crossCert

Next-generation of Energy Performance Assessment and Certification

Towards Reliable, Practical, and People-Centred European Energy Performance Certification of Buildings

MAIN PROJECT RESULTS

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1 Project summary

The crossCert project is a European initiative under the Horizon 2020 framework, focusing on improving the next generation of Energy Performance Certificates (EPCs). The main objectives of the project are to increase the accuracy, usability, and harmonisation of EPCs across Europe, ensuring that these certificates become more reliable tools to support building energy renovations, a crucial component of the EU's climate goals for 2030 and 2050.

The crossCert project supports the EU's building renovation wave, a key aspect for reaching carbon neutrality by 2050. By improving the effectiveness of EPCs, crossCert aims to help reduce the performance gap in energy performance assessments and promote broader uptake of energy-efficient practices across Europe.

The project objectives are:

- **Improved accuracy and usability:** crossCert seeks to enhance the precision of EPCs and their usability by testing both current and upcoming certification procedures on over 140 buildings in 10 European countries.
- **Data utilisation and integration:** Developing tools and guidelines to better exploit EPC data, linking it to renovation roadmaps, and improving data availability for public authorities and users.
- **People-centred EPCs:** crossCert aims to design EPCs with a strong focus on user experience, enhancing public engagement and understanding. The project aims to create EPCs that are more user-friendly and focused on the needs of building owners and users.
- **Harmonisation across Europe:** It emphasises reducing the variability in EPC practices across different countries, fostering a more unified approach across Europe.

crossCert is based around **cross testing**, a structured process of assessing both current and emerging EPC methodologies across different European countries. This involves conducting multiple rounds of testing on selected buildings, which encompass various types, sizes, and climatic conditions, to compare EPC procedures across ten countries. The goal is to determine whether EPC methods are robust, reliable, and harmonised across member states. The cross-testing results provide valuable insights into energy consumption, CO_2 emissions, and other relevant metrics, helping to validate and refine the EPC approaches. This testing also supports the development of a comprehensive, harmonised framework for EPCs that can be used for future regulatory and operational improvements.

The project is structured in seven work packages, as follows:

WP1: Coordination, oversees the overall project, ensuring all activities are implemented as planned and meet the project's objectives.

WP2: Cross assessing EPC paradigms, involves testing existing and new EPCs in different European countries to assess their performance and user-friendliness. The results of these cross-certifications form the basis for recommendations on how to improve EPCs.

WP3: Deriving technical guidelines for EPCs, focuses on producing technical recommendations for the next generation of EPCs, including how to incorporate new indicators like thermal comfort and indoor air quality.

WP4: Adding value to EPCs, works on creating tools and strategies to increase the value EPCs offer to users, including links to building renovation databases and energy audits.

WP5: Towards human centric EPCs, aims to design EPCs that cater to users' needs, improving training for EPC issuers and promoting these next-generation certificates.

WP6: Harmonising/converging EPCs in Europe, focuses on developing recommendations to standardise EPC practices across Europe, enhancing comparability and reliability.

WP7: Project outreach, engages with stakeholders and ensures that project results are widely shared and implemented, facilitating cooperation among European energy agencies and EPC issuers.

This document summarises the main findings from the crossCert project across the four objectives listed above.

The crossCert partners are:

- **Austrian Energy Agency** (AEA) – Austria
- **Center for Energy Efficiency – EnEffect Foundation** (ENEFFECT) – Bulgaria
- **Centre for Renewable Energy Sources and Saving** (CRES) – Greece
- **Climate Alliance** (CA) – Germany
- **Energy Consulting Network AS** (ECNET) – Denmark
- **Ente Regional de la Energía de Castilla y León** (EREN) – Spain
- **Heriot Watt University** (HWU) – United Kingdom
- **Institute for Innovation and Development of University of Ljubljana** (IRI UL) – Slovenia
- **KAPE** (Krajowa Agencja Poszanowania Energii) – Poland
- **MIEMA** (Malta Intelligent Energy Management Agency) – Malta
- **North West Croatia Regional Energy Agency** (REGEA) – Croatia
- **Universidad de Zaragoza** (UNIZAR) – Spain (Coordinator)

2 Technical guidelines for developing EPCs

The technical element of crossCert is concerned with understanding the detail of EPC methodologies used in target countries, how they differ in terms of inputs and outputs used, and advising on next-generation approaches through comparative exercises of those different methodologies. Top-level analysis of EPCs, and the direction received from Directives such as the EPBD, is not always able to reflect on this technical detail, particularly when such detail is different across European countries. The project therefore aims to provide case-studies and a framework from which decisions on good practice and harmonisation (and the limits of the latter) can be supported.

The key objectives of this work stream are:

- **Comprehensively review the EPC methodologies currently adopted in target countries** (inputs, outputs, calculation engines, assessments, and assessor training).
- **Investigate the importance of "Performance Gaps" in EPC methodologies**, that is, the differences between real and EPC-modelled energy consumption.
- **Review of KPIs and metrics**, both existing and proposed.
- **Evaluate and compare approaches to energy efficiency recommendations in EPCs**, including the presence of causation between approach to EPC and resulting measures.
- **Propose harmonisation approaches for EPC verification and design choices**, including a review and comparison of the quality assurance practices within each country.

2.1 EPC assessment methodologies show considerable differences across Europe

The crossCert project addresses key technical aspects of EPC methodologies, including calculation inputs and outputs, KPIs, performance gap, renovation measures, and quality verification methods to provide possible improvement suggestions for future EPCs and highlight the difficulties in achieving harmonisation across Europe. This is further informed by the L, C and P cross tests carried (Gómez and Fueyo, 2022), studying the differences in methodologies.

The initial phase of this work involved a comprehensive comparison of EPC frameworks across the crossCert partner countries. The details of these frameworks were gathered using methodology guidelines (Austria (OIB, 2019), Bulgaria (Ministry of Regional Development and Public Work, 2017), Denmark (The Danish Transport, 2018), Greece (Technical chamber of Greece, 2012), Malta (BRE, 2012b), Poland (Rozporządzenie Ministra Infrastruktury I Rozwoju, 2015), Slovenia (PIS, 2014), Spain (IETcc-CSIC, 2019), and UK (BRE, 2012a; BRE, 2020)). In addition, a questionnaire was used to collect the details of each country's assessment methodology from the participating partners. This step was essential to highlight potential differences that could influence the results of C, L and P-tests (Gómez, 2022). The review identified significant variations in the general type of methodology, provision of official software, sources of input data, energy categories included in the calculations, and output indicators and metrics.

In general, the EPBD (EPBD, 2018) allows countries to issue EPCs using asset ratings or operational ratings for issuing EPCs. While all crossCert countries have a route for calculating asset ratings, only some (Denmark, Poland and Slovenia) allow assessments based on energy consumption data. In Bulgaria, although operational ratings are not used in EPCs, energy consumption data is used for calibrating the EPC model. The type of calculation methodologies also varies in the studied countries. The EPBD specifies that the calculation methodology can be steady state or dynamic. Most studied countries use steady-state models while there are certain routes for using dynamic models in the UK and Spain (Sayfikar and Jenkins, 2022).

The metrics and KPIs used in the crossCert partner countries also differ in their scope, but there are common elements across all countries, primarily focused on energy performance. Austria, Denmark, and Spain integrate comprehensive KPIs, including energy consumption, CO_2 emissions, and lifecycle environmental impacts. Denmark also includes indoor air quality and thermal comfort. Countries like Bulgaria, Croatia, and Poland use more basic energy consumption metrics, with less focus on smart technologies or advanced environmental KPIs. The UK emphasises energy consumption, CO_2 emissions and cost aspects. Slovenia and Greece incorporate both energy efficiency and financial KPIs, particularly regarding renovation and lifecycle costs (Karolina and Piotr, 2024).

Countries' approaches to providing calculation software also vary. Some countries implement their official calculation methodology in official software, which must be used by the assessors (Spain, Bulgaria and Malta), some provide further commercial options (UK, Denmark and Greece), and the rest only have commercial software available.

Although the EPBD provides general guidelines about the categories of energy consumption recorded on EPC ratings, not all countries follow the same pattern. For example, lighting energy consumption is not considered in Danish, Polish and Spanish residential EPC methodologies.

Cooling energy consumption is also not included in residential EPCs in the UK and Austrian methodologies. Furthermore, across crossCert countries, electrical appliances' energy consumption is only included in energy consumption values in the non-residential EPC methodology in Bulgaria (Sayfikar and Jenkins, 2022).

Calculation input data is also approached differently by each country. Methods for gathering input data range from mandatory on-site visits by the assessors in some countries to relying primarily on generic building characteristics in others. Countries including Austria, Croatia, Denmark, Greece, Malta, Spain, and the UK rely mostly on databases of standardised values for various calculation input parameters, such as occupant behaviour, HVAC system operation and characteristics, and building envelope specifications. In contrast, Bulgaria, Poland and Slovenia allow assessors to exercise greater discretion in determining these inputs.

The comparisons summarised above show that the EPC methodologies use various degrees of standardisation in their calculation approach and can be categorised based on this criterion. While a more standardised approach can streamline the EPC assessment process and ensure consistency across different buildings, it may not always accurately reflect the actual energy consumption of a specific building, as standardised values may not capture the unique characteristics and usage patterns of individual structures. On the other hand, the flexibility of a tailored methodology can enhance the accuracy of EPC results by enabling assessors to consider the specific characteristics of a building and its occupants. However, it can also introduce variability and potential inconsistencies in EPC assessments, as different assessors may employ different judgments and assumptions.

Another primary area of variation in EPC assessment approaches is the renovation recommendations provided in the certificates in different countries. These recommendations vary in format, sources of information, and level of detail. In some countries, EPCs provide detailed renovation plans, while in others, the recommendations are more generic. Some countries provide the amount of energy (or carbon emissions, or cost) savings on the EPC certificate (or, in the case of Austria, in a separate document). Differences also exist in the method used for generating the recommendations, countries including the UK, Croatia, Denmark, Greece, Malta, Slovenia and Spain have implemented default recommendations in EPC software, while others require the assessor to come up with them. The reliance of countries on assessors also brings up another dimension of differences between countries: assessor educational background and training, which also varies significantly (Jenkins and Sayfikar, 2023).

A summary of the findings is shown in Table 2.1 and Figure 2.1 (Sayfikar and Jenkins, 2024a).

	HVAC schedules	HVAC specification	Lighting and equipment schedules	Occupancy	Construction thermal parameters	Ventilation rates	Infiltration rate	Setpoits
Austria	Default based on building type	Default values available	Default values	Default values	Database available	Database available	Default values available	Fixed
Bulgaria	Assessor	Actual values	Assessor	Assessor	Database available	Measurement/ assessor's knowledge	Measurement/ assessor's knowledge	Assessor
Denmark	Assessor	Default values available	Default values	Default values	Database available	Database available	Default values available	Depends on use type / activity level / control
Greece	Default based on zone activity type	Default values available	Default values	Default values	Database available	Database available	Default values available	Depends on use type / activity level / control
Malta	Default based on zone activity type	Default values available for some building categories	Default values	Default values	Database available/ inference based	Database available	Default values available	Depends on use type / activity level / control
Poland	Assessor	Default values available	Default values or assessor	Assessor	Database available but outdated	Database available	Default values available	Depends on use type / activity level / control
Slovenia	Default based on zone activity type	Actual values	Default values	Default values or assessor	Database available	Database available	Measurement/ assessor's knowledge	Depends on use type / activity level / control
Spain	Default based on building type	Actual values	Default values	Default values	Database available/ inference based	Database available	Default values available	Fixed
UK	Default based on zone activity type	Default values available for some building categories	Default values	Default values	Database available/ inference based	Database available	Default values available for some buildings	Depends on use type / activity level / control

Table 2.1 Summary of the comparison of calculation inputs across crossCert countries

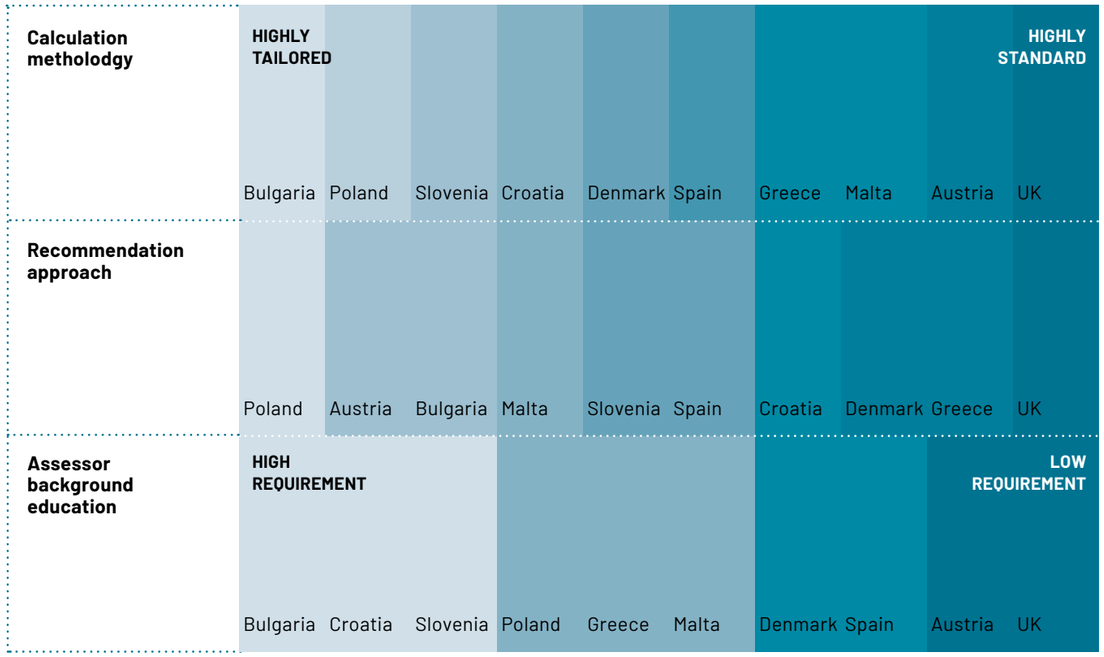

Figure 2.1 Comparison of countries' approaches towards EPC calculation and EPC recommendations

2.2 EPC quality control procedures are not consistent across Europe

Similar to the considerable variations between EPC assessments across countries, there are differences between the countries' current approaches to quality control mechanisms for EPCs. Comparing these mechanisms allows for a discussion around best practice approaches towards a harmonised framework. While performing random independent checks, as prescribed by Article 18 of the EPBD (EPBD, 2018), is the main tool all countries use for quality control of EPCs, targeted controls are also used across some countries to ensure high-quality certificates (Loncour and Roelens, 2015). Implementing low-cost measures, such as using validation rules in the calculation software or applying consistency checks to the central EPC databases, can also complement these steps to further ensure high quality certificates. Aligning quality control steps to an individual country can be achieved by looking at the differences between methodologies highlighted in previous sections.

Table 2.2 summarises the findings regarding differences in verification approaches currently used across the crossCert countries. Some countries take advantage of validation rules applied within their EPC software and databases, while others only implement independent checks. Interestingly, countries with more standardised methodologies, such as the UK, Denmark, Austria and Spain, have implemented more automatic controls than the more tailored methodologies. This could be a result of more complex methodologies requiring manual checks by experts rather than automatic checks.

	Standardisation rating (1-highly tailored, 5- highly Standardised)	Software validation rules	Database automatic controls	Organisations in charge of independent checks
Austria	5	A list of errors and explanations about them. No warnings about out-of-range values	In some regions in Austria, the EPC database is used for independent quality checks	Performed by relevant energy agencies
Bulgaria	1	Some of the input fields have limits, but the allowed range is wide	Not automatically checked; however, the certificates are checked by the relevant authority before being lodged on the database	SEDA
Croatia	4	There are some checks on inputs and results. No warnings about out-of-range values.	There are no quality controls on the EPC database	The Ministry of Physical Planning, Construction and State Assets
Denmark	4	Input parameter validation measures	The EPC database is equipped with automatic data validation. It is automatically compared with other building data.	The Danish Energy Agency
Greece	4	Input parameter validation measures	Automatic validity check of EPC data is performed on the national EPC registry platform.	The Ministry of Energy
Malta	5	Input parameter validation measures	The data is thoroughly checked and cleaned before being lodged	The Malta Competition and Consumer Affairs Authority (designated by the Building and Construction Authority (BCA))
Poland	2	No validation measures	The EPC registry automatically checks for missing data; however, there are no automatic checks for the validity of EPC data.	An independent body
Slovenia	3	Input parameter validation measures	The electronic EPC registry runs an automatic check on the EPC certificates	the Inspectorate of the Republic of Slovenia on behalf of the Ministry of the Environment and Spatial Planning
Spain	4	Limited validation measures (mostly focused on missing inputs for the technical systems) are implemented, No warnings about out-of-range values.	Some automatic checks including various identifiers, date of issue, the length of time between the site visit and EPC issue date, useful area, energy rating typology and negative final energy values	Varies regionally, the relevant institution (Autonomía) In each region
UK	5	Highlights out-of-range values	In-built validation rules applied: use of accredited software, missing fields, out-of-range values, parameter formats, consistency, and controlling the trends of data	Accreditation Schemes The Department for Levelling Up, Housing and Communities

Table 2.2 Current approaches in quality control in crossCert countries

2.3 The performance gap varies with country and methodology

The discussed differences can lead to variations in EPC outputs across countries. Performance gap (the discrepancy between modelled and actual energy consumption in buildings) can be used as a medium to explore such differences in EPC outputs. A sample of 65 case study buildings across the crossCert countries were evaluated, and the link between the methodology type and the performance gap was analysed (Sayfikar and Jenkins, 2023).

The results shown in Figure 2.2 depict that the performance gap is generally lower for more tailored methodologies compared to more standardised ones, with Bulgaria as an exception. (It is important to note the sample size was too small for detailed statistical analysis, and countries are not represented equally in that sample.)

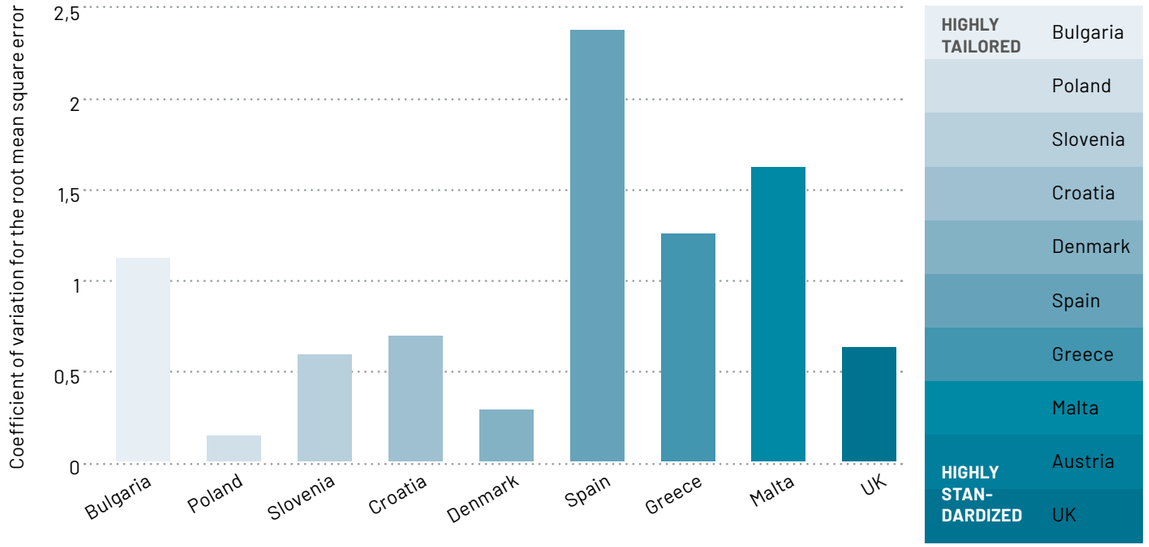

Figure 2.2 Comparison of the performance gap across crossCert countries

2.4 The path towards next-generation EPC metrics requires guidance, particularly around the limits of harmonisation

Further to enhanced quality controls, the introduction of more dynamic KPIs in next-generation EPCs, such as real-time energy use and lifecycle environmental impact, will provide more actionable insights for the users. Harmonisation of KPIs across countries is essential to make EPCs comparable and effective in driving building decarbonization. This work highlights the importance of smart technologies and human-centric metrics, ensuring that future EPCs not only measure energy efficiency but also prioritise occupant comfort and well-being. Additionally, integrating financial KPIs such as lifecycle costs will encourage more informed decisions about renovations (Karolina and Piotr, 2024).

With the knowledge gained from comparing methodologies across the crossCert partner countries, as well as studying next-generation EPCs proposed in projects such as D2EPC (D2EPC, 2023) and ePANACEA (ePanacea, 2024), it is important to reflect on what an EPC is actually for and at what point proposed innovations may take EPCs away from their original purpose. Therefore, a framework was proposed for categorising and comparing different EPC approaches. The framework aims to assess what priorities have been used in the formulation of each EPC approach, and how different approaches compare with each other, or, whether a direct comparison is feasible. A set of criteria is proposed for understanding the type of EPC assessment under consideration. These criteria are a combination of current EPBD requirements and likely future directions of EPCs. The proposed framework is intended for understanding how EPCs are developed, highlighting the challenges of harmonisation of EPCs across Europe (Jenkins and Sayfikar, 2024).

This framework proposes six criteria to achieve these goals, ranging from the ability of an assessment to represent a real building, to the ease of scalability of a method (two factors that can be at odds with each other). The adaptability of that framework to new metrics and technologies is also used as a way of understanding the possibility of incorporating key parts of next-generation metrics and innovations. Table 2.3 shows the application of the framework for nine types of EPC methodologies: four currently in use, and five next-generation EPCs. Clearly, no single approach perfectly fulfils all criteria. The existing trade-off between detailed building information and the methodology's generalisability is evident in some of the ratings. More detailed and tailored assessments, requiring additional data or calculations, can pose challenges on widespread adoption. Consequently, such methods may not be suitable for large-scale policy decisions affecting all buildings. When it comes to future EPCs, it's crucial to determine if a proposed innovation is intended to be applied to all standard EPCs or only as an added optional route for specific building types. If the goal is widespread use, the method must excel in Criteria 4 and 5, whereas for limited applications, factors like Criteria 2, 3, and 6 are more critical.

	(1) Highly standardised, steady-state EPCs	(2) Highly tailored, calibrated steady-state EPCs	(3) Standardised dynamic EPCs	(4) EPCs using operational rating	(5) ePANACEA M3 Route (Dynamic simulation)	(6) ePANACEA M2 Route (steady-state simulation)	(7) ePANACEA M1 Route (operational rating)	(8) D2EPC Asset rating	(9) D2EPC Operational rating
Examples	UK, Austria, Malta	Bulgaria	UK nonresidential category 5 buildings, Spain	Certain buildings in Slovenia, Denmark and Poland	As above	As above	As above	As above	As above
Criterion 1- Alignment with reality	Low	High	Medium	High	High	Medium	High	Medium	High
Criterion 2- Quantifying new metrics	Low	Low	Medium	Low	High	Medium	Low	High	High
Criterion 3- Accommodate new technology	Medium	Low	High	Medium	High	Medium	Medium	High	High
Criterion 4- Suitability for punitive action	Low	Medium	Medium	High	High	Medium	High	Low	High
Criterion 5- Extrapolating and standardising	High	Low	Medium	Low	Low	Medium	Low	High	Medium
Criterion 6- Quality of input information	Low	High	Medium	High	High	Medium	High	Medium	High

Table 2.3 Degree that criteria are satisfied when applied to a range of EPC frameworks

3 Increasing the value of EPCs

The next-generation EPCs have significant potential to improve their usefulness. A detailed analysis of current EPCs in target countries is paired with research into how they can be integrated into national databases and renovation one-stop shops, while leveraging tools such as energy audits, building logbooks, and renovation passports. This can help end-users and investors fully grasp the benefits of building renovations.

Key goals include:

- **Identifying relevant regional and national databases** for EPC integration.
- **Increasing EPC acceptance by end-users and investors** by ensuring they understand the data and have access to up-to-date information.
- **Determining the best link between EPCs and tools like energy audits and renovation passports** to improve renovation efficiency.
- **Exploring how to connect renovation one-stop shops with EPCs** to address market fragmentation and unlock their untapped potential.

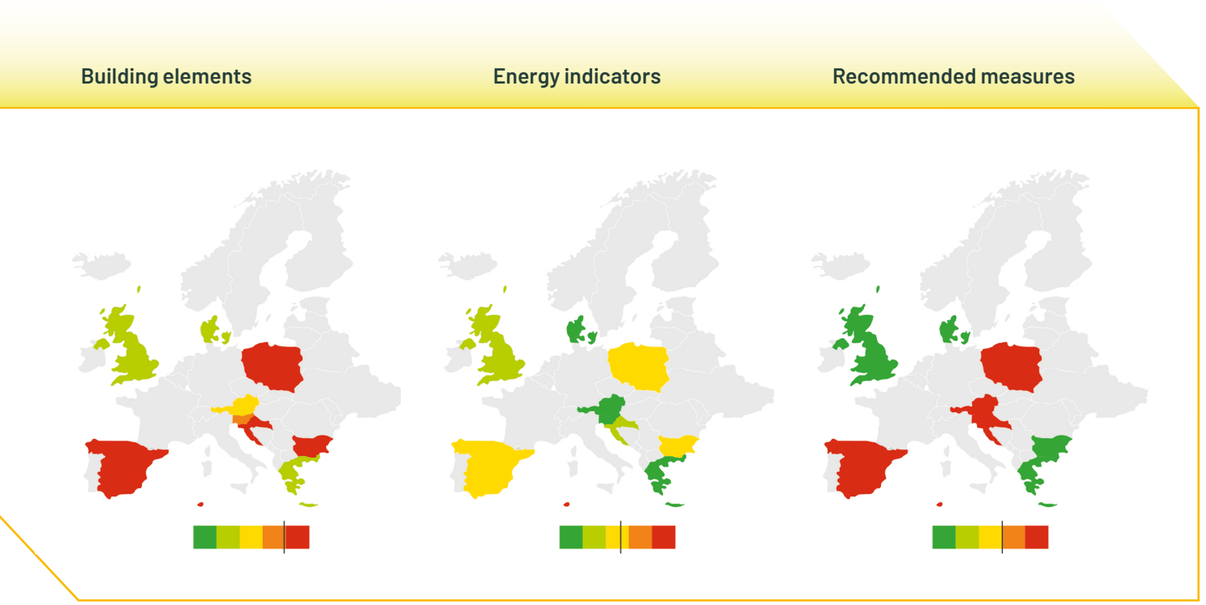

Figure 3.1 Overview of data availability in the EPC databases of the crossCert partner countries

3.1 Existing EPC databases require improvement and interactivity

The crossCert project has identified key barriers and challenges to digitising and integrating current and next-generation EPCs into regional and national databases. These challenges include user interactivity and access limitations, which hinder the ability to map energy demand and develop future heat/energy maps for cities, as well as other applications like local renovation roadmaps, policy-making, and research.

Key findings from the data collection process revealed that while most EPC databases are accessible online, issues such as language barriers and limited access restrict the usability of the data. Surveys conducted with project partners analysed stakeholder groups, including public authorities, homeowners, ESCOs, and researchers, to assess the value of upgraded databases for each group. Additionally, the team explored EPC databases to evaluate their ease of use, data availability, and potential obstacles for users unfamiliar with the platforms.

Regarding current EPC database performance, most countries maintain national EPC registers, and around 70% of these databases offer public access. A common use of XML files to process EPCs suggests potential for harmonisation across countries. However, differences in data disclosure persist, leading to a fragmented landscape of EPC databases.

Key conclusions include:

- **EPC registration:** Most countries use energy assessors to submit data, with some relying on agencies or certifiers. XML and PDF files are standard, but some countries, like Poland, also allow manual entry.
- **Data disclosure:** While most databases provide general building information, additional non-energy data (e.g., geo-coordinates) would enhance usability. Disclosure of building elements and energy performance indicators is inconsistent, with Poland, Spain, and Bulgaria needing improvement. Slovenia and Austria lead in transparency. (See Figure 3.1.)
- **Recommendations:** Energy efficiency recommendations are only displayed in a few countries, limiting their usefulness in guiding investment decisions.
- **Digitalisation and interactivity:** Although digitalisation levels are high, data protection laws and restricted access limit full data availability in some countries. XML processing offers a technical pathway towards harmonised access to EPC data. (See Table 3.1.)

In summary, while EPC databases show promise, improvements in data accessibility, harmonisation, and disclosure are needed to fully unlock their potential for stakeholders and end-users.

Countries	Who can access registry data?	Does the database allow to extract information?	Accessibility rate
Spain	Public information.	Yes	100%
Poland	The only public data is information on persons authorised to draw up EPCs and information on the public.	No	25%
Slovenia	Public with limited information and certifiers - every EPC with all information available in it.	Yes	75%
Bulgaria	Public information.	Yes	100%
Greece	Only available for energy assessors and registry administrators.	No	25%
Croatia	Energy certifiers can access all data, while the general public only have access to non-editable data.	Yes	75%
Austria	The EPC issuer and the building owner have only access to their certified uploaded building.	Yes	50%
United Kingdom	Public information.	No	50%
Malta	Registry data is only available to BCA. Assessors can only view their own EPCs.	No	0%
Denmark	Public information	Yes	100%

Table 3.1 Data accessibility and user interactivity analysis of EPC databases in crossCert countries

The barriers and challenges facing existing EPC databases have been identified in relation to meeting the needs of key stakeholders, including public authorities, Energy Service Companies (ESCOs), homeowners, and researchers. Figure 3.2 shows the percentage of countries encountering these barriers, with higher percentages indicating more significant challenges. The main obstacles are the lack of essential information and difficulties in interacting with the datasets. Analysis reveals that ESCOs and homeowners face the most difficulties in accessing and using EPC databases. Even with an ideal platform structure, concerted efforts are needed to improve user understanding of the data.

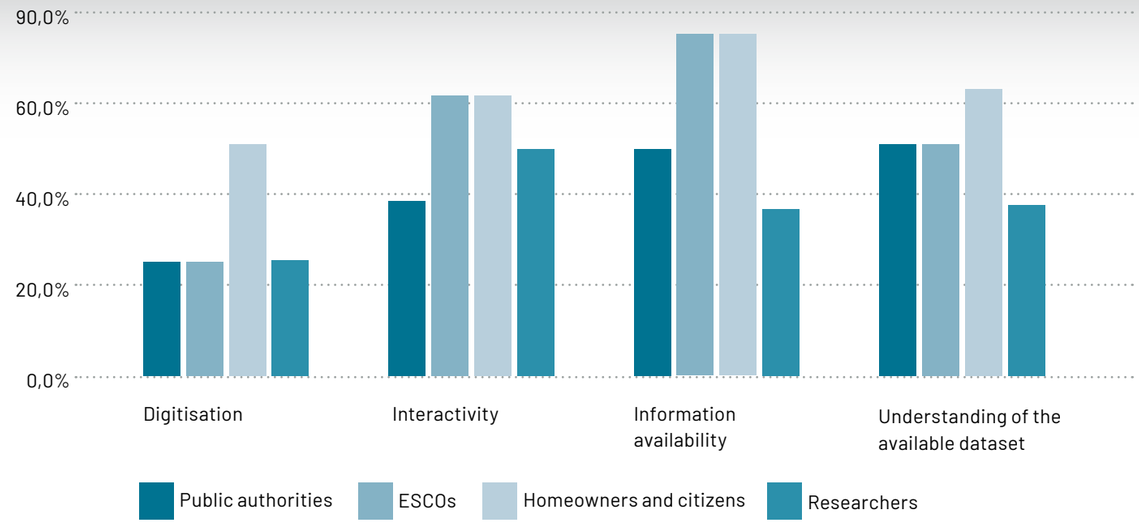

Figure 3.2 Barriers identified by stakeholders regarding EPC database interaction and use

Based on questionnaire responses from partners, the following proposals aim to improve EPC databases:

- **Increase information availability**, with a focus on expanding the scope of accessible data.
- **Enhance user interactivity** on visualisation platforms (EPC database front-ends), enabling stakeholders to manage data more effectively.
- **Improve interoperability** between EPC databases and other administrative databases, facilitating data linkage.
- **Harmonise XML processing**, as all assessed countries currently use and store EPC XML files.

Figure 3.3 presents a set of guidelines for developing next-generation EPC databases. It outlines three key components: tools, guidelines, and expected achievements. The diagram illustrates how specific tools and actions, such as digital registration, public information access, and data filtering, can enhance digitisation, data availability, interactivity, understanding, and interoperability of EPC databases.

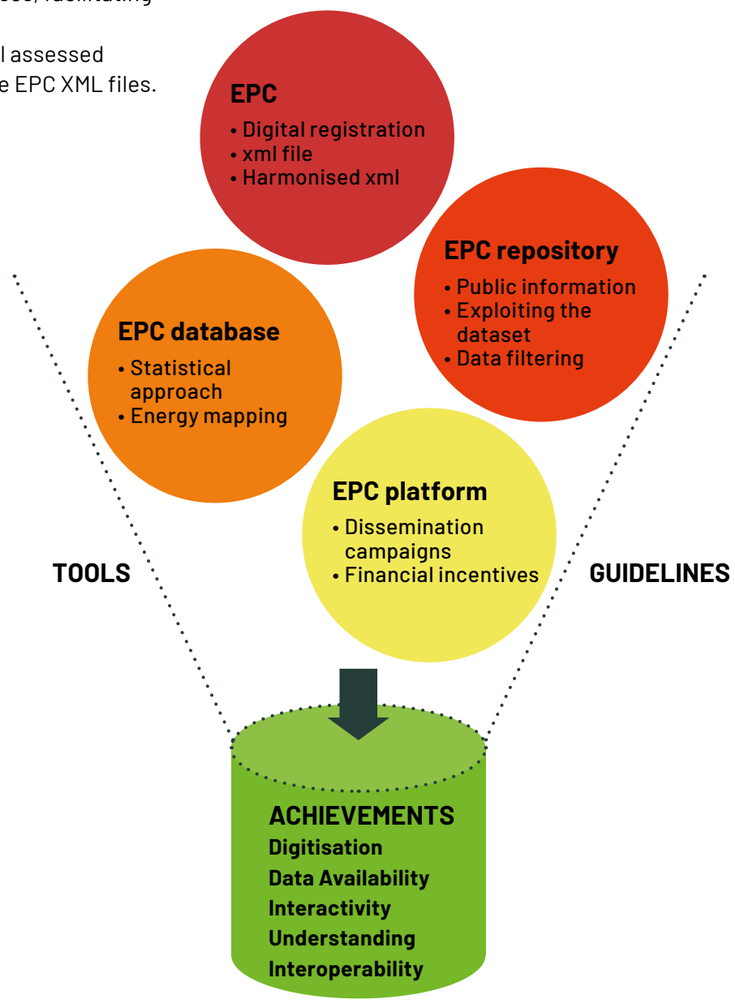

Figure 3.3 Proposed guidelines to develop the next generation EPC databases

The following best practices for information dissemination are essential to harmonise EPC databases across EU countries:

- **Full disclosure of EPC elements:** All EPC elements should be fully disclosed, directly extracted from registered XML files. This includes greater focus on building envelope elements, especially their conservation status, which is crucial for meeting the EU's renovation objectives.
- **Comprehensive energy indicators:** While CO_2 emissions are widely shared, databases should also display other key parameters such as final energy, primary energy (renewable and non-renewable), and energy demands (heating, cooling, and DHW). Normalising these indicators across countries would facilitate a common language and improve database consistency, as this data is already embedded in XML files.
- **Inclusion of recommendation measures:** Fewer than 50% of crossCert partners currently share energy efficiency recommendations in their databases. Making these recommendations widely available would provide direct benefits to stakeholders.
- **Georeferenced data:** Including cadastral identifiers and georeferenced coordinates would enhance EPC databases and improve interoperability with other administrative databases.
- **Full digitisation:** Achieving full digitalisation across all EPC databases in the EU is critical. Financial incentives should be introduced to support this goal.
- **Unrestricted access:** Ensuring full access to EPC data for all users is essential. Currently, only 40% of crossCert partner countries offer full access, while the remainder impose restrictions. This needs to be addressed to enhance transparency and usability.

3.2 Digital EPC provides investors with up-to-date data and more accurate investment planning

In addition to improving user-friendliness, a digital EPC format offers significant benefits for potential investors. These include access to up-to-date, dynamic data that more accurately reflect real conditions, compared to outdated, static paper formats.
Integrated databases within certification tools provide valuable support to EPC issuers. For instance, in Denmark, Austria, and Spain, standard data for costs, lifespans, and energy prices are already incorporated into certification software. Guidelines for the development of EPC tools also recommend including additional calculation parameters, such as current energy costs and unit costs for energy-saving measures, managed by administrators in each country.

Real-time data integration has several key advantages:

- It helps identify the most cost-effective steps to achieve building standards (e.g., nZEB).
- It allows for the comparison of investment costs and energy savings across different combinations of measures.
- It enables the prioritisation of recommendations and the development of timelines, linking them to Building Renovation Passports (BRPs).

3.3 Energy audits, building logbooks and building renovation passports integration with EPCs enables access to valuable data

The availability of clear, accessible information on buildings and renovation measures is crucial for end-users deciding whether to rent, buy, or renovate properties. **Building Renovation Passports (BRPs)** and **Logbooks**, mandated by the updated **Energy Performance of Buildings Directive (EPBD)**, serve as central tools for storing this information. These tools enable users to plan and monitor building renovations toward achieving zero-energy status.

Several H2020 projects have developed concepts for BRPs and Logbooks, with a focus on **next-generation Energy Performance Certificates (EPCs)**. These concepts aim to link EPCs with energy audits, Building Information Modelling (BIM), and BRPs, creating a dynamic system for energy management beyond traditional static EPCs.

Challenges in linking EPCs, energy audits, and BRPs

The integration of EPCs with energy audits, Logbooks, and BRPs faces obstacles, particularly regarding **data privacy, interoperability**, and **stakeholder coordination**. Ensuring secure data exchange and standardising systems across countries is vital. Additionally, the technical complexity of keeping data up-to-date and the need for stakeholder training adds to the challenge. Legal frameworks must evolve to accommodate these changes while addressing data protection concerns.

Role of energy audits

Energy audits, especially for older buildings, provide essential data for updating EPCs and BRPs. However, differences in audit requirements and decentralised systems across EU countries hinder data integration. Some countries, like **Croatia** and **Denmark**, have made progress in digitising and sharing building data, while others, such as **Poland** and **Spain**, lag behind in using digital tools.

Sources of building information and reporting

Reporting renovation activities and heating system changes is essential for keeping data current. However, many countries do not mandate such reporting unless linked to building permits or subsidies. Linking EPCs to other databases, like funding databases or land registers, would enhance the system's effectiveness (Table 3.2).

Advancing digitalisation

Most crossCert partner countries are not yet advanced in digitalising building information and setting up BRPs and Logbooks. There are legal and technical barriers, as well as a general lack of willingness to link data sources. Nonetheless, examples of good practices and ongoing development efforts show promise.

Key recommendations

1. **Full digitalisation** of EPC systems across the EU is crucial, supported by financial incentives.
2. **Data integration:** EPCs should include comprehensive energy indicators (CO_2 emissions, final energy, and energy demand), with standardisation across databases.
3. **Secure data sharing frameworks** should be established, and stakeholders should be trained to use these systems effectively.
4. **API integration** and automated updates are needed to ensure real-time data flows between EPCs, energy audits, and BRPs.
5. Advanced technologies like **blockchain** for data security and **machine learning** for predictive analysis should be leveraged to enhance data accuracy and reliability.

In conclusion, the integration of next-generation EPCs with energy audits, Logbooks, and BRPs offers a promising path toward improving building energy efficiency across Europe. However, continued efforts to address technical, legal, and organisational challenges are required to unlock their full potential.

	Any retrofitting or replacement	Major renovations	Change of heating system	Linkage to funding database	Linkage to EPC database	Land register
Austria	Reporting not mandatory	Building permit	Report	Yes	Yes	Yes
Bulgaria	Building permit	Building permit	Report	No, but database existing	No, but database existing	No, but database existing
Croatia	Reporting not mandatory	Report	Report		No, but database existing	No, but database existing
Denmark	Report	Report	Building permit		Yes	Yes
Greece	Building permit	Building permit	Reporting not mandatory	Yes	No, but database existing	Yes
Malta	Reporting not mandatory	Building permit	Reporting not mandatory		Reporting not mandatory	Reporting not mandatory
Poland	Reporting not mandatory	Building permit	Report		No, but database existing	Reporting not mandatory
Slovenia	Reporting not mandatory	Reporting not mandatory	Reporting not mandatory		No, but database existing	No, but database existing
Spain	Building permit	Reporting not mandatory	Reporting not mandatory		No, but database existing	No, but database existing
United Kingdom	Building permit	Building permit	Reporting not mandatory			

Advanced stage – Measures have to be reported or applied for in a building permit, database are linked.

Existing potential to use data – Database existing, with potential to be linked.

High improvement potential – No record of measures, no database available.

Table 3.2 Sources of building information and linkage of energy audits to different databases

3.4 High readiness of next-generation EPC schemes for integration with one-stop shops in some crossCert countries

One-stop shops have gained increased prominence in the EPBD as key resources for renovation information and advice, with a dedicated article outlining their role. The directive links one-stop shops with other tools like renovation passports and EPCs, recognising their importance in supporting regulations such as Minimum Energy Performance Standards (MEPS). These synergies are expected to boost the use of one-stop shops. According to the EPBD, website links to relevant one-stop shops will soon be a mandatory part of both renovation passports and EPCs. Building owners with EPC ratings below class "C" will be directed to these one-stop shops for renovation guidance.

Research on the one-stop shops developed and operational in crossCert countries has explored how future EPCs can support these platforms. The aim is to accelerate building upgrades and increase renovation rates. The analysis shows that 88% of the one-stop shops have a holistic approach and are verified by relevant authorities. Over half are digital (62%), with some being interoperable with other databases (35%) and featuring recommendation tools (32%).

The readiness of next-generation EPCs to link with existing one-stop shops is shown in figure 3.4. The best integration conditions have been identified in the following crossCert countries:

- **Bulgaria:** Incorporation with REVERTER OSS, SHEERenov+, and SUNShINE platforms
- **Denmark:** Integration with SparEnergi and BetterHome
- **Slovenia:** Linked with ENSVET
- **Spain:** Connected with ENERHAT, Solutions4Renovation, RenovEU, and HORIS
- **UK:** Integration with Retrofit Works and Ecofurb.

EPC integration in One-Stop Shops

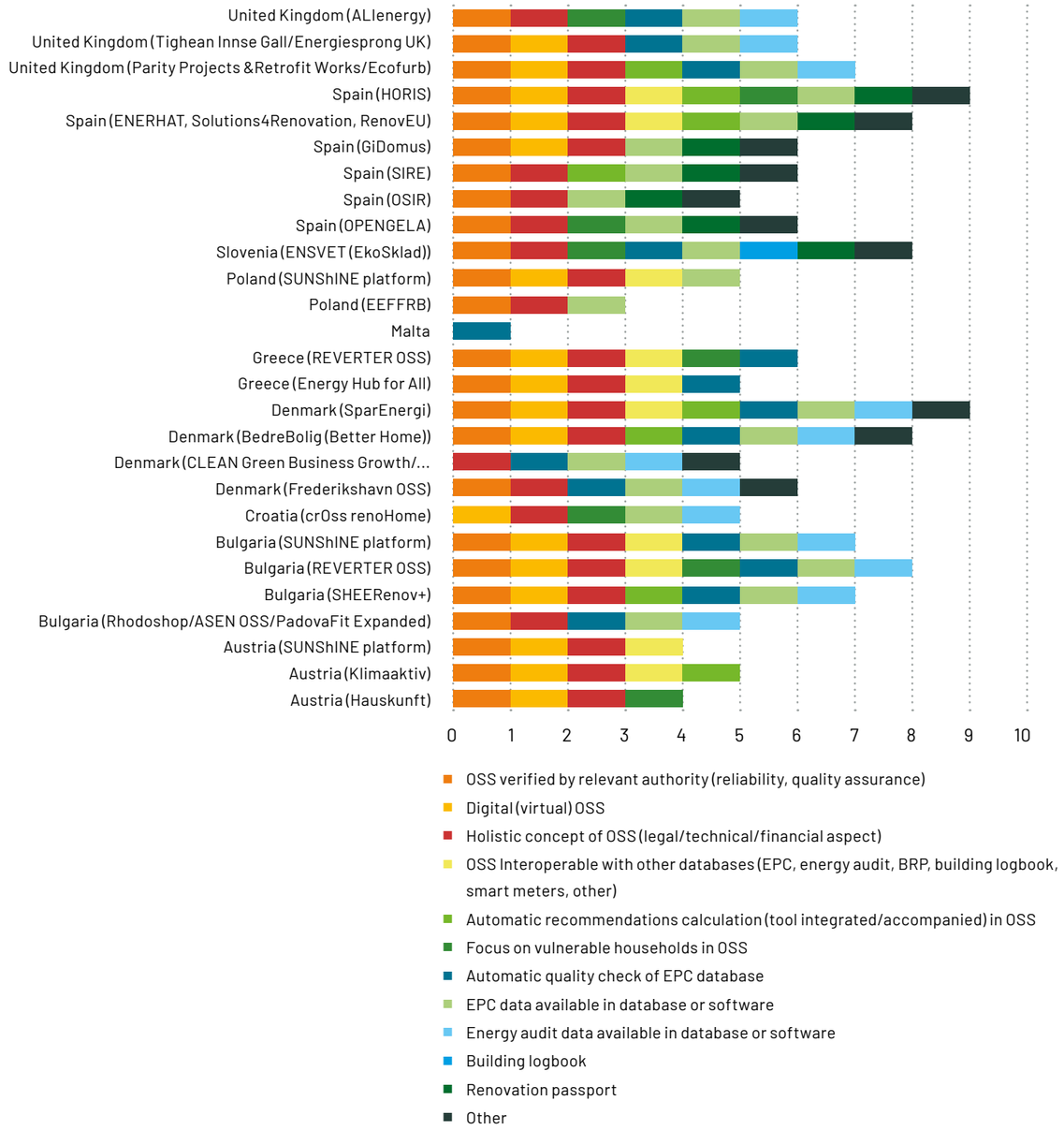

Figure 3.4 Analysis of EPC integration within One-Stop Shops

4 Making EPCs more people-centred

Across Europe, EPCs are typically seen as drivers for building renovation and energy performance improvement. However, research shows that many perceive EPCs as merely an "administrative necessity" with little value, a view shared by both construction experts and property owners (Bančič and Vetršek 2022). To address this, crossCert promotes a people-centred approach to EPCs, focusing on three key areas for improvement: user experience, system optimisation, and public perception.

The success of next-generation EPCs depends on user acceptance. To foster this, crossCert pursued several objectives:

1. **Adopt a people-centred perspective:** Traditionally seen as a technical issue, energy performance in buildings must now incorporate social perspectives. crossCert applied social science insights to better understand how EPCs can be more relevant and valuable to users.
2. **Improve design:** Using 'design thinking', a people-centred approach, we recommend enhancing both the products (EPCs) and services (support, assessment, certification) to better meet user needs, avoiding distractions like technical debates over calculation methods.
3. **Optimise internal systems:** EPC assessors, who play a key role in the system's success, need better support. Understanding their role can highlight opportunities for optimising the EPC system internally.
4. **Boost promotion and marketing:** Effective marketing campaigns are crucial for motivating homeowners to undertake energy renovations. Our research suggests that well-crafted campaigns can increase the impact of EPCs.

To maximise the impact of these findings, crossCert developed infographics that present complex ideas in an accessible way for both non-technical users and professionals. These tools can help policymakers identify opportunities for people-centred improvements in EPC systems, complementing technical enhancements in areas like calculation methods.

4.1 People-centred means giving people priority over technical, methodological and policy aspects

EPCs have been present in Europe for over two decades, but their anticipated impact, as promoted by policy narratives, has yet to be fully realised. Despite significant EU funding for projects aimed at improving various aspects of the EPC system, success has been limited (see Bančič and Vetršek 2022). A key issue is the disproportionate focus on technical, methodological, and policy aspects, while the people behind the system—EPC assessors, support networks, and users—are treated as secondary.

Our approach to **people-centred EPC products and services** takes the opposite view: it places people at the core, with technical aspects like calculation methods seen as secondary. Policies shape everyday experiences through the interplay of materials, skills, and meanings, which are constantly shaped by interactions among stakeholders. To improve EPC systems, it is essential to understand these dynamics—social networks, trust, power, perceived value, media influence, and social justice. This holistic approach ensures that EPCs serve their intended purpose by addressing the needs and interactions of the people involved.

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Our first infographic (Figure 4.1) maps the EPC creation process, offering a broad perspective on the people-centred aspects of the EPC assessment service. While the EPC itself is the central element, the focus is on the people involved in its production and use, demonstrating that the value of EPCs is generated through these interactions. Emphasising the roles of individuals within the energy performance assessment process is crucial for understanding, people-centred design'. This approach is particularly relevant for EPC-related products and services, which are typically dominated by technical and policy perspectives. The originality of crossCert's qualitative, people-focused approach provides an innovative example of applied interdisciplinary research.

4.2 Holistic EPC design concerns both the EPC and the services that make it meaningful and valuable for people

EPC design encompasses both the EPC as a final product and the services associated with it, such as building performance assessments, issuing certificates, and providing customer support (e.g. booking assessments, interpreting results). It includes visual elements like colour-coded energy ratings and icons, content elements such as data on energy consumption, savings, and recommendations, and service design elements like the methods and tools assessors use to evaluate buildings and communicate with clients.

Trust in the accuracy and usability of EPC information is critical to how EPCs are perceived and valued (Jenkins, Sayfikar, and Bančič 2024). However, good EPC design goes beyond just the product. Effective communication between the assessor and the property owner, particularly in explaining renovation and energy optimisation options, greatly enhances the value of the service. Both the EPC product and the service are essential components that contribute to the overall value of the EPC system and should not be treated as standalone entities. High-quality services can significantly improve the usability and trustworthiness of EPCs by aligning them with the specific needs and interests of users.

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Our second infographic focuses on **EPC design** and takes the reader through the stages of **design thinking**, applied specifically to EPCs. It highlights that design is a process, not just a product, and that policymakers must give equal importance to the quality of services related to EPCs. Moreover, the infographic emphasises the need to involve diverse stakeholders in the design process to ensure the EPC system meets the needs of all users.

4.3 Understanding the assessors' journey outlines pathway to meaningful internal improvements of existing EPC systems

EPC assessors play a central role in delivering EPC assessments and certifications. They are crucial in shaping how users experience the service, perceive the value of EPCs, and form opinions based on their expectations. As key figures within national EPC systems, assessors are essential to the effectiveness and purpose of EPCs.

However, our analysis of training schemes for EPC assessors in several European countries (Simeonov 2024) highlights that delivering high-quality services is not solely the assessors' responsibility. National policymakers and system implementers also play a vital role. To ensure assessors can provide excellent service, the EPC system must offer strong support, including quality customer service, comprehensive training that equips assessors with the necessary skills, and robust mechanisms to uphold EPC standards.

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Our third infographic maps the career path of EPC assessors, from education to certification, illustrating their critical role within the EPC system. It also identifies areas for improvement in training and support to optimise the overall performance of the system.

4.4 Effective EPBD policy intervention requires impactful promotion and marketing campaigns

Mass media plays a significant role in shaping public opinion, even in technical areas like energy policy and building renovations. Our study on media coverage of the 2023 German Building Energy Code (Turfin 2024) illustrates how media can impact these discussions. It is essential to prioritise people in these debates and counterbalance the technical focus with clear, accessible communication. Effective campaigns should address uncertainties and knowledge gaps, preventing misinformation or exaggerated claims.

Moreover, it's important not to assume that people make purely rational decisions based on facts. Many homeowners are content with their current situations, unaware of potential benefits, or hesitant to start complex renovation projects. Campaigns focused solely on financial savings are insufficient. Instead, people-centred marketing must connect with individuals' everyday lives and motivations.

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Our infographic on **EPC promotion and marketing** highlights key strategies for promoting the EPC system. It stresses the importance of people-centred campaigns, starting with understanding target groups, crafting tailored messages, and choosing the right communication channels. Recommendations include addressing deeper motivations, using trusted networks, and providing clear, engaging information.

Figure 4.1 crossCert EPC journey infographic

△ **Before** - *The knowledge*

○ **During** - *The service*

□ **After** - *The product*

1 RAISE AWARENESS

The fundamental first step on the EPC Journey is to equip people with the basic knowledge they need to understand how EPCs can have a meaningful impact on the everyday professional and personal lives. This understanding will help them to engage proactively in the following steps of the journey.

KEY CHALLENGE: Lack of strategies and resources targeting awareness raising.

How to demonstrate that EPCs are more than just an administrative requirement, but a meaningful part of life in contemporary European societies?

2 ENGAGE

In cases where EPCs are decisively beneficial or factually required by law, key stakeholders need to have a good understanding of their responsibilities towards the EPC system that call for their action, as well as the case-specific privileges and benefits that are expected to motivate their engagement.

KEY CHALLENGE: Poorly communicated stakeholder responsibilities and associated benefits.

How to communicate individualized case-specific motives and obligations regarding ordering or using EPCs, and how to integrate EPC assessment with activities and processes that are meaningful in people's lives?

3 ARRANGE THE ASSESSMENT

Clients' first contact with the EPC service provider, aimed at arranging practical details of the assessment, is the first step in the EPC Assessment Service. Despite its organizational focus, this step is pivotal in creating value for the client, demonstrating professionality and building solid ground for delivering good value throughout the following steps.

KEY CHALLENGE: Poor qualities and practices in EPC customer service.

How to enhance the value proposition for the customer? How to improve the arrangement process, making it more effective, simpler, effortless and value-driven?

4 GATHER DATA & INFORMATION

Following the arrangements, the service provider needs to collect data and information required for calculating and issuing the EPC. This includes details on the building's construction, occupancy, and energy consumption. A site visit by a qualified EPC assessor is the most common and most reliable method in the established EPC assessment practice.

KEY CHALLENGE: Limited interaction between customers and EPC assessors.

How to improve the interaction between the EPC assessor and the client during the on-site visit? How to motivate EPC assessors to deliver better service, and clients to be more engaged?

5 PROCESS DATA & INFORMATION

Once the assessor gathers all the necessary data & information it has to be processed according to the established national protocol. This mainly involves office work, to calculate the EPC indicators and to complete administrative actions required to issue the EPC as an official document.

KEY CHALLENGE: Optimization of work required by EPC assessors.

How to optimize the calculation method and user interface of the calculation software? How to optimize the administrative process of issuing the EPCs as official documents?

6 ISSUE & DELIVER EPCs

Delivering the EPC to the client is the closing phase of the EPC Assessment Service. The final product should be interpreted, contextualized and presented in a way that meets or surpasses the client's expectations. In most cases, the service provider also needs to deposit or register the EPC with the appointed authority or institution.

KEY CHALLENGE: Lack of interest and engagement on one or both sides of the service.

How to motivate both the service provider and the recipient to dedicate time and attention at the moment of EPC delivery?

7 USE EPCs

The usability of EPC products and services should be considered a key element of the EPC concept, as this ultimately translates into value and meaning for the institutions and the people who should benefit from it. EPCs should therefore not only *inform* about buildings' energy performance but also *support* and *enable* meaningful actions and transactions.

KEY CHALLENGE: Poor integration of EPCs with actions and processes associated with buildings.

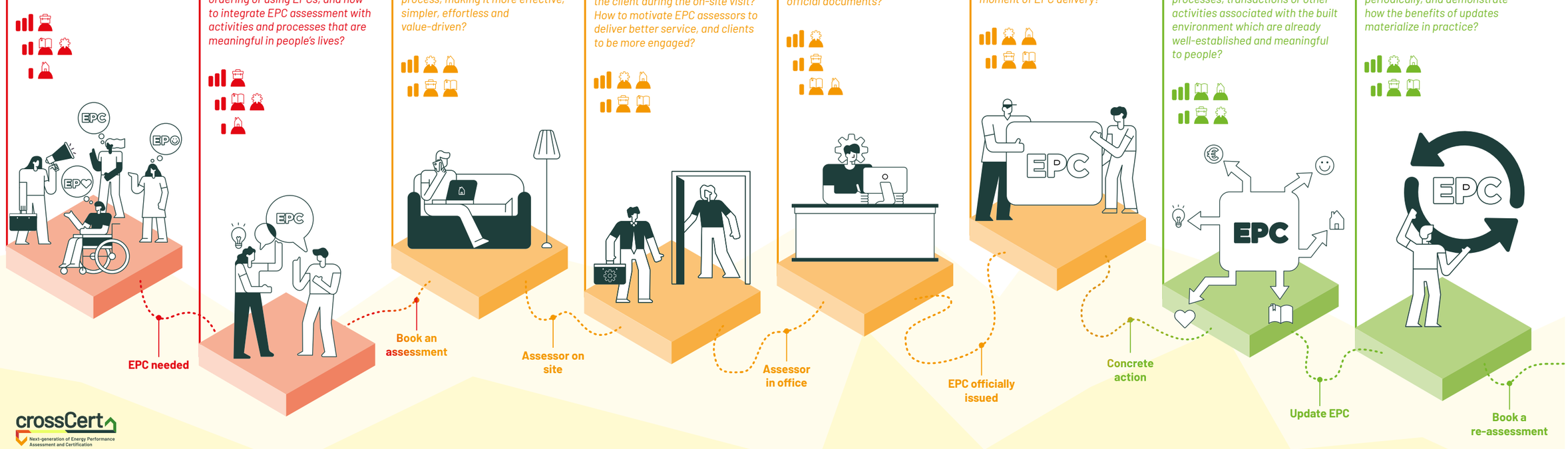
How to enhance the integration of EPCs with goal-oriented processes, transactions or other activities associated with the built environment which are already well-established and meaningful to people?

8 REPEAT

EPCs of today have a temporary value, as they are a static description of the building's energy performance at the time of their issuing. With time, the factors that define buildings' performance change, as do the policies and regulations that define the current EPC systems. A periodic update of EPCs is therefore necessary to ensure their relevance.

KEY CHALLENGE: Lack of awareness and materialized benefits associated with periodic updates of EPCs.

How to increase awareness of the need to update existing EPCs periodically, and demonstrate how the benefits of updates materialize in practice?



crossCert
Next-generation of Energy Performance Assessment and Certification

Why This infographic Matters

The crossCert EPC Journey describes the creation of an **Energy Performance Certificate (EPC)**, an official document used to rate the energy performance of buildings. It is a map of steps involved in obtaining and utilizing an EPC, keeping the EPC as the main 'protagonist' of the mapped process, yet highlighting the key stakeholders involved at each step. The **EPC Assessment Service** is at the core of the journey, outlining dynamics between the service provider and the customer, contextualized with key steps before and after the service takes place, which provide the basis for the EPC products and services to create value for everyone involved, and have a meaningful impact on the world.

EPC System

The EPC system is a functional network of stakeholders and institutions that enable, co-create and otherwise support the existence and functioning of the national EPC schemes. Besides people who drive the system, it includes the **EPC Scheme** – a conceptual and legislative framework that includes protocols and methods that define the national rules and standards regarding the issuing of EPCs – and other non-animate means they use in their efforts to keep the system working.

EPC Profiles

EPC Service Support Network refers to profiles that develop the conceptual framework for implementation of the national EPC schemes, as well as stakeholders that enable and/or implement (enforce or exercise) the official conceptual framework.

EPC Expert Users are people assumed to possess considerable knowledge in the area of buildings and the built environment, which also implies a capacity to interpret EPCs as advanced users, and possibly use EPCs as part of their professional practice.

EPC Assessors are people trained and certified to do EPC assessments. In essence, they are part of the EPC service support network yet play a pivotal role in translating EPC theory into practice, connecting the EPC system with the public.

EPC General Users are people assumed to possess a lesser extent of relevant EPC-related knowledge yet are expected to interpret and use EPCs meaningfully in pursuit of their specific goals related to buildings.

Involvement level

KEY
The level of involvement and responsibility is high.

INDIRECT
The level of involvement and responsibility medium.

CONTEXTUAL
The level of involvement and responsibility is low.

Legend

KEY CHALLENGE
Key issues associated with individual steps, complemented with a guiding question aimed at provoking solution-oriented thinking.

Millestones

IRI UL

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Figure 4.2 crossCert EPC design infographic

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Next-generation of Energy Performance Assessment and Certification

Design Thinking for Impactful & Meaningful Design of EPC Products & Services

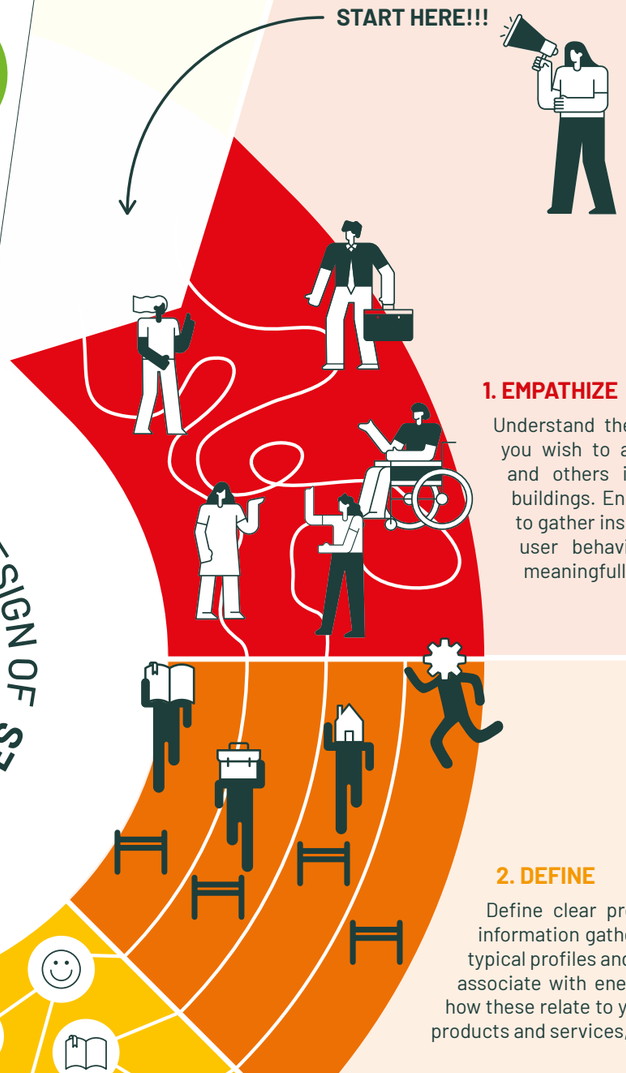
Design thinking is a people-centred iterative problem-solving approach that emphasizes empathy, collaboration, and experimentation. Throughout this process, it's essential to maintain a people-centred mindset, involving stakeholders at every stage to ensure that the outcomes truly meet the needs of the people they are intended to serve, as well as to ensure they contribute towards the core purpose of the Energy Performance Certificates (EPCs) and EPC systems across Europe – to promote energy efficiency, sustainability, and transparency in the built environment and to support decision making for building renovations.

IMPACTFUL & MEANINGFUL DESIGN OF

EPC Design

EPC PRODUCTS & SERVICES

START HERE!!!



1. EMPATHIZE

Understand the needs and challenges of the people you wish to address – building occupants, owners, and others interested in the topic of energy in buildings. Engage with a wide range of stakeholders to gather insights into energy consumption patterns, user behaviours, and pain points these people meaningfully associate with the topic.

2. DEFINE

Define clear problem statements by synthesizing the information gathered during the empathy phase. Identify typical profiles and specify typical problems and goals they associate with energy efficiency in buildings. Also, define how these relate to your own objectives associated with EPC products and services, and search for synergies.

3. IDEATE

Generate a wide range of creative ideas for addressing the problems and opportunities defined in the previous step. Conduct brainstorming sessions, engage team members from a variety of backgrounds, and involve the people for whom you are developing. Explore both technological and behavioural solutions, products, and services, and prioritize them based on feasibility, impact, and alignment with user needs.

4. PROTOTYPE

Develop prototypes for the most promising ideas shaped in the previous step. For physical or technology-based solutions, create physical or digital prototypes that illustrate functionality. For behavioural interventions, consider creating simulations or interactive experiences to test user engagement, for instance with the EPC or the building.

5. TEST

Conduct usability testing and gather feedback on the prototypes. Assess the performance, user experience, and effectiveness of the proposed energy-efficient solutions. Identify any issues or areas for improvement and refine the prototypes accordingly. Keep the purpose of the EPC system firmly in mind throughout this process and observe if tested solutions lead towards desired results.

6. IMPLEMENT

Develop a plan for the full-scale implementation of new solutions or a change management plan for the already existing EPC products or services. Collaborate with key stakeholders to integrate the solutions into the existing processes and systems. Consider scalability, cost-effectiveness, and long-term maintenance requirements. Monitor and evaluate the implementation to ensure it meets the defined goals and objectives.

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Figure 4.3 crossCert EPC assessor's journey infographic

△ **Before** - *The introduction* | ○ **During** - *The training* | □ **After** - *The service*

1 INFORM AND MOTIVATE

Access to adequate information is the key prerequisite to spark an interest in prospective EPC Assessors to begin their training journey. Potential candidates need to understand the general purpose & goals of the EPC System, and to grow motivated, they need to understand how EPCs are related to their personal professional goals and aspirations.

KEY CHALLENGE: Recognition of the role of EPCs.

How to onboard committed professionals that will bring the purpose of the EPC System to life?

2 ENGAGE

As the first step, interested candidates need to apply with the establishments that offer training courses or certification. In most EU countries, candidates must meet specific educational background requirements (in engineering, architecture, or similar technical expertise) or prove specific professional experience in a relevant field of work.

KEY CHALLENGE: Differences in EPC training frameworks.

How to harmonize the training frameworks across Europe for enhanced effectiveness of EPC Systems?

3 TRAIN AND BUILD COMPETENCE

Following successful application, the candidates receive a combination of theoretical courses and materials, practical training, and learning support from the training provider. The institutional frameworks across Europe vary substantially both in terms of content (structure, length, and balance of theory and practice) and organisation (the degree to which they are regulated, institutionalized, or open to the market).

KEY CHALLENGE: Unharmonized training content.

How to design the training to optimize the learning experience and maximize the benefit for training participants?

4 CERTIFY

In most European countries, candidates need to pass an official post-training examination if they wish to obtain the status of a certified EPC Assessor. Typically, the exam consists of a theoretical and practical part, the latter being focused on mastering the process of collecting and processing of data for production of the EPCs.

KEY CHALLENGE: Different competences of the EPC Assessors.

How to harmonize the learning objectives across Europe to ensure optimal qualification standards for EPC Assessors?

5 PRACTICE EPC ASSESSMENT

Certified EPC Assessors are the primary ambassadors of the EPC System, raising public awareness about the relevance of the EPC System and offering their services to all segments of the system. This implies communication with the clients, gathering and processing of the necessary data and information, energy modelling, identifying suitable energy savings measures, and ultimately issuing and delivery of the EPCs.

KEY CHALLENGE: Inconsistent quality of EPC assessments.

How to motivate EPC Assessors to deliver top quality service to their customers and the system?

6 PERFORM QUALITY CHECKS

Continuous quality control and efforts for improvement are essential for maintaining high quality standards and public trust in the EPC System. In this regard, all EPC Assessors should periodically undergo performance checks. Poor performance should be adequately addressed while outstanding performance should be recognised and rewarded.

KEY CHALLENGE: Insufficient quality control.

How to streamline quality control and reward top-performing EPC Assessors?

7 CONTRIBUTE TO THE EPC COMMUNITY

Experienced assessors should share their knowledge and experience with peers, promote best practices, and contribute to the overall development and improvement of the EPC System. The focus is on fostering professional growth of community members through mutual support and cooperation for the advancement of the field of expertise.

KEY CHALLENGE: Lack of positive identification with the role of an EPC Assessor.

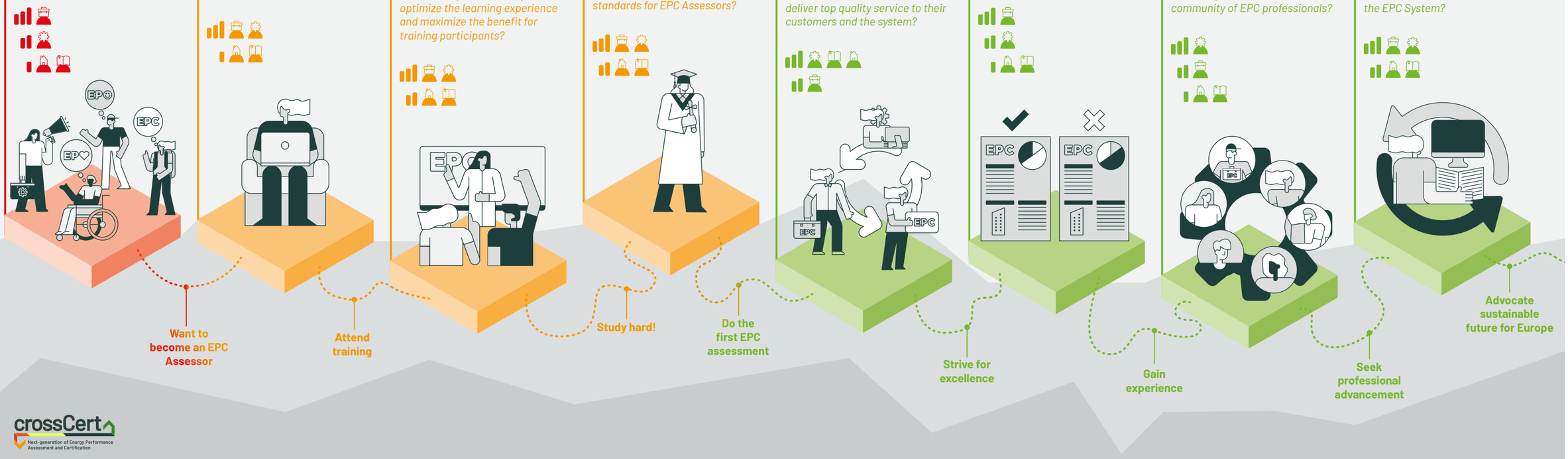
How to motivate EPC Assessors to actively contribute towards the community of EPC professionals?

8 UPSKILL AND GROW PROFESSIONALLY

Energy performance in buildings is a rapidly evolving field of expertise. Periodic refresher courses, advanced qualification trainings, and other forms of upskilling are available in several European countries. Although not universally obligatory, practicing EPC Assessors are widely expected to participate and pursue continuous professional growth.

KEY CHALLENGE: Adequate response to the growing ambition in building renovation.

How to motivate EPC Assessors to actively seek professional advancement for the benefit of the EPC System?



crossCert
Next-generation of Energy Performance Assessment and Certification

Why This infographic Matters

EPC Assessors are the cornerstone of the **EPC System** and are widely recognized as key actors in realizing the purpose of EPCs. The crossCert **EPC Assessor's Journey** maps key steps by which they progress in their career and contribute towards keeping the system in function. Each step of the journey represents a reflection point to understand better the role of EPC Assessors, and search for potential improvements of the existing system in the future. Despite the specific focus on EPC Assessors, the purpose of this infographic is to support future advancement of the EPC System for the benefit of all **EPC Profiles** involved in its functioning.

EPC System

The EPC system is a functional network of stakeholders and institutions that enable, co-create and otherwise support the existence and functioning of the national EPC schemes. Besides people who drive the system, it includes the **EPC Scheme** – a conceptual and legislative framework that includes protocols and methods that define the national rules and standards regarding the issuing of EPCs – and other non-animate means they use in their efforts to keep the system working.

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INDIRECT
The level of involvement and responsibility medium.

CONTEXTUAL
The level of involvement and responsibility is low.

Legend

KEY CHALLENGE
Key issues associated with individual steps, complemented with a guiding question aimed at provoking solution-oriented thinking.

Key signpost

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Figure 4.4 crossCert EPC promotion and marketing infographic

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Next-generation of Energy Performance Assessment and Certification

EPC PROMOTION & MARKETING

To optimize the influence of Energy Performance Certificates (EPCs) on energy efficiency, sustainability, and transparency in the built environment, promotion and marketing strategies should be considered an integral part of the policy implementation process.

The crossCert approach to EPC Promotion and Marketing emphasizes a people-centred strategy that consists of three stages. In the **ideation phase**, we analyse target groups, craft key messages, and identify effective channels. The **creation phase** assembles these elements into actionable campaign plans tailored to our audience. Finally, the **implementation phase** puts these plans into real-life action, supporting informed building renovation decisions and fostering sustainable futures across Europe.

1. IDEATION PHASE

KNOW WHO YOU WISH TO COMMUNICATE TO

Target group / Persona

Behavorial

- **Dwelling characteristic** — Surface, age, individual house, energy performance, localisation
- **Sociodemographic characteristics** — Age, income, presence of children
- **Environmental concerns** — Waste separation, public transportation, ...
- **Energy context perception** — Risk aversion

Structural

- **Fiscal and regulatory policies**
- **Access to capital**

KNOW WHAT IS YOUR MESSAGE

Promotion messages

- **Condition of Domestic life**
- **Triggers**
- **Benefits of renovation measures**

KNOW YOUR CHANNELS

Trust persons

- **Social networks**
- **Professional networks**

Trust information

- **Government homepages**
- **Energy agencies**
- **Consumer organisations**

2. CREATION PHASE

Develop tailored Campaigns

3. IMPLEMENTATION PHASE

Communicate and support

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5 Harmonising EPCs in Europe

The crossCert consortium has focused on establishing the foundation for successful collaboration and knowledge sharing across Europe. One of the key achievements was the creation of the crossCert community, which identified key stakeholders in each participating country. This community was critical to ensuring the project's success, particularly in the harmonisation of the next generation of Energy Performance Certificates (EPCs).

The project's primary goal was to foster widespread knowledge exchange, essential for unifying EPC methodologies across Europe. A significant outcome was the development of the **EPC knowledge exchange centre**, a web-based repository that serves as a central platform for sharing EPC-related information: legislation, studies and analyses, other related project and platforms, and a database of buildings (hosted on the EU Zenodo platform) that can be used for testing EPC schemes.

The main objectives of this effort were:

1. **Guideline development**: Providing clear guidelines to facilitate the convergence of EPC processes across the EU. This was achieved by setting up the **EPC knowledge exchange centre**, which offers freely accessible and curated information.
2. **Stakeholder engagement**: Building an active **EPC stakeholders' community** to promote the exchange of information, ideas, and best practices related to EPC processes in different countries.
3. **Comparative analysis**: Gathering and analysing data on national EPC methodologies to develop comprehensive **guidelines** aimed at standardising EPCs across Europe.

These efforts laid the groundwork for improving the comparability and effectiveness of EPCs, supporting broader goals of harmonisation within the EU's energy efficiency policies.

5.1 The status quo of harmonisation in EPC ratings through cross testing

The crossCert project involved extensive cross-testing of various European countries' methodologies for Energy Performance Certificates (EPCs) to explore discrepancies, harmonise procedures, and learn from best practices. The project was structured around two key tests: C-building testing (comparing methodologies across similar climates) and L-building testing (local assessments focusing on performance gaps). The testing aimed to assess the feasibility of harmonising EPC processes across Europe by highlighting differences in calculation methods, data use, and the role of default values.

C-building testing involved cross-testing methodologies between countries with similar climates, focusing on specific types of buildings. The visiting country applied the host country's EPC methodology to buildings in the testing country. For example, an Austrian building was tested using both Austrian and Slovenian EPC methods, with input guided by the hosting country. This process provided insight into how methodologies aligned or differed in aspects such as heating demand, primary energy consumption, and CO_2 emissions.

Key observations revealed variations in how different EPC methodologies treated inputs like local climate data, heating systems, and building orientation. Some countries, like Bulgaria, incorporated calibration steps using real energy consumption data, resulting in more accurate results. This contrasted with countries like the UK, where default values played a significant role. Figure 5.1 illustrates a comparative analysis of heating energy demand across testing countries, highlighting where correlations between methodologies were robust and where significant discrepancies existed.

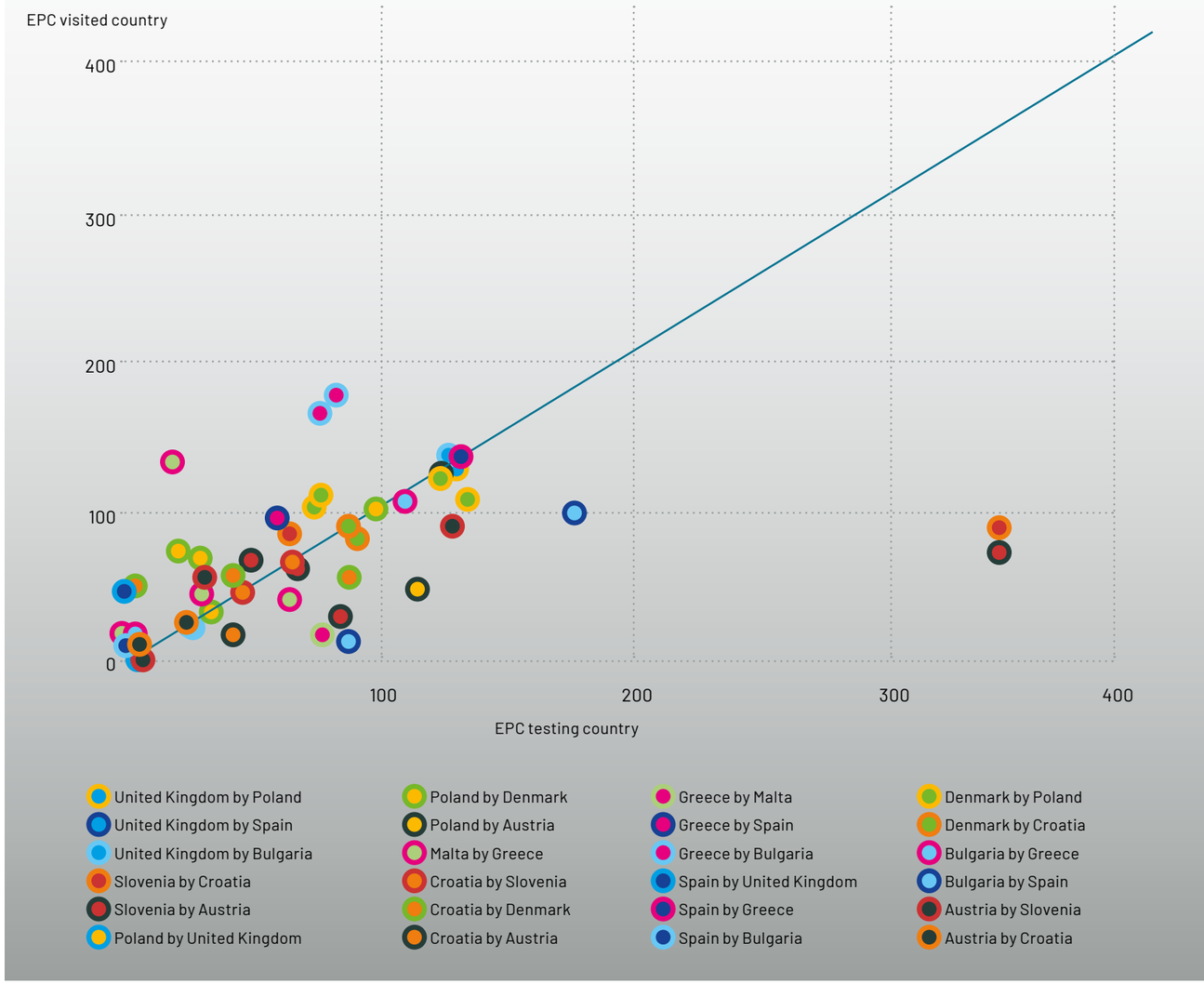

Figure 5.1 Energy demand for heating (kWh/m2/year) calculated with the EPC of the testing country versus energy demand for heating (kWh/m2/year) calculated with the EPC of the visited country.

In **L-building testing**, countries compared their EPC-generated energy consumption data with actual metered consumption for local buildings, investigating the "performance gap"—the difference between modelled and actual energy usage. This analysis was pivotal in identifying the robustness and accuracy of EPCs, particularly in residential versus non-residential buildings.

Countries like Denmark demonstrated a smaller performance gap (ranging from -1% to 22%) due to well-structured EPC guidelines and training. On the other hand, the UK experienced gaps as high as 233%, partly due to simplified EPC models that excluded electrical equipment and standardised occupancy schedules. Factors such as the use of default values and lack of building-specific data were common contributors to these discrepancies.

The key findings from cross testing are the following:

- **Consistency in energy class labels**. Despite variations in methodology, energy class labels (e.g., A+, B, etc.) for the same building were relatively consistent across countries (Figure 5.2). Buildings rated as highly energy efficient in one country typically received similar ratings under other countries' EPC methods. This consistency is essential for formulating EU-wide building renovation policies and standardising renovation targets.
- **Performance gap and input variables.** The study identified significant differences in the calculation of primary energy consumption and CO_2 emissions due to methodological diversity. Dynamic models and real-data calibration, like those in the UK for non-residential buildings, yielded more accurate results than static models. However, this accuracy came at the cost of higher data requirements and the need for better training for EPC issuers.
- **Role of default values.** Default values, commonly used across many EPC methodologies, streamlined processes but reduced the accuracy of certifications. Countries like the UK and Spain showed heavy reliance on these values, while Bulgaria's approach of adjusting the EPC to actual consumption data proved more accurate. The inconsistency in the application and transparency of default values was a significant obstacle to harmonisation.
- **Impact of terminology.** A recurring issue was the lack of uniformity in language and calculation parameters across different countries' EPC methodologies. Terminological discrepancies hindered the comparability of results.
- **Recommendations for harmonisation.** The findings highlight the necessity of harmonising EPC input parameters, methodologies, and databases across Europe. Recommendations included the creation of georeferenced, open-access databases for EPC data, a more unified approach to handling building-specific inputs like thermal bridges and user behaviour, and improved training for EPC issuers, particularly for those using dynamic models.

In conclusion, crossCert's testing revealed that while EPC methodologies across Europe share some similarities – particularly in energy class labels – significant methodological differences remain. The performance gap, inconsistent use of default values, and lack of standardised terms are major hurdles to harmonisation. Future efforts must focus on refining these areas to promote more reliable and comparable EPCs across the European Union.

EPC testing country	A	B	C	D	E	F	G
A	6	1	1	0	0	0	0
B	1	2	5	1	0	0	0
C	0	1	6	1	1	0	0
D	0	0	2	2	3	1	0
E	0	0	0	0	0	2	1
F	0	0	0	0	0	0	2
G	0	0	1	0	1	1	0
EPC visited country	A	B	C	D	E	F	G

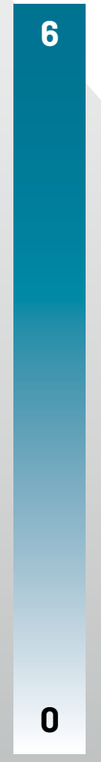

Figure 5.2 Energy and emissions labels obtained with the EPC of the testing country versus energy and emissions labels obtained with the visited country EPC.

5.2 Quality control frameworks can be standardised, whilst allowing for country-specific flexibility

The findings of the comparative exercises in crossCert were used to generate advice and frameworks for moving towards harmonisation of EPCs and applying next-generation EPCs across European countries. From this a framework is proposed for next-generation EPC quality control measures, as well as for categorising and comparing current and next-generation methodologies.

Considering all the differences discussed, any next-generation quality control mechanism needs to be able to address the variations in assessments and adapt to each country's specific needs.
A framework for adapting quality control mechanisms to an EPC methodology is proposed in Figure 5.3 (Sayfikar and Jenkins, 2024b). This framework suggests that the quality control mechanism should depend on the calculation methodology, EPC software, EPC document, and assessor qualifications.

For methodologies on the more standardised end of the spectrum (Figure 5.3), it is possible to eliminate more errors by implementing validation rules in the EPC software. For more tailored methodologies, such as the Bulgarian methodology, manual checks by experts might be more critical and should be emphasised. For countries that use non-accredited EPC software, stricter manual checks by independent experts should be prioritised. Additionally, the degree of detail in certificates can influence which quality control measures should be prioritised. Furthermore, a country's approach to EPC recommendations (and consequently assessors' qualifications) can help determine which quality control mechanisms are better suited to the needs of their methodology. Based on these criteria, suggested quality control measures for various categories of EPC assessment methodologies are listed in Table 5.1.

Criteria	type		Suggested quality control measures
Calculation methodology	Standardised		Validation rules in the software
	Tailored		Validation rules in the software + Manual checks
EPC software	Only accredited software		Validation rules in the software
	Any software		Manual checks
EPC document	Detailed		Automatic checks by the EPC database+ Manual checks
	Simplified		Automatic checks by the EPC database
EPC recommendations	Tailored	Savings calculated	Depending on the assessor's qualification/experienceàtargeted checks
		Savings not included	
	Standard	Savings calculated	Automatic checks by the EPC database+ Depending on the assessor's qualification/experienceàtargeted checks
		Savings not included	Automatic checks by the EPC database
Assessor qualification	Low requirement		Targeted checks+ Manual independent controls
	High requirement		Manual independent controls

Figure 5.1 A framework for harmonisation of EPC quality control

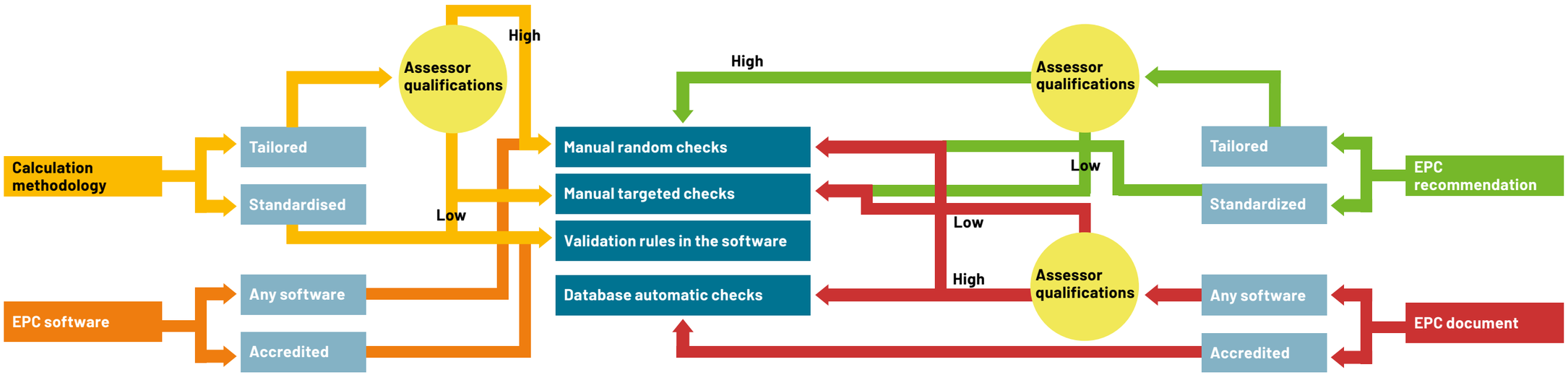

Figure 5.3 A framework for harmonisation of EPC quality control

5.3 EPC knowledge exchange centre as an information repository

The Knowledge Exchange Centre in the crossCert project serves as a web-based repository designed to share information about Energy Performance Certificates (EPCs). It is a central hub where stakeholders can access detailed knowledge on EPC approaches, results from crossCert, and relevant outcomes from other related projects. The centre is a single access point to analyses of EPC schemes, requirements, performance gaps, human interfaces, new Key Performance Indicators. It is intended to help public authorities and other relevant entities adopt new EPC practices and ensure knowledge sharing across Europe.

The Building Repository is a public, curated repository that contains detailed data on buildings, including their Energy Performance Certificates and, when available, measured energy performance results. This repository may be used as a benchmark for testing new EPC methodologies. By anonymizing and sharing these data sets, the repository allows for external parties, such as EPC issuers and public authorities, to assess and validate EPC procedures, facilitating a harmonised approach across member states.

5.4 Key harmonisation recommendations

Energy Performance Certificates (EPCs) are fundamental instruments within the European Union's (EU) strategy to achieve ambitious goals for energy savings and to combat climate change. However, the effectiveness of EPCs is currently undermined by significant discrepancies in methodologies, formats, and implementation across member states. The harmonisation guidelines report proposes a comprehensive set of recommendations for aligning EPCs, paving the way for improved comparability, transparency, and ultimately a more energy-efficient building stock within the EU. This is a summary of the guidelines:

- **Regulations for energy performance assessment and certification.** Develop a standardised EU-wide regulation for assessment and certification. This regulation should build upon existing best practices and incorporate regional specificities where necessary.
- **Input and output parameters of the EPC process**
  Establish a standardised list of mandatory input and output parameters for all EPCs across the EU.
- **EPC databases**
  Develop a central EU EPC database with a standardised data structure and common protocols for data exchange.
- **EPC checking and verification procedures**
  Implement a harmonised system for EPC verification across the EU.
- **Training and certification of EPC experts**
  Establish a common EU framework for the training and certification of EPC experts.
- **Human friendliness of the EPC**
  Develop standardised and user-friendly EPC formats across the EU.
- **Bridging the performance gap**
  Implement strategies to bridge the gap between predicted and actual energy consumption.
- **Marketing buildings with better EPCs**
  Develop standardised and transparent marketing tools to highlight the financial and environmental benefits of buildings with strong EPC ratings.

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