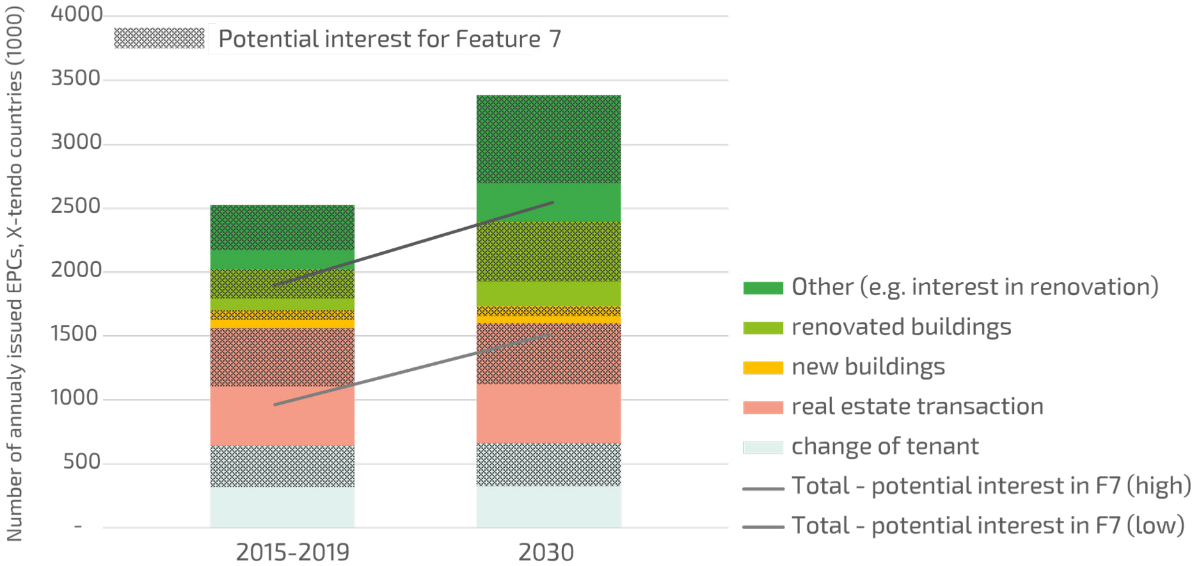
The information from the DBL could be used to prefill new EPC calculations, with consent from the homeowner. In case the EPC is already issued, the previous EPC data will be transferred to the reissued EPC. However, some EPC assessors are sceptical of the quality of the previous EPCs and consider that checking it is more work than filling it in from scratch. One issue is the data ownership of the inputs, which often belong to the EPC certifier. Meanwhile the homeowner only owns the output parameters, which are also present in the EPC database. In Estonia the input calculation values are also available. Another issue is how to store historical data of more EPCs in the DBL. For instance, in Portugal once a new EPC is issued, the previous data is kept in the EPC database (although the certificate is no longer valid), but in some countries the data may be overwritten.

4.4 Estimation of the quantitative replicability potential

In this chapter, an estimation on the quantitative replicability potential of this feature is provided in the X-tendo countries. This follows the methodology described in section 3. *Figure 8* shows the total number of annually issued EPCs, by 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*[8] in *Annex 1*. A high relevance is assumed in particular for building renovation and real estate transactions (interest of the buyer), leading to a range of 39%-74% of all EPC end-users showing potential interest in the results of the Logbook feature. The total number of interested EPC-end-users for all trigger points is estimated to about 1.0 – 1.86 million in the base year which may increase to 1.50 – 2.55 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 assigned by categories, each representing a range, for example, 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 in case that a building does not perform very well according to a certain indicator. Thus, for the "lower" case the 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.

The upper range of the results is similarly high for all X-tendo countries. However, there is also a high bandwidth between the lower and the upper boundary, resulting mainly from the perspective (seller perspective for the lower boundary, buyer perspective for the higher boundary). Thus, it means that the benefits of the DBL and of linking the logbook with EPCs is unevenly distributed between the buyer vs. the seller.

Figure 8 – Number of annually issued EPCs by trigger points and the estimated share of potentially interested EPC end-users, total of X-tendo countries (Feature 7). Historical data 2015-2019, projection until 2030.



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

4.5 Next steps for implementation

4.5.1 Calculation method and quality assurance

Many Member States are at an early stage of implementation of the DBLs; thus, they will benefit of implementation roadmaps, process flows, business models and good practices to successfully roll out logbooks. The following steps are considered to be necessary at the EU and national level:

- Provide clear scope of the logbook and clear legal framework.
- Include process for regular data validation updates.
- Develop a logbook data model.
- Design protocols for data capturing and data sharing.
- Engage stakeholders.

For countries at an early stage of implementing DBL the following stages are crucial:

- Develop a digital EPC database with quality checks.
- Mapping of other existing databases.
- Mapping of benefits and stakeholder interests.
- Mapping of information flows.
- Ensuring interoperability and data sharing, respecting GDPR.

4.5.2 Capacity building for delivery bodies and training needs for assessors

The main efforts in terms of capacity building within the public agencies involved in the DBL relate to the interoperability of databases, which includes issues with data protection and privacy. Experts consider that DBL data should be handled similarly to other public data such as the EPC database. The public agencies will have access based on a need-to-know basis, however, this could be a barrier in implementing cross-checks to validate inconsistencies between databases.

4.5.3 Political discourse/ market or end-user awareness

The logbook should be conceived in a modular fashion right from its conception. This is necessary not only due to cost but also because it needs to take into account available information, the state of development of real estate markets, market expectations and legal/regulatory circumstances.

Experts consider that it will be difficult to track the evolution of renovation rates with the building logbook, but it will be useful to track light renovation measures. It will be also possible to track the level of the investment because, since it is linked to the OSS, it will have information on the total surface of the renovated building stock, the total amount invested, as well as a percentage of public funding. The possibility to track and monitor renovation depths and rates will be highly relevant to develop and improve LTRSs. **An important** driver of DBL could be the integration of data regarding building performance, income and climatic conditions, which are relevant for the energy poverty indicator.

4.6 Conclusions

At this early stage of DBL implementation, Member States display different maturity levels of EPC databases, as well as different available databases to be integrated. Successful implementation of the DBL can bring multiple benefits to many stakeholders in terms of reducing administrative burdens and making processes more efficient and cost-effective. The homeowners can be encouraged to contribute to updating information by having access to additional services, subsidies as well as private and public funding. However, there is a risk of confusion between various innovative policies and instruments being currently introduced in parallel by the EPBD recast such as DBL, building renovation passport and SRI which should be addressed from an early stage of their implementation. The integration of socio-economic indicators into the DBL can help track and tackle energy poverty.

Key takeways:

- Lack of digitalised databases, low quality of data and inconsistencies between and within databases are important barriers to the successful implementation of the DBLs.
- Because of differences in maturity in digitalisation between Member States the DBL concept should be modular and adjustable to the local context. However, EU guidelines regarding the concept, principles related to data ownership and use, process flows, business models and good practices are necessary.
- Experts consider data protection a crucial aspect and encourage a public DBL based on the principle that the homeowner owns the data. General data handling consent is not enough, it is also necessary each time any part of data is shared with a public or private actor for a specific purpose.

Key action points:

- Setting up usable EPC databases shall enable the implementation of DBL in all Member States.
- EU guidelines for the concept and data interoperability are necessary to avoid market confusion between the EPC, BDL, EPC database, OSS and BRP.

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