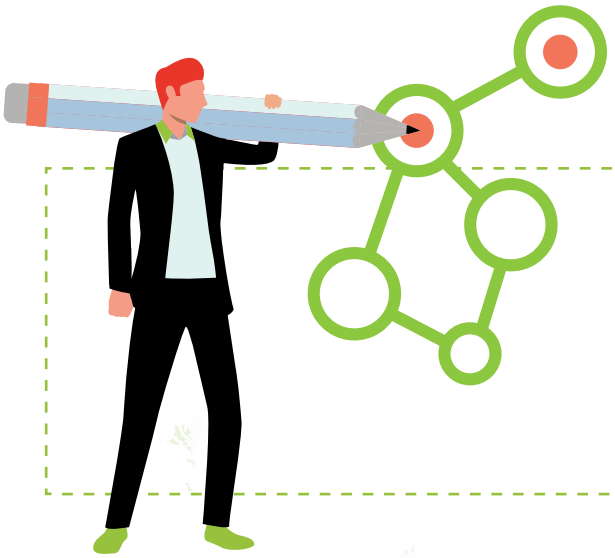

X-tendo

FEATURE 8:

ENHANCED RECOMMENDATIONS

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

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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

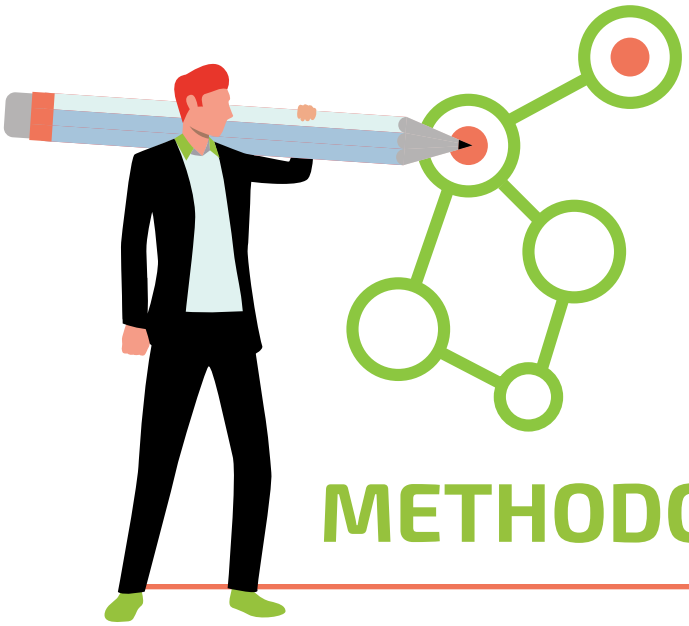
OBJECTIVE OF THE REPORT

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 8: ENHANCED RECOMMENDATIONS

4.1 Overview

For building owners undertaking deep renovation, individual building renovation roadmaps or end-user tailored recommendations become more adequate and to provide more accurate information. The latter is not part of the scope in this X-tendo feature.

EPC recommendations in many EU countries are not sufficiently informative to meet objectives. While reliable and usable indicative recommendations are sufficient for buying and selling houses, deep renovations require detailed recommendations. This feature demonstrates how to automatically provide enhanced recommendations in EPCs, mainly for building transactions (sell/ buy/ renovate), and how they can be linked to national long-term renovation and climate strategies for the building stock. The aim is not for the X-tendo feature to be stand-alone tool, but to demonstrate a method which could be later integrated into national software.

This approach could enhance the quality of recommendations by ensuring that they are not only in line with building requirements, but also in line with the national long-term energy and climate objectives. Therefore extending the recommendations currently provided in EPC schemes. Although the proposed recommendations will improve the status-quo, they cannot fully replace professional advice. For building owners undertaking deep renovation, an individual building renovation roadmap or end-user tailored recommendations become more appropriate to provide more accurate information.

The proposed method is built on three pillars:

1. Enhancing actual recommendations by demonstrating how building-specific recommendations could be automatically generated: this will comprise a discussion of how co-benefits resulting from these recommended measures can be included in the EPC recommendations.

2. Showing how the costs of recommended measures can be included in the EPC provision process, enabling calculation of the cost-effectiveness of the recommended measures.

3 Setting targeted values for recommendations to guarantee that they are in line with national long-term renovation and climate strategies for the building stock. In addition to the calculation methods, guidelines will also be provided on how to perform the calculations and assess the values, as a support handbook for energy auditors.

The method can be divided in three parts: providing measure-by-measure recommendations, assessing the whole building impact of all recommendations and providing an economic assessment. The third is optional, as it will depend on the availability and link to external databases, such as cost databases. Another aspect covered by the methodology is the definition of the target building, which can be set based on 1) actual building standards regulations, 2) energy auditors' expertise, or 3) national long-term renovation strategies or other climate plans.

4.2 Key insights from testing

Table 9 - Test projects summary in implementing countries for enhanced recommendations

Country	POLAND	SCOTLAND (UK)	DENMARK
Type of Testing	In-building Testing/ System Testing	In-building Testing	In-building Testing/ System Testing
Number of testing cases	10 residential multi-family buildings	8 single-family buildings and 2 single-family apartments	10 single-family buildings
Tool	Calculation tool	Calculation tool	Calculation tool
Testing Period	04/2021 - 11/2021	07/2021 - 11/2021	05/2021 - 11/2021

In-building testing

In-building testing was conducted by Poland, the UK and Denmark using the tool developed for enhanced recommendations. A calculation spreadsheet tool was provided with instructions and descriptions that forms a solid foundation to supplement EPC assessments. Based on a selected building, its documentation (audit report etc.) and additional external sources (prices of material, technical devices etc.) the calculation was done for providing recommended renovation measures.

- The results were mainly focused on building envelope, space heating system, renewable systems, air infiltration and MVHR.
- The calculations require lots of intricate construction data that is not immediately available e.g. the full breakdown of the wall construction in old buildings for thickness of elements.
- An extension of the tool to give an estimate of the energy demand for the recommended measures would be beneficial and practical.

System testing

In system testing the objective was to verify the functionality of the tool against the real energy audit documentation of the building. The outputs, time for calculation procedure, and accuracy were also assessed:

- The calculation time was shorter than a full energy analysis done for the energy audit.
- The tool is simplified but less accurate. The calculations are done for each building partition and recommendations are provided in contrast with the energy model analysis in the audit. This is more accurate. Polish experts understood that this tool can be used to support energy auditors by helping them to save time.
- The time needed to use the tool was around 0.5 hours for each building tested.

4.3 Drivers and barriers for a wide uptake of the feature

4.3.1 Calculation method and quality assurance

Polish and UK experts found that the enhanced recommendations feature generates results similar to energy audits. Austrian stakeholders indicated that higher quality of recommendations would be useful for meeting the criticalities of integrating increased costs. This could vary from region to region and would be valid only for the validity of EPCs (5-10 years). Experts from the UK also considered this aspect not just for costs but also material, fuel etc. As a solution to this it would be reasonable to provide ranges of cost instead of absolute costs that can vary based on regions. In Estonia, EPC recommendations are provided from a standardised list of recommendations and are not very detailed. Accurate gathering of building-related and end-user behaviour data helps in providing more accurate recommendations. One of the main barriers in providing these recommendations is that they are prone to differ based on specific conditions in buildings and the behaviour of occupants.

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

EPC recommendations are useful for homeowners to take key decisions on the renovation of their buildings or on the real estate transaction of buying a home. While these recommendations are made available in varied forms across different EPC schemes, they still lack clarity, accuracy and guidance for homeowners. Some drivers identified for the feature are that the outputs presented in a user-friendly manner, it highlights the type of recommended measure and consequent implication in terms of costs, emissions, energy demand and compliance with efficiency and decarbonising targets. A national cost database would enable the assessors to calculate and recommend the costs more efficiently. Some barriers from a social perspective are:

- Recommendations can have influence on the selling price of dwellings and the seller would have to pay for the EPC calculation.
- The potential of the building with all feasible building renovation measures would be useful for the homeowner, however, producing this information takes time.
- The split-incentive issue where the owner gets an EPC and the buyer sees what needs to be invested should be made transparent in real estate transactions.

Though Austria did not test this feature, the experts highlighted the need to focus on the presentation and illustration of the recommendations in the EPCs to make them more effective for owners and use marketing instruments to raise stronger awareness for recommendations. Denmark identified that digitalisation and standardisation in the new feature is a helpful and if implemented in the national software, it can support the energy auditors to provide EPC recommendations. Detailed and tailored recommendations inform real estate buyers or sellers during building transactions about the condition of the buildings and help them in taking appropriate measures for the building renovation.

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

There are many opportunities for the construction sector to give a push to the implementation of renovations through platforms such as one-stop-shops whilst enhanced recommendations are made available to the homeowner in EPCs. The feature developed shows what additional data is needed to provide enhanced recommendations and support energy auditors' work. Some of the drivers from the construction sector are:

- No additional expertise beyond an intermediate level of energy auditing practice is required to provide the "enhanced recommendations".
- Integration of enhanced recommendations with financing options and one-stop-shops are necessary to implement to increase their impact.
- Standardized checklists and calculations to support auditors and consultants would be useful to provide enhanced recommendations.
- An automated approach would provide more effective recommendations based on specific building type.

In Denmark, an EPC auditor gives recommendations based on their experience and use standardised defaults with mandatory consideration of renewables. Whereas UK experts advise that tailoring costs by selection of specific items would be very useful for the assessor and this functionality would improve how recommendations are provided.

4.3.4 Economic and market drivers and barriers

While for real estate transactions reliable, usable and indicative recommendations are sufficient, for the planning of deep renovations detailed and tailored recommendations are required. In the cases of deep renovation, recommendations are important for the owners undertaking and implementing them. Accuracy and detail are the key differences that consequently reflect on the amount of information needed and the adequate tool to generate the targeted recommendation:

- Accurate gathering of building-related and end-user behaviour data should be done in a way that keeps EPC costs affordable.
- Imbalance in the trade-off between accuracy and higher EPC prices against less accuracy and lower EPC prices.
- The assessment for providing recommendations is cheaper than the energy audit.

In the UK, EPCs give a current snapshot of the building performance but they are not used for stepwise renovation. So, including the enhanced recommendations would make the EPC richer and this would push the owners to go into more detailed analysis and also increase awareness. In Scotland, the government is mandating owners to get to a specific EPC class by a certain year under long term renovation and to encourage owners to learn more about recommendation information.

4.3.5 Consistency with existing policies and standards

In many countries, building codes for existing buildings are not as restrictive as for new buildings. This means that the energy performance achieved after the renovation might not be sufficient to achieve decarbonisation targets. Policies should consider long-term renovation and decarbonisation targets. A more ambitious integration in policies and standards could enhance EPC recommendations, by ensuring that they are not only in line with energy efficiency standards, but also with long-term low-carbon emissions targets and national policies. Among other drivers, across the EU, a variety of tools and methods are being used to provide detailed and tailored recommendations that could be utilised. Some major barriers regarding policies and standards are:

- Currently no clear definition of enhanced recommendations is available at EU level.
- Empowering the buyer through policies that focus on making suggestions more concrete would be important.
- The target values should be derived from the LTRS or a strategic document which has a policy agreement .
- There should be a link between the building stock data and how EPC data reflects the status so it would be easy to model for long term renovation strategies.
- The overall targets of building stock need to be broken down to each building. Using different bench marking or data modelling would impact the policy goals.

The Danish BetterHome/BetterHouses, a one-stop-shop solution, provides enhanced tailored recommendations for technical improvements and personalised recommendations based on the consultant's on-site visit. While in the UK, Energy Saving Trust's Portfolio Energy analysis Tool (PEAT) enables customers to build an energy efficiency package that meets their personal needs, budget, and objectives through tailored recommendations. In Austria, the recommendations need be related to the Austrian nZEB standard (which combination of measures must be taken to achieve nZEB standard) and it's already linked with national policies.

Compatibility with the EPC scheme

There is a window of opportunity to improve the EPCs and engage with policymakers. EPC recommendations still lack detail and in many countries are based on standardised lists. Enhanced EPC recommendations can be easily and automatically integrated into the existing EPC auditing processes. The developed feature will be incorporated in existing EPC calculation software to ensure long-term effectiveness. Long-term replicability will be assured if the provided methods are integrated into EPC calculation software or automatically integrated into energy auditors' practice. Calculation procedures are based on best practices that are nationally allowed and foreseen in existing standards and is therefore one of the main drivers for its use in the EPC scheme. There is no integration with available EPC calculation software but this feature can be used as a standalone method. Existing recommendations within the EPC are not displayed well, are low quality and are not individually tailored for end-users. Hence, there would need to be a comprehensive approach from the end user perspective.

Polish experts recommended that the feature should be linked to the software of each country to apply it. Most of the data should be taken from EPC calculation (parameters of building), thus it will be easier to implement. The feature could be used for providing recommendations for the building envelope, building systems and new systems such as MVHR etc. The UK has an existing system that is running and self-contained so it is difficult to move to a newer system. Denmark encountered some problems regarding compliance data where in their EPC system some values were difficult to manually calculate. The tool is not as precise as the recommendations made by an EPC consultant that are tailored to a specific house. Austria has a system to provide at least two recommendations in a given EPC for an existing building and how to reach nZEB standards whilst the on-site visit is not mandatory.

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 9* shows the number of annually issued EPCs, by the different trigger points in the total of 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*[9] in *Annex 1*. A high relevance is assumed for real estate transactions (interest of the buyer) and general interest in the potential improvement of building energy performance, leading to a range of 24%-73% of all EPC end-users showing potential interest in the results of the Enhanced recommendations feature.

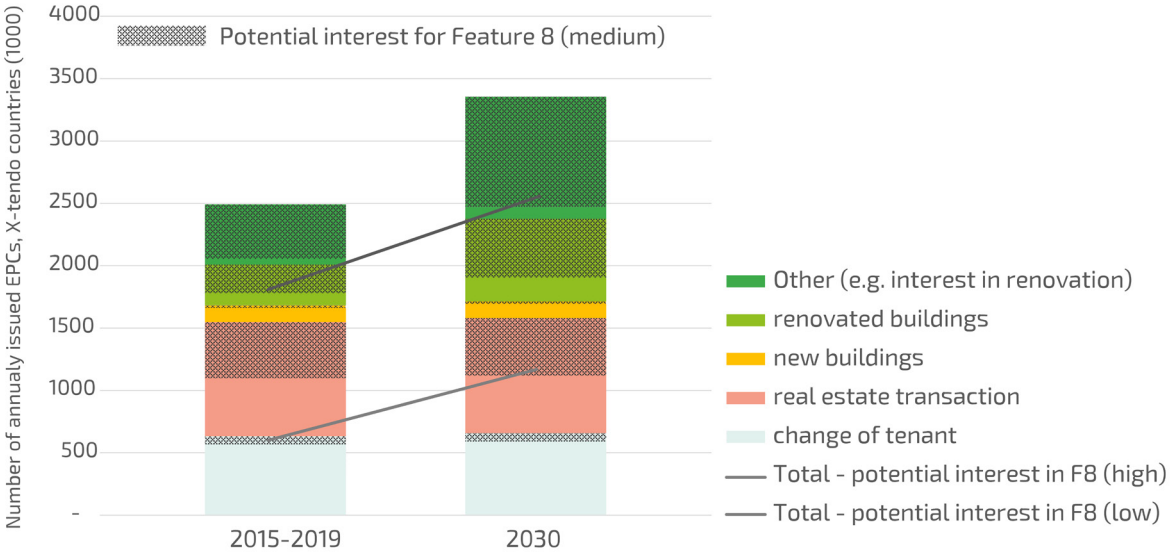
[9] The shaded areas (labelled as medium) in Figure 10 were derived as the average of the low/high range depicted in Table 14.

The total number of interested EPC end-users for all trigger points is estimated to about 0.6 -1.83 million in the base year which may increase to 1.19 -2.62 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" the lower value of interest (typically the interest of the seller) is assumed whereas for the "higher" higher value (typically representing the interest of the buyer) is considered.

For Feature 8, it is assumed that the interest of EPC end-users in receiving more reliable information on renovation recommendations strongly differs for the buyer vs. the seller. Thus, the difference results from the bandwidth of the estimation plus the difference of the perspective (seller-perspective for the lower boundary, buyer perspective for the higher boundary).

It can be observed that there is 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). This indicates that there is a strong conflict of interest between the buyer showing a high interest in the information on expected, required and recommended building renovation and the seller, who orders the EPC. This calls for strong control, standards and guidance for EPC issuers when providing renovation recommendations.

Figure 9 – Number of annually issued EPCs by trigger points and the estimated share of potentially interested EPC end-users, total of X-tendo countries (Feature 8). Historical data 2015-2019, projection until 2030.



4.5 Next steps for implementation

4.5.1 Calculation method and quality assurance

For the successful implementation of this feature, stakeholders from Poland identified the need to establish a costs database in the future. Where there is no national software for providing enhanced recommendations, it would be beneficial in those contexts that private companies implement the new interface.

There is need for a method which does not use automatised and standardised recommendations and works in different urban contexts. These should be different and tailored to user needs. Another important aspect to enable this feature would be to integrate member state level databases into the third-party software used for the calculation of enhanced recommendations. The future versions of the tool can provide an energy and carbon emissions comparison for different recommendations. From the end-user perspective, it should be optimised based on costs and quality with details on the payback time. There should also be information on the lock-in effects of each recommended measure. Comparison of pre- and post-renovation works in results of the tool would merit the inputs/calculations.

4.5.2 Capacity building for delivery bodies and training needs for assessors

Polish experts advise that the authorities responsible for the EPC implementation should develop the cost database. Regarding the accuracy of the energy savings calculations, these must be manually inserted, not calculated by the tool. Austrian experts outline that it is critical to display the costs for renovation measures and that assessors need relatively less training to provide these to end-users. Other services by public bodies are important such as loans, grants and subsidies in collaboration with banks and other financial institutions. UK experts identified that no significant increase in time was required to do the EPC for enhanced recommendations since many inputs already exist.

4.5.3 Political discourse/ market or end-user awareness

In Poland, energy auditors who prepare EPCs do not provide recommendations. The feature being developed is promising to include some recommendations in the EPC. Experts from Denmark see this feature as very relevant as the existing recommendations are quite time and effort consuming, thus the new feature could make the work of the EPC assessors easier.

4.6 Conclusions

EPBD emphasises that the renovation measures must be technically, economically and functionally feasible for homeowners. Article 10 in the EPBD 2021 recast [25] focuses on Building Renovation Passports, where a qualified expert is required to make an on-site visit and advise on a roadmap to the owner. This feature is an important step towards the development of such roadmaps and advice on benefits in terms of energy savings, savings on bills, GHG emissions as well as other wider benefits. These recommendations would have a potential link to financial and technical support. However, there is no common definition of recommendations at the EU level, which provides an opportunity for impactful implementation of this feature. The revised EPBD has outlined that EPCs shall include recommendations for the cost-effective improvement of energy performance and reduction of GHG. There is a specific focus on measures carried out in connection to a major renovation or elements independent of building envelope or systems. The enhanced recommendations feature tool is designed to augment these aspects while also displaying the co-benefits that the end-user will get from renovation measures. However, an extension of the developed methodology is required in order to provide a potential indication of payback over the lifecycle. The recommendations are provided for building envelope, space heating system, renewable systems, air infiltration and MVHR.

The quantitative estimations on the impact of the uptake of this feature in X-tendo countries indicate that there is a strong conflict of interest between the buyer, showing a high interest in the information on expected, required and recommended building renovation, and the seller who orders the EPC. This calls for strong control with standards and guidance for EPC issuers when providing renovation recommendations. The total number of interested EPC end-users for all trigger points is estimated to about 0.6 – 1.83 million in the base year which may increase to 1.19 – 2.62 million EPC end-users in the year 2030.

Key takeways:

- This enhanced recommendation feature is an important step towards developing roadmaps and giving advice on benefits in terms of energy savings, savings on bills, GHG emissions as well as other wider benefits.
- The methodology has a specific focus on measures carried out in connection to a major renovation or elements independent of building envelope or systems.
- The feature demonstrates how to automatically provide enhanced recommendations in EPCs, mainly for building transactions (sell/buy/rent).
- The developed feature has the capability to be incorporated in existing EPC calculat ion software to ensure long-term effectiveness.
- No additional expertise beyond an intermediate level of energy auditing practice is required to provide the "enhanced recommendations".

Key action points:

- An extension of the developed methodology is required in order to provide a potential indication of payback over the lifecycle.
- A strong control with standards and guidance for EPC issuers when providing renovation recommendations is required in order to ensure that recommendations are in line with long-term climate and energy targets.
- A clear definition of enhanced recommendations is required at the EU level to harmonise the approach.
- Display of cost of renovation measures and services for loans, grants and subsidies should be integrated with enhanced recommendations (see also feature 9 in the next Chapter).

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

16.1 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;
Denmark	Statistics Denmark. *https://www.statbank.dk/EJEN88.* 02 Feb 2022; Statistics Denmark. *https://www.statbank.dk/statbank5a/selectvarval/saveselections.asp.* 02 Feb 2022; Statistics Denmark. *https://www.statbank.dk/statbank5a/SelectTable/Omrade0.asp?SubjectCode=6&ShowNews=OFF&PLanguage=1.* 15 Feb 2022;
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&PUBLICACOESstema=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;
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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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AAECR Asociația Auditorilor Energetici pentru Clădiri din România

ENEA

BPIE

КАПЕ CRES

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