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The future of EPCs: Data, policy, and public perception in the race for energy efficiency

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ABSTRACT

Amidst the pressing concern about climate change, the construction sector has been identified as one of the main energy consumers in Europe, which also positions it as one of the sectors with the greatest potential for efficiency improvements. In response to this, the European Union established the Energy Performance Certificate (EPC) system, with the aim of boosting transparency and encouraging sustainable renovations. However, the results have not been as expected. Some of the causes of this are poor data quality, limited public awareness and inadequate legislation, which together undermine trust in the certification process. In addition, concerns about the possible exclusion of low-income households have sparked debates about the financial burdens and possible rent increases following energy efficiency improvements. This article presents insights from a qualitative study of various stakeholders, including public agencies, technical experts and real estate professionals, examining prevailing perceptions of EPC design, implementation and utility. Key findings reveal that mandatory policies drive adoption, but administrative complexities and inconsistent metrics erode public trust. Furthermore, the gap between specialist and non-specialist audiences prevents the certificate from playing a role in motivating behaviour change. The new version of the European Commission's Energy Performance of Buildings Directive (EPBD) introduces standardised templates and databases. Added to this, stakeholder feedback highlights the need for public education, accurate energy data and tailored financial mechanisms. This study concludes that to refine EPC policies, integrated and holistic frameworks are needed that address socio-economic risks, foster equity and accelerate Europe's transition to low-carbon housing.

1. Introduction

The construction sector is one of the most important energy consumers in the European Union (EU), responsible for approximately 40% of final energy demand and 36% of carbon dioxide (CO2) emissions (Filippidou et al., 2017; Ibañez-Puy et al., 2017; Li et al., 2017). More specifically, the residential sector contributes to 66% of energy consumption and 64% of emissions in buildings in the EU (Lopez-Gonzalez et al., 2016). Furthermore, around 75% of the 210 million existing homes in the EU are energy inefficient, and between 75% and 80% of them will still be in use in 2050 (Fabbri et al., 2016). This means that the building sector has one of the greatest potentials for energy savings and carbon footprint reduction.

In this context, the Energy Performance of Buildings Directive (EPBD), adopted in 2002, and revised in 2010, 2018 and 2021, is the legislative framework par excellence established by the European Union to improve the energy efficiency of buildings. One of the most relevant contributions of this Directive was the introduction of the Energy Performance Certificate (EPC), which consists of a simple scale from A to G, to convey the energy performance of the buildings, including reference values and standards to contextualize the assessment, and recommendations to make cost-effective energy improvements. Through Directive 2002/91/EC (European Union, 2002b), the EPBD required EU Member States to issue an EPC whenever a building or dwelling is built, sold or rented, with a validity of up to 10 years, provided that no significant modifications are made to the building during this period. After, the 2010 revision of Directive 2010/31/EU (European Union, 2010) strengthened the role of EPCs in the real estate market by requiring their inclusion in property sale or rental advertisements and mandating their transfer to new owners or tenants. Then, the Directive 2012/27/EU (European Union, 2018) went further, emphasizing compliance with energy performance standards for buildings acquired by central government institutions.

In 2018, Directive (EU) 2018/844 (European Union, 2024) introduced amendments to both Directive 2010/31/EU and Directive 2012/27/EU, focusing on improving transparency and incorporating

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uniform criteria for calculating energy performance metrics. Member States were tasked with developing national strategies, with measurable indicators of progress, to achieve the Union's long-term objective of reducing greenhouse gas emissions by 80–95% by 2050 (compared to 1990 levels). This approach aimed to ensure a transition towards a decarbonised and highly energy-efficient building stock and to promote cost-effective upgrades of existing buildings to nearly zero-energy buildings. Key updates included the introduction of requirements for ventilation and heating systems, support for electromobility, smart building readiness, and advanced energy-efficient technologies. It also emphasized the need for energy-efficient renovations and the implementation of national financial mechanisms to facilitate energy improvements. These amendments considered typical operating conditions to provide a more comprehensive assessment of building energy performance.

Recently, in line with the call for climate action expressed in the European Green Deal, and with the aim of reducing greenhouse gas emissions by 55% by 2030 and achieving total carbon neutrality by 2050, the European Commission presented a new legislative proposal to revise the Energy Performance of Buildings Directive (European Commission, 2019). Already recognised as an integral part of the European Union's climate policy framework, EPCs are sought to be aligned with the most recent regulatory updates. Among these, it is possible to mention the Fit for 55 package (Wilson, 2021), which aims to modernise EU climate and energy policies with measures such as requiring buildings belonging to public authorities to reach zero-emission standards by 2026, and for all new buildings to meet that standard by 2028. This Package also stipulates those buildings constructed from 2028 onwards must have solar installations as a requirement, as must buildings undergoing significant renovations by 2032. Furthermore, by 2035, fossil fuel-based heating systems are expected to be banned in both new and renovated buildings (Nunes & Lopes, 2024). Another example is the alignment of EPCs with broader EU policies, such as the Clean Energy Package, which aims to address the problem of energy poverty. As Gouveia and Palma (Gouveia & Palma, 2019) point out, EPCs provide essential information on the energy performance of buildings, allowing to identify areas for improvement and support the adoption of energy efficiency measures. Through recommendations for renovation and increased energy efficiency in buildings, these certificates contribute to improving living conditions while reducing emissions, thus promoting environmental and social objectives (European Commission, 2020).

It is noteworthy that in the face of different national political and legislative contexts, the EU granted Member States (MS) flexibility in implementing EPCs, allowing them to adapt the framework to their specific conditions. Consequently, EPCs feature different parameters and rating scales across the EU, reflecting unique local and national circumstances through tailored metrics (Ruggieri et al., 2023).

However, perhaps due to this flexibility, the impact of EPCs on the real estate market, in terms of acceptance and usage, has so far been difficult to quantify. According to some researchs, the most significant influence of EPCs can be found in the sales segment (Hyland et al., 2013). In this sense, it was found that houses in the same neighbourhood that are presented as energy efficient are rented or sold faster and at a higher price than those with a lower energy performance (Concerted Action EPBD, 2016). Thus, tenants and construction investors in several countries expressed their willingness to pay more for energy efficient buildings (Haunstrup Christensen et al., 2014). In line with this, a survey involving 12 EU countries revealed that 73% of respondents considered EPC to be an important factor when making the decision to renovate the building (Charalambides et al., 2019). In a survey in Belgium (IBRoad Project, 2018) around 50% of buyers and 37% of tenants said that EPC influenced their choices.

Nevertheless, other research suggests that EPCs have minimal impact on consumer choices when purchasing or renting properties and are seldom utilized in price negotiations for sales or rentals. This is partially attributed to the prevailing conditions of the housing market; however, in both scenarios, consumers require more compelling indicators of the importance of energy efficiency (Cespedes-Lopez et al., 2022).

This shows that despite the perceived benefits of the EPC there are still problems to overcome to achieve mass acceptance across the EU (Jimeno, 2023). Recent studies found that there are identifiable barriers to the adoption of large-scale use of EPCs (Arc Arcipowska et al., 2014; Pasichnyi et al., 2019). Among them, stand out:

- Lack of quality of data for the evaluation of energy performance.
- Insufficient information to motivate renewal.
- Limited implementation to provide a robust source of information for energy planning in some countries.
- Complex or insufficient access to financing.

In relation to the first point, the EPC certification process appears to depend significantly on the judgment of energy assessors, resulting in a subjective approach where the reliability of data quality may be questionable. Hardy and Glew (Hardy and Glew, 2019) conducted a large-scale study in which they pointed out identifiable errors in the England and Wales data set, such as repeated assessments where built form variables differed, or energy efficiency measures were apparently removed. The authors predicted that between 36% and 62% of certificates contained at least one such identifiable error, and that when assessors discovered and corrected one or more errors and a new certificate was submitted, this led to a change in the EPC rating of 4 points. Furthermore, Hyland et al. (2016) find that there is evidence of "clustering" of energy efficiency certification on the positive side of letter cuts. This means that buildings are more often rated at the lower end of a higher letter than at the higher end of a lower letter, for example a group of properties with C3 labels rather than D1. They claim that this grouping may be the result of assessors trying to ingratiate themselves with homeowners in an effort to increase repeat business. Such situations can result in a loss of credibility for assessors and EPC label issuers, which in turn can undermine confidence in EPC labels in general.

Regarding the second point, on the dissemination and promotion of the benefits of executing a renovation in accordance with EPC recommendations, it was found that building owners do not carry out energy efficiency renovations mainly due to a lack of awareness of the resulting benefits, lack of access to technical advice and lack of financial support (Baek & Park, 2012; Gonzalez Caceres, 2018).

The third issue is closely tied to the autonomy of Member States in applying EPC systems. The downside of this policy, designed to facilitate Certificate adoption, is that variations between countries impede, and in certain instances obstruct, meaningful comparison. For example, in the case of Spain, it is clear that due to its energy policies and energy efficiency support programmes, significant progress has been made in implementing EPC and promoting energy efficiency in buildings compared to other European countries (Watts et al., 2011; Travezan et al., 2013). However, it is speculated that the country is still behind other countries such as Germany (Comerford et al., 2018), Portugal (Hardy & Glew, 2019), the Netherlands and the United Kingdom (Fuinhas et al., 2022; Galvin et al., 2024). A report published by IDAE and Miteco on the State of Energy Certification of Buildings (December 2021), reflects that in Spain a total of only 5,249,158 energy certificates were registered, of which 97.7% correspond to existing buildings and 2.3% to new buildings.

At last point, homeowners express difficulty in implementing home improvement recommendations due to the cost implications that it entails (Murphy, 2014). To overcome this financial obstacle, Member States have established a series of subsidy schemes to incentivize homeowners to improve their homes to achieve higher performance levels. Recently, the European Commission issued a statement in which it presents a provisional agreement between it and the 27 Member States stablishing that, to fight against energy poverty and reduce energy bills, renovations must be incentivized and accompanied by measures of financing aimed in particular at vulnerable customers and buildings with the worst efficiency results, where a higher proportion of households in energy poverty live. Furthermore, it highlights that Member States will also need to ensure that safeguards are in place for tenants, to help address the risk of eviction of vulnerable households caused by disproportionate rent increases following renovation. This agreement now requires formal adoption by the European Parliament and the Council (The Scottish Association of Citizens Advice Bureaux, n.d).

Additionally, on December 19, 2023, the Commissioner for Energy and the Energy Ministers of the 27 EU Member States signed a Joint Declaration on Energy Efficiency Financing and the European Coalition for Energy Efficiency Financing (the Coalition) within the framework of the Transport, Telecommunications and Energy Council (TTE Council). The Joint Declaration underlines the importance of mobilizing private investment for energy efficiency and creating a viable long-term financing framework for energy efficiency investments, as well as marking the first step towards the creation of the Coalition, which establishes a way of trilateral cooperation between the Commission, the Member States and the financial institutions. The objective of the Coalition is to create a favorable market environment for investments in energy efficiency and increase the private financing necessary to contribute to the achievement of the energy and climate objectives of the European Union for 2030 and 2050, working along 3 different lines: a political level, a group of experts, and national centres, i.e. specific working groups that will be developed at national level to identify energy efficiency financing solutions for each market (European Commission Press Release, 2023).

Aligned with these initiatives, the data provided by EPCs (such as U-values of the building envelope, the HVAC system, the fuel source, or recommendations, among others) can assist in establishing priorities for building renovation, allowing owners to decide to what extent they want to improve their properties through energy labels. These “green” policies, in turn, promote greater adoption of EPC (European Commission, 2023).

The recommendations arising from the EPCs guide building owners to apply possible improvements, while the labels allow energy consumption to be compared before and after modernization. Certificates can therefore be used as a tool to encourage people to undertake building renovation. According to various studies, building renovation is recognized as having greater energy conservation potential than could be achieved by new buildings (Hyland et al., 2013). The European Commission has estimated that renovation has potential energy savings of up to 46% between 2021 and 2030 (Jimeno., 2023). Building renovations, such as improvements to window, wall and roof insulation, replacement of aging heating systems, adoption of heat recovery systems and employment of intelligent control systems, have been shown to be effective approaches to reducing demand energy and promote a comfortable indoor climate (Cajias & Piazolo, 2013; Charalambides et al., 2019).

While these studies are encouraging, it is important to consider the "non-energy" risks associated with the large-scale adoption of EPCs. Some authors argue that implementing EPCs could lead to unintended socioeconomic consequences, disproportionately affecting vulnerable populations and deepening existing inequalities.

In this regard, a significant risk arises from the practical reality that EPC have been reduced to a transactional requirement, functioning basically as a *de facto tax* on property rentals or sales. This dynamic creates a feedback loop that seeks to minimize the cost of obtaining the certificate, often resulting in superficial compliance and a significant loss of its informational value. For vulnerable populations, this risk manifest in several ways. Firstly, although the cost of obtaining an EPC certificate may not be a significant barrier, lower-income groups often lack the financial resources to implement the recommendations provided in the certificate, making energy-efficient renovations unattainable. Additionally, many individuals within these groups are tenants rather than homeowners, leaving them structurally excluded from decision-making processes regarding property improvements. The situation is made worse in jurisdictions where landlords, by making energy efficiency improvements, can increase rents, often pricing vulnerable tenants out of the market. This phenomenon can lead to low-quality renovations under the guise of improving energy efficiency, whose sole aim is to increase rental prices, displacing low-income tenants and further deepening housing insecurity. In this scenario, landlords renting out properties may lack incentives to undertake costly renovations, as they do not directly benefit from the improvements in terms of energy savings or quality of life. This misalignment of interests between landlords and tenants further perpetuates the stagnation of necessary upgrades, disproportionately impacting tenants living in substandard housing.

The analysis of these social dimensions in the context of the evolution of EPCs considers components such as equity in access to housing, energy poverty, tenant displacement or gentrification, among others. For example, Galvin et al. (2024) point out that the inadequate infrastructure conditions of social housing exacerbate the difficulty in accessing energy services for its inhabitants. The concluton is that energy solutions aimed at the modernization of old social housing must take into account the financial and social constraints of tenants, many of whom prioritize basic needs over energy concerns.

Even though interventions and renovations in urban space are considered successful in energy terms, their consequences, both in terms of their impact on the real estate market and the local economy and in terms of the socioeconomic effects at the housing level, are still a topic of study.

In this regard, Hin Ho (2013) highlight that certifying buildings to sustainability standards, such as LEED or BREEAM, can translate into tangible economic benefits for real estate investors, particularly in the Real Estate Investment Trust’s (REIT) sector. However, the study suggests that these benefits are not uniform and depend on the type of property, the quality of certification and market conditions, implying that EPCs may not accurately reflect a building’s true energy performance or its impact on financial returns, underlining the need to improve the accuracy of data within EPCs to avoid distortions in the perceived value of sustainable buildings (Hin Ho et al., 2013).

On the other hand, Kazemzadeh et al. (2023) provide evidence that policies promoting green housing can boost local economic growth by stimulating investment and job creation in sectors such as construction and green technology (Comerford et al., 2018). However, in their study they also suggest that housing with high EPC ratings may have unequal distributional effects, as high upfront costs of energy efficiency may create access barriers for vulnerable populations, exacerbating socioeconomic inequalities in access to sustainable housing. The author reflects on the possibility that the implementation of EPCs without financial support mechanisms reinforces housing exclusion and limits the benefits of the energy transition to certain market segments.

Finally, from a more macroeconomic approach, raise the implications for energy efficiency policies and emphasize that while EPCs and other regulations can generate significant benefits in terms of emissions reduction and job creation, their effectiveness depends largely on the quality of the data used for their implementation and monitoring (Hardy & Glew, 2019). As mentioned above, this suggests that flaws in the accuracy of EPC data could undermine their credibility and limit their impact as a public policy tool.

In light of the above, a first step to comprehensively understand these issues is to conduct a consultation with stakeholders to identify solutions for improving the functionality of EPCs. In this document, social considerations were addressed within the analytical framework through the design of specific research questions and interdisciplinary approaches. The study explored stakeholders’ opinions on the efficiency and public awareness of current EPCs, the opportunities and barriers they present, and their potential to exclude vulnerable populations. Additionally, it examined how EPCs could be restructured to better meet user needs, emphasizing the importance of actionable and relevant information. For instance, a central question investigated the risks of EPCs becoming a factor of exclusion for vulnerable populations and proposed measures to mitigate such risks, including policy reforms and financial mechanisms.

Table 1
Map with interviewed stakeholders.

	Public bodies	Enterprises	Representatives	Social entities
Energy providers		Energy cooperatives		
Builders & technics		Supplier of insulation materials Performance programmers Supervisor of technical energy projects Quality assurance technician Recycling electric & electronic waste	Professional association of architects	
Real estate sector	Public social housing provider & manager		Professional association of managers in real estate	Social housing provider & manager
Financial sector		Seed investment fund for startups & incubator		
Regulatory bodies	Municipal one-stop shop			
End users & defenders		Qualified expert	Resident association Consumer association	Housing association

It should be noted that, in a broader context, research on the social aspects of EPCs is essential for improving their implementation, adoption, and usefulness. Achieving sustainability and decarbonization goals requires the trust and participation of stakeholders, particularly vulnerable groups. In this sense, policies that fail to address these issues risk perpetuating inequalities and undermining the credibility of EPCs as tools for meaningful change. Conversely, incorporating social levers into policy design can bridge the gap between intended and actual energy performance outcomes, ensuring that EPCs not only meet regulatory objectives but also contribute to social inclusion and resilience.

This article focuses on researching the main concerns of the stakeholders involved in the development and implementation of EPC, with a view to the development work of the next generation of energy efficiency labels.

2. Method and data sources

This research adopts a qualitative approach aimed at uncovering less evident aspects of the use and implementation of Energy Performance Certificates by consulting a broad range of stakeholders. The proposed methodology entails the active inclusion and participation of all stakeholder groups, recognizing their roles and fostering dialogue to identify drivers, barriers, and potential implications underlying the practical application of EPCs. The method employed consisted of conducting in-depth interviews, analyzed manually using an interpretive framework, with a primary focus on identifying emerging themes, comparing various perspectives, and fostering critical reflection on EPC-related practices.

The process commenced by identifying stakeholders relevant to the research, defined as "individuals, groups, or organizations that may influence, be influenced by, or perceive themselves as affected by a decision, activity, or outcome of a project." To this end, the methodology outlined by the Project Management Institute (PMI) was adopted (Guide, 2017), which is designed to recognize the principal stakeholder groups. These were categorized into three key groups:

- Those directly involved in the implementation of EPCs and the formulation of their regulatory framework, including organizations and companies responsible for conducting EPC evaluations, developing EPC software, and entities tasked with establishing the legal framework and specific regulations.
- Those directly or indirectly affected by EPC evaluation and certification, such as building users and owners, facility managers, the general public, resident associations, and other local community groups.
- Those with a vested interest in EPC evaluation and certification, including researchers, academics, environmental and social advocacy organizations, and potential users or clients in future projects.

Through this approach, the representative participation of all actors involved in the EPC chain was ensured. The results show a high level of participation from respondents in Spain, as the country presents two particular conditions: a large number of low-energy-efficiency buildings and an aging housing stock, providing valuable insights from Spanish on these issues. Due the focus of our research, a particular emphasis was placed on exploring the perspectives of the second group. Based on this focus, a stakeholder map was developed, categorizing actors according to two criteria: the type of organization (public, business, representative, or social) and their role in the housing market (e.g., energy suppliers, builders, construction-related technicians, real estate managers, construction financiers, housing users, and their advocates). Table 1 illustrates the resulting framework.

The table underscores the multidimensional interactions among diverse stakeholders across key sectors essential for urban sustainability, housing access, and technical innovation, mapping their distinct roles within an interconnected framework, organized into four main categories: public bodies, enterprises, professional representatives, and social entities. Each category is further broken down into specific sectors of activity, detailing the types of organizations or roles represented within them. Energy providers are exemplified by energy cooperatives under enterprises, focusing on cooperative and socially oriented energy production and distribution, though no direct representation from public bodies or professional organizations is identified.

In the builders and technics sector, enterprises include suppliers of insulation materials, energy performance programmers, supervisors of technical energy projects, quality assurance technicians, and recyclers of electric and electronic waste, complemented by a professional association of architects. In the real estate sector, public social housing providers and managers operate as public bodies, while professional associations of real estate managers represent enterprises, and social housing providers function as social entities.

The financial sector highlights enterprises such as seed investment funds for startups and incubators, emphasizing support for innovative projects in construction and sustainable urban development, with no explicit representation from public or social entities. Regulatory bodies are represented by a municipal one-stop shop, indicating a facilitating and regulatory role in housing and energy projects. The end users and defender's category includes qualified experts as enterprises and associations of residents and housing as social entities, advocating for the rights and interests of residents and service end users.

Nineteen interviews were conducted among the identified actors, comprehensively covering all predefined profiles described in Table 1. The perspectives collected include those of public entities responsible for providing public housing and managing public and private rental housing, as well as citizen service offices at the municipal level involved in participatory urban renewal initiatives. From the private business sphere, contributions were obtained from: (a) companies representing different stages of the housing life cycle and associated services, (b) a cooperative company involved in energy generation and distribution, and (c) private companies specialized in the production of insulation materials, energy-related programming, energy project supervision, e-waste recycling, and EPC processing. In addition, insights from a technology project incubator equipped with seed capital funds were incorporated to represent the financing phase.

Moreover, the views of professional associations representing various stakeholder profiles were included. These comprised a professional association of architects, including members specializing in EPC certification, an association of housing managers, as well as several consumer and housing user associations. With respect to housing management, a diverse range of perspectives was gathered from two public housing companies, a professional association of real estate managers, and a social organization dedicated to providing housing for individuals facing inclusion challenges.

It should be mentioned that, although direct insights from regulatory bodies were not obtained, their perspective will be extrapolated through desk research and by analyzing the responses provided by other stakeholders regarding emerging approaches and ongoing discussions at the European level. These discussions are likely to shape mandatory requirements for EPCs across all European Union member states in the near future.

Methodologically, the sample was considered sufficient for the following reasons:

- All the initially planned actors were covered.
- Discretionary non-probabilistic sampling was considered where the actors identified as those who could contribute the most to the study were selected. This type was considered because it can be applied to a group made up of highly specialized people who cannot be chosen through any type of probabilistic sampling.
- Allowed accurate results taking into account the type of sample selection and methodology used in the research.

2.1. Interview questions

Five open-ended questions were designed to allow interviewees to express their opinions freely and comprehensively. These questions were structured to elicit responses on key areas such as public awareness of EPCs, their effectiveness, opportunities for improvement, barriers to their adoption, risks of social exclusion, and the utility of the information provided by EPCs, as well as additional data needs.

The open-ended format was deliberately chosen to avoid constraining respondents' answers, thereby facilitating a rich and nuanced understanding of their perspectives. To ensure the questions were meaningful and effectively aligned with the study's objectives, they were pretested with a small group of experts from different stakeholder categories. This pre-testing phase helped validate the clarity, relevance, and scope of the questions, ensuring they could comprehensively capture diverse viewpoints. Feedback from the pre-test was incorporated to refine the questions, avoiding potential ambiguities and ensuring that the language used was accessible and unbiased. These are the five open-ended questions:

1. Which is your opinion about the efficiency and level of public knowledge about the current Energy Performance Certificate (EPC)?
2. Which are the main opportunities and drivers (propellers) of the current EPC?
3. Which are the main barriers /obstacles of the current EPC?
4. Which are the risks of EPC to be a factor of exclusion of vulnerable population? If there is a risk of exclusion, how can it be avoided?
5. The EPC collects a large amount of information, what part of this information do you consider is not necessary in the current situation? What new information should be included?

The proposed methodology, based on a discretionary sampling approach that included a diverse range of actors with varied characteristics, enabled this study to capture a broader spectrum of opinions and perspectives. This approach overcame traditional limitations associated with working with homogeneous groups and reduced reliance on high statistical significance. The diversity of participant profiles significantly enriched the analysis, providing a valuable depth of information on the topics addressed.

2.2. Methodological limitations

The study recognizes a potential geographic bias, as 84% of the interviewees stakeholders are based in Spain. Although this imbalance may affect the broader applicability of the findings across the European Union, several factors mitigate its impact, ensuring the results retain considerable relevance.

Firstly, many of the Spanish stakeholders who participated in the study are actively engaged in transnational discussions and collaborations with colleagues from other EU countries. These interactions provide them with insights into the challenges and solutions implemented in different contexts, allowing their perspectives to extend beyond strictly national boundaries. Secondly, several of the issues raised by the Spanish stakeholders are corroborated by existing literature on EPC implementation across the EU. These shared concerns—such as the variability in the quality of certifications, barriers to renovations, and the socio-economic risks of EPC adoption—are well-documented and align with findings reported in studies from other member states.

Furthermore, the research team validated the Spanish stakeholders' perspectives through consultations with international partners and cross-referencing with broader European studies. This approach helped confirm that the themes and recommendations identified in the study are not isolated to the Spanish context but reflect trends and challenges observed at the EU level.

It should be noted that the primary objective of this research is to analyse stakeholders' perceptions regarding the current design and implementation of EPCs, rather than to assess the policy-making process or the comparative effectiveness of national regulatory frameworks. For this reason, while the challenges faced by policymakers in implementing EPC directives and the potential inconsistencies arising from different national approaches are important issues, these topics fall outside the scope of the present study. Such an exploration would require a larger and more geographically representative dataset and a detailed review of legislative and institutional differences across EU member states. As this study prioritises the perspectives of stakeholders directly involved in or affected by the EPC framework, it does not aim to address the complexities of policy harmonisation at EU level.

With the above, the authors acknowledge that the geographic focus of this study may limit the ability to fully capture country-specific nuances, particularly in Member States with distinct regulatory frameworks or socioeconomic conditions. In this regard, future research efforts should prioritize a more balanced geographic representation of stakeholders to ensure even greater robustness of the findings.

3. Results and discussion

3.1. Adoption and implementation of EPCs

The analysis of the interview responses revealed a range of perspectives regarding the inquiries posed. Among the most salient findings, several themes emerged that highlight the challenges and opportunities surrounding Energy Performance Certificates (EPCs). These themes span from the gap in the understanding of energy efficiency concepts between specialized and non-specialized audiences, and the level of comprehension of the implications of EPC ratings, to the perception of users regarding the reliability of EPCs and the practical utility of the information they provide. To enhance understanding of these findings, the following sub-sections will provide a detailed breakdown of each thematic result.

3.1.1. Specialist vs. non-specialist perceptions

When analysing the responses of the stakeholders, the gap in the perception of EPCs between users from technical, planning and policy-making sectors versus non-specialist users or those from other fields and disciplines became evident. On the one hand, the use of EPCs by investors and financial institutions showed that this profile of respondents was familiar with the existence and mandatory requirement of EPCs in real estate transactions. However, it is surprising that some authors point out that there is a high probability that the in-depth knowledge of EPCs within the investment community is considerably limited. (European Commission Press Release, 2023).

On the other hand, non-users and non-specialist EPC users showed a superficial knowledge, with the majority of respondents of thid group recognising the EPC score only because of its similarity to the rating system used for household appliances, but failing to fully understand its meaning.

3.1.2. Gap in understanding and public distrust

The results obtained show that there is a low level of understanding among the non-expert public regarding the information contained in the energy assessment document. In this sense, we identified that the term "efficiency" is widely used and understood among engineers, private areas (building designers or product developers), stakeholders of global organizations and policy makers (European Commission, 2023), but it is a rarely used concept among the non-specialist population. As a consequence, it is observed that ignorance about the information contained in the certificate and the lack of understanding of its real implications result in distrust in the Energy Performance Certificate (Rodrigues et al., 2012).

3.1.3. Energy savings vs. efficiency

Linked to the previous item, an interesting point highlighted by one of the interviewees was the concern that the current sensitivity around EPCs has not yet taken the necessary step to focus on reducing consumption rather than making consumption cheaper. This suggests that the idea of "energy savings" is gaining ground, but that the concept of "energy efficiency" is still far from being fully embraced. Therefore, greater awareness and education is needed to achieve citizen commitment to energy efficiency.

3.1.4. Information and trust

From the above results, which identified, on the one hand, a lack of knowledge of the information contained in the certificate, and on the other, a lack of understanding of its real implications, opinions were detected that are associated with a feeling of mistrust towards EPCs.This was particularly evident when respondents highlighted inconsistencies in the calculated data and the actual consumption data, in particular when the values are expressed in money rather than kW/h (European Union, 2018). In this sense, the EPCs suffer from a lack of incorporation of any consideration of the real energy use that is being made of the property. Thus, some of the interviewees claim that the certificates are designed with theoretical scenarios based on consumption that are not aligned, for example, with the reality of public social housing. In words of one of the intervieweers: "if it doesn't fit the usage profile of your home, it won't fit your consumption either."

3.1.5. Utility and acceptance

Respondents acknowledge that citizens perceive the EPC as a costly administrative requirement with no real value for them. In their words, "although the law requires it in real estate transactions, it is often not carried out or is marked as pending when the transaction is carried out directly between individuals rather than through a real estate agency."

All of this means that the existence or not of this certificate and the valuation obtained have little influence on the purchase/rental decisions of individuals and families. It is symptomatic that in real estate agencies this information appears in the advertisements because it is mandatory, but it appears in a "small box" because it is not taken into account when choosing a home, although other characteristics such as location, nearby services, etc. are valued (Lainé, 2011).

3.1.6. Specialists view

Participants with technical expertise placed considerable emphasis on the breadth of information provided in the certificate, recognizing it as a valuable work instrument that is widely utilized and, in some cases, mandated. They additionally underscored the impartiality afforded by having the EPC issued by an external agent. Architects noted a marked shift in professional thinking away from demolishing and reconstructing, favoring instead the refurbishment of existing buildings. In this context, the EPC emerges as an effective mechanism for advancing renovation policies, such as revitalizing traditional neighborhoods and historic urban areas.

Furthermore, these technically oriented respondents regard the EPC as an opportunity to foster and disseminate a standardized energy-efficiency vocabulary among diverse stakeholders, especially in new construction projects or comprehensive refurbishments. Some interviewees also observed that the EPC may confer recognition of a building's efficiency value, which can have economic implications for both property valuation and rental income.

Despite the predominantly favorable perception of EPCs among technical professionals, they highlighted a significant shortage of companies and skill sets dedicated to building renovation, which in turn hampers progress toward the broader goal of enhancing the energy efficiency of Europe's building stock.

3.1.7. EPC´s end users

Based on the data gathered, a fundamental question arises concerning the tool's actual target audience: *Who, ultimately, is the end user?* There is no clear consensus among the interviewees on this point. Some respondents suggest that if the end-user is the public administration, for urban planning purposes or to achieve net-zero cities' goals, it should bear the costs of obtaining the information, thereby relieving citizens of the burden of financing this certificate. However, if the end-users are property owners and tenants, the certificate should be redesigned to align it with their needs as a first step in fostering public engagement with it. Furthermore, this issue ties into European Commission programs which, while driving the development, improvement, and adoption of EPCs, openly acknowledge the expectation (and need) of incorporating private financing sources into efforts aimed at the decarbonization of cities within the frameworks of the energy transition.

Aligned with the opinions of the interviewees, desk analysis showcases that, at this stage, the EPC is not tailored enough to the end-user's needs and interests. For instance, there is an increasing interest for the feedback on the real energy consumption especially when it provides a comparison with the previous year. Also, when tackling the renovations, owners and tenants are interested in the information on costs but at the same time they consider that important financial responsibility should be assumed by the public sector. On the other hand, when buying or renting a house, information on energy performance becomes important. In this sense the EPC should become an integrated tool to finance renovations and "accessing one-stop-shops in Member States policies" (European Commission, n.d).

At this point, we allow ourselves to briefly reflect on a non-exhaustive list of actions that policymakers could undertake in different areas to improve the aforementioned weaknesses of EPCs:

- Education: Promote educational initiatives to clarify the distinction between "energy savings" and "energy efficiency", ensuring that both the technical and non-technical public understand these fundamental concepts.
- Understanding: Foster efforts to improve public understanding of EPCs by clearly explaining their content and implications, making their relevance to energy efficiency and cost savings more apparent to all users.

- Perception: Address the subjective appreciation of EPCs by the general public, working to change the narrative from seeing them as bureaucratic requirements to recognizing their strategic value.
- Trust: Build public trust in EPCs by improving the quality and reliability of the data they provide, so that they are seen as credible tools for achieving meaningful energy efficiency.
- Utility: Transform EPCs from being mere administrative requirements in real estate transactions into practical tools that facilitate energy efficiency improvements and informed decision-making.
- Acceptance: Encourage broader adoption and appreciation of EPCs among all stakeholders, including tenants, landlords, buyers, sellers and investors, making them a necessary and valuable component of energy efficiency initiatives.
- Financial policies: Policymakers could prioritise the design of tools that facilitate addressing the financial burden of implementing EPC recommendations, particularly targeting low-income groups and tenants, while protecting against post-renewal rent increases.

3.2. Drivers of the current EPC

A majority of interviewees identified Public Administrations as key drivers behind the current implementation of Energy Performance Certificates (EPCs), emphasizing the importance of public financial support in both the issuance of EPCs and the execution of building renovations. Additionally, the leadership of European institutions in advancing urban renewal initiatives was highlighted. Financial aid programs rely on precise measurement methodologies, making EPCs an essential instrument for demonstrating tangible improvements in energy efficiency—a prerequisite for accessing public funding, tax exemptions, or financial incentives. For example, in countries such as Austria, Estonia, Germany, and Ireland, EPCs serve as a gateway to public grants and low-interest loans for homeowners (Stromback et al., 2021).

Certain events are also recognized as catalysts for advancing energy efficiency and the adoption of EPCs, even if their influence is temporary. For instance, heightened awareness of rising energy costs, driven by geopolitical events like the invasion of Ukraine (European Union, 2024; Wilson, 2021) and climate extremes such as unprecedented heatwaves and cold spells (Gouveia & Palma, 2019; Nunes & Lopes, 2024), has brought energy efficiency into sharper focus. Similarly, the extended confinement during the COVID-19 pandemic underscored the importance of comfort and spatial quality in homes, which are increasingly valued not just as places to sleep but as multifunctional living spaces (European Commission, 2020).

In addition, it is acknowledged that the younger generations have a higher level of sensitivity and knowledge regarding energy efficiency. As they become more involved in housing decisions, this sensitivity is expected to drive the interest in energy efficiency in daily life, as seen with the increased focus on recycling issues (European Union, 2002a). These are the main drivers identified by the interview participants.

3.3. Barriers of the current EPC

The respondents almost unanimously pointed out the administrative process and bureaucracy involved as an obstacle. They also highlight the complexity of accessing public funds, referring to this as "added complexity in procedures."

Additionally, they emphasize the percibed limited usefulness of the EPC for the public, which leads individuals to seek the cheapest service regardless of the quality offered, rendering it currently valueless. This has resulted in a destruction of the market for EPC certification experts, with low-quality certifications being offered via email after analysis of building photos without in-situ inspection. These low-quality certifications are further exacerbating the lack of confidence in the tool and driving out good professionals with rates that are not competitive or valued for their quality. This has led to a shortage of trained professionals and demotivation of expert professionals.

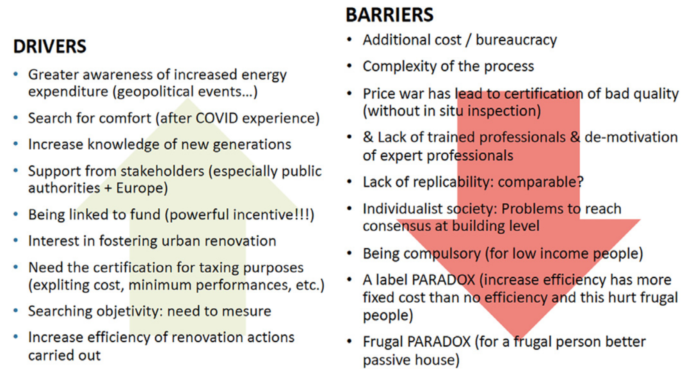

Fig. 1. Summary of factors detected regarding drivers and barriers of current EPCs.

The deficiency in professionalism and the diversity of instruments, as well as the heterogeneity in their application, ends in different results when the same building is evaluated by two different technicians or two different tools. This further undermines the credibility of the energy efficiency certificate as an objective measurement tool.

The Energy Performance Certificate outlines improvement measures, but many of these, especially passive energy efficiency measures, depend on the collaboration of all residents, including in shared common areas, to achieve full effectiveness. This necessary agreement is not an easy task in an individualistic society like ours. However, one of the interviewees sees a positive aspect in this, as the urgency of the climate crisis will inevitably force us to explore community solutions sooner rather than later.

Another barrier that has been mentioned concerns the mandatory requirement for low-income individuals to obtain EPCs. While public administrations can provide financial support to cover the cost of these certificates, the greatest challenge for this group lies not in the cost itself but in its derived consequences.

In this context, two paradoxes have also been identified among the barriers. On the one hand, there is a "Label paradox," where the most energy-efficient buildings have a higher level of automation and shared solutions, such as central heating, which results in higher fixed costs than less efficient buildings. This cost can be a disadvantage for individuals who are budget-conscious and do not take advantage of these facilities. One of the respondents suggests thinking about the cost of starting up a highly energy-efficient building: “The cost of starting a highly energy-efficient building is significantly higher compared to other buildings due to the increased complexity of the installations. Centralized solutions could result in penalizing individualized consumption. Furthermore, the high level of non-payments creates issues of coexistence as those who pay must cover for those who do not.”

Connected with this paradox, the second one, known as the Frugal Paradox, emphasizes the strategic importance of passive solutions for individuals who are frugal, as these helps reduce maintenance costs and the energy requirements of a house. Managers from a public social rental company stated: “We prefer to be less efficient in facilities and more efficient in management (…) In our case, it is very clear that people are not going to interact properly with a building that is technically complex. We need passivity; we need things to work in a way that is not highly automated from the user’s perspective, but highly automated from the perspective of the building manager, which is us.” They concluded with a straightforward request: “Innovate however you want, but at no extra cost.”

Thus, everything stated above, in terms of barriers and facilitating factors, is presented in the Figure 1:

In addition to these findings, desk research also critiques the EPC methods, identifying two key problems with EPC assessments across EU member states. The first problem is related to the Performance Gap and specifically to the "accuracy" of energy data. Second problem regards the standardized energy assessment. According to Jenkins, a standardized approach to EPCs will (by design) attempt to simplify modeling inputs into a finite number of options and there is the risk of providing misleading information about the performance of a specific building (Jenkins, 2021;Stromback et al., 2021). In this context, ongoing research projects, both empirical and theoretical, is being funded to determine the most effective approach for large-scale energy assessments in buildings and the enhancement of EPC methodologies.

3.4. Spillover effects

The question regarding the risk of exclusion posed by the certificate elicited the most divergent responses. When asked about the potential exclusionary risks, most interviewees with a technical background generally did not identify any significant concerns, referring only to the financial burden of paying for the certificate if it were to become mandatory. However, what are the broader implications of improvement measures, especially if EPCs become compulsory in the near future?

Most respondents highlighted that the significant investments required to modernize older homes could present a challenge and suggested that the solution might lie in designing better governmental programs to provide subsidies for issuing EPCs and implementing the recommended improvements. Some participants also pointed to a lack of interest among various segments of the population in renovating their homes, citing reasons such as financial constraints, personal life stages, disinterest due to properties being intended for rental purposes, among others.

In addition to this, a group of respondents noted that "smart buildings and smart living create a technological gap between generations," raising the issue of the digital divide as a factor that impacts strategies heavily reliant on home automation for achieving greater energy efficiency.

It is worth emphasizing that the two main challenges identified are centered on low-income individuals. On one hand, there is the risk of a double penalty for those living in inefficient homes who, due to their economic circumstances, cannot afford the necessary improvements. This could even escalate to a triple penalty if regulations mandate green taxes or fees for those who do not reside in certified homes or if their certificates fail to meet pre-established energy consumption requirements set by policymakers. On the other hand, there is the challenge of addressing the threat of gentrification that could result from significant improvements in energy ratings within a neighborhood. Upgrades introduced by homeowners may lead to renegotiated rental agreements, often resulting in steep rent increases that may become unaffordable for tenants.

This dynamic can lead to the displacement of tenants from their neighborhoods, pushing large groups of people to the outskirts of cities. In this context, the goal of achieving energy efficiency standards could become a source of tension and conflict between property owners and tenants (Figure 2).

From the obtained responses, we conclude that strategies to achieve energy efficiency in the building sector through the widespread implementation of EPCs as a tool must take into account indirect challenges and develop protective mechanisms for low-income individuals. These challenges are particularly related to rising rental and housing costs driven by energy efficiency improvements. It is worth noting that some interviewees suggested the creation of one-stop municipal offices, similar to those proposed by the OpenGela project (Opengela, n.d): "proximity offices located in neighborhoods where energy rehabilitation interventions are to be carried out, providing step-by-step guidance and support to citizens. This proximity fosters citizen participation in a process that they gradually take ownership of."

However, interviewees also identified positive indirect effects stemming from the expansion and application of EPCs. They highlighted that

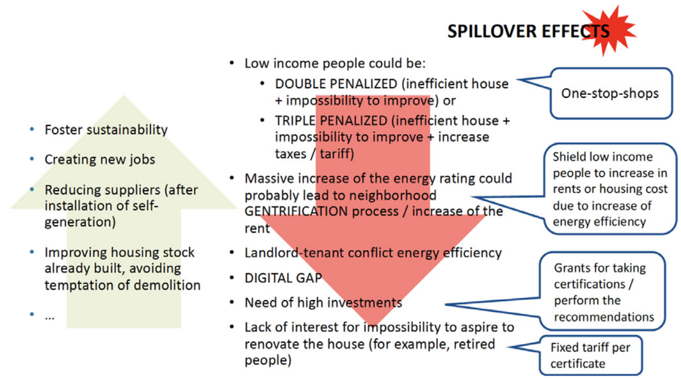

Fig. 2. Summary of factors detected regarding positive and negative spillover effects.

these certificates can promote sustainability by preserving the existing housing stock rather than demolishing it, while the broader urban regeneration acts as a driver of new economic activity and employment.

In the context of positive indirect effects, a review of the literature reveals that Fabbri and Gaspari (2021) emphasize how the EPBD promotes the need to address energy poverty. These authors employed a mixed methodology, combining data on the energy costs of each housing unit, the energy poverty threshold, and the calculation of the building's energy performance limit associated with the EPC in the city of Bologna. This approach generated a GIS-based map identifying buildings potentially affected by energy poverty. According to the authors, this effort aimed to support the decision-making process in addressing energy poverty risks (Bio Intelligence Service, 2013).

Finally, the interviewees indicated that, insofar as these energy renovations lead to savings in energy consumption and incorporate self-generation solutions, they will contribute to reducing energy demand and dependence, particularly benefiting users organized in collective schemes, although individual users will also see benefits.

3.5. Included information

It was identified that some responses were related to the information contained in and the presentation of data within the EPCs. One of the recommendations was that the tool should include two distinct sections, considering that it is intended for two types of end-users: experts and non-experts. In this way, a section aimed at non-expert users could adopt a more qualitative approach, incorporating graphical and schematic information, while allocating more space to explain the customized improvement measures suggested. Respondents recommended retaining the color and letter coding, as it is intuitive and similar to that used for household appliances. Meanwhile, a separate document could present all raw data and technical information from the EPC, specifically targeting expert audiences.

A second set of recommendations suggested that, to enhance trust in the certificate, it would be beneficial to avoid the coexistence of different systems for performing calculations and to adopt a uniform design for presenting EPC ratings. These suggestions align with the findings and recommendations of Stromback et al. (2021) for improving the EPC (European Commission, 2023). For example, regarding the presentation of information and the training of assessors, the authors emphasize the need for greater consistency across all Member States, particularly in the format of the reports and the quality standards for energy efficiency certificate ratings. They highlight, on the one hand, that the granularity of the reports is critical for the accuracy of energy efficiency certificate ratings. On the other hand, they note that some Member States must improve the training and qualifications of individuals conducting the audits for energy efficiency certificates.

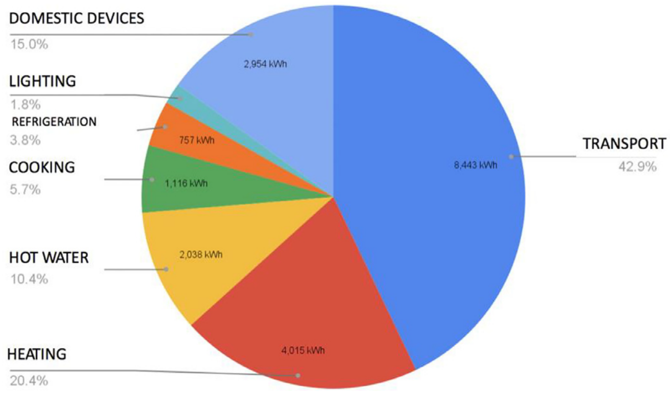

Fig. 3. Distribution of energy consumption in the Spanish household.

Finally, a third set of recommendations focuses on incorporating additional information related to environmental impacts in the EPCs. Examples include acoustic protection, indoor air quality, the location and orientation of buildings, the use of materials and energy during construction, usage, and decommissioning, as well as data on the actual performance of buildings, comfort levels, and spatial quality—particularly considering the effects of the pandemic-related confinement. Some respondents even suggested that this measure should include information about transportation and connectivity needs, as they consider these to be part of the total energy consumption of a household. As a reference, Figure 3 shows the average distribution of energy consumption in Spanish households, illustrating that 42.9% is allocated to transportation.

Finally, it is worth noting that some interviewees expressed concern about the emergence of new certificates focused on other environmental impacts that may conflict with the EPC. Improvements in one certificate could lead to lower ratings in the other. For this reason, they advocate for a more integrated approach that seeks to balance these objectives.

3.6. EPC in the 2022 EPBD recast proposal

The EPBD recast proposal introduces a much-needed definition for deep renovation: a renovation transforming a building into a NZEB (before 2030) and into a ZEB, i.e., to EPC class A (as of 2030) (Chegut et al., 2014). But, to obtain an accurate measure of this achievement, it is necessary to introduce positive and comprehensive improvements to the EPC framework.

EPBD recast proposal requires Member States to ensure that as of 2026 all EPCs comply with a common EU template, which includes indicators on primary energy use, operational greenhouse gas emissions and the share of renewable energy in energy use.

By the same date, EPCs will have to be based on a harmonized scale of classes, with A representing zero emission buildings, and G equating to the 15% worst-performing buildings at national level. Buildings Performance Institute Europe (BPIE) applauds the proposal for an increased scope of indicators and the push for ensuring more comparability (Hyland et al., 2013). One additional class (A+) should be added to account for positive energy buildings, which have an even higher performance level than ZEBs.

The EPBD recast proposal also states that EPCs from G to D class have a validity period of five years, while EPCs from C to A class are valid for 10 years. The new text requires Member States to ensure that EPCs are digital and issued by independent experts following an on-site visit.

However, all the improvements made on rescaling, design and additional indicators might only apply to a small proportion of EPCs, since not all buildings would be required to get a new EPC by an established date. Besides the current obligation to issue an EPC when a building is constructed, sold, or rented to a new tenant, the EPBD recast proposal rightly widens it to other situations, such as the renewal of an existing rental contract and major renovation.

In addition, buildings owned or occupied by public bodies must all get an EPC. These modifications, although welcome, will not drastically expand the coverage of the building stock with EPCs. It is also unclear whether EPCs issued before the end of 2025 would have to be reissued according to the new provisions, or if they would still be valid for another 5 or 10 years, leading to two different types of EPCs on the market. This is a critical point when considering that the implementation of other provisions, like minimum energy performance standards (MEPS), will be based on an EPC rating which classifies buildings according to the amount of energy consumed (kW/year-m2) and/or CO2 emissions, as a result positioning them from the letter “A” (best energy rating) to the letter “G” (worst energy rating) (Travezan et al., 2013).

A different point of view is added by the BPIE in its police briefing “The make-or-break decade: making the EPDB fit for 2030” (IBRoad Project, 2018). The briefing proposes to increase the use of and access to quality data, notably in the form of EPC databases, to design relevant strategies and track progress of implementation.

Specifically, the EPBD should:

- Require all Member States to have a national, easy-to-access EPC database, including in a digital format.
- Set quality principles for data management for EPC databases beyond recommendations to increase the quality of EPCs per se. They should be user-friendly with facilitated access; interoperability with other databases, such as cadastral databases, can help with planning renovation interventions, benchmarking, and comparability.
- Clarify the objectives of data gathering (what data to gather and in what format) and design of data governance (clarifying obligations of different actors at different stages of the process – collection, storage, processing, sharing, access, and reporting). One area that could be explored is to grant differentiated access to EPC databases depending on who the user is (prospective buyer, owner/tenant, bank, notary, construction company, one-stop-shop manager, etc.). In this context, a clarification of General Data Protection Regulation (GDPR) rules in relation to building-relevant data would be welcome.

The EPBD should also introduce a definition and requirement for Member States to make use of Building Renovation Passports (BRPs) and of Digital Building Logbooks (DBLs), which provide common data templates facilitating data collection, organization, visualization, and comparison. Finally, the EPBD should design an overarching system for data collection and management that functions coherently to collect and provide the best and most reliable information, whether to building owners or to policymakers. This means that existing EPC databases should be fit for upcoming data from BRPs or DBLs, and data systems governing EPCs, BRPs and DBLs should be designed in a coordinated way.

Overcoming non-financial barriers to renovation will be essential for increasing renovation rate and depth. Owners and tenants should have easy access to information and guidance facilitating investment decisions. Some instruments exist already, but they need improvement, as well as broader acceptance and dissemination to have a meaningful impact on renovation activities.

3.7. Increase the quality of the EPC framework

EPCs were introduced in the EPBD in 2002, with the aim of:

- Giving information at a certain point in time (linked to selling or renting a building) about the energy performance of the building, and
- Laying out some (general) recommendations about which steps to undertake to improve it.

Table 2
Crossing perspectives.

<table>
<tr><th>Issue</th><th>Stakeholders</th><th>EPBD recast proposal</th></tr>
<tr><td>Knowledge of the public about current EPC</td><td>Stakeholders agree that educational efforts are needed to help the public understand the EPC, linking it to energy savings, carbon reduction, and economic benefits. Currently, it is seen as a bureaucratic formality.</td><td>The EPBD recast proposal focuses on technical improvements to the EPC, such as standardizing templates and adding energy and emissions indicators, but it does not address public education on its benefits.</td></tr>
<tr><td></td><td colspan="2">Both the stakeholders and the EPDB recast proposal agree that the mandatory policies have been an impetus for the adoption of the PCAs. The recast proposal also proposes to deepen this policy, by making the energy certificate mandatory in new situations, such as the renewal of an existing rental contract and major renovation.</td></tr>
<tr><td>Main opportunities and drivers of the current EPC</td><td>Key drivers for EPC adoption include rising energy costs, public policies like renovation subsidies, and increased awareness due to events like the economic crisis and the war in Ukraine.</td><td>The EPBD proposal emphasizes mandatory EPC issuance as a driver and suggests expanding it to rental renewals and major renovations. It also recommends improving data quality, adding indicators, and offering tailored recommendations</td></tr>
<tr><td></td><td colspan="2">Advances in legislation are drivers on which both stakeholders and the EPCB recast proposal agree. On the one hand, the promulgation of mandatory laws that establish the EPC as a requirement for housing procedures has promoted its adoption. On the other hand, specific laws are necessary to guarantee the homogeneity of energy evaluations to obtain EPCs, ensuring their reliability.</td></tr>
<tr><td>Main barriers and obstacles of the current EPC</td><td>The lack of clear legislation and inconsistent certification methods are major barriers to EPC adoption. Additionally, the complexity of procedures to obtain subsidies and the higher cost of energy-efficient buildings hinder progress.</td><td>The EPBD recast proposal highlights the variability in EPC quality as a barrier to public trust. It recommends a comprehensive approach to improve the certification process, including better auditor training, stricter quality controls, and more frequent checks.</td></tr>
<tr><td>Risks of the EPC as factor of exclusion of the vulnerable population</td><td>There are mixed opinions among stakeholders on the risk of EPCs contributing to social exclusion. Some believe that the high cost of building rehabilitation could exclude vulnerable populations, while others see economic barriers as the main issue, which could be mitigated by state subsidies. A third group believes the EPC itself is not a factor of exclusion, viewing it as a transparent tool for indicating energy performance and potential costs.</td><td>The EPBD recast proposal does not directly link EPCs to social exclusion but acknowledges the need to address energy poverty in low-performing buildings to meet climate goals. It emphasizes the importance of financial support, technical assistance, and renovation passports, while leaving monitoring and verification largely to individual Member States.</td></tr>
<tr><td>EPC information and data collection</td><td>Stakeholders focus on the quality and quantity of EPC information, criticizing the overemphasis on technical aspects related to active measures while neglecting passive solutions such as building orientation. They suggest including environmental factors like noise, air quality, and carbon footprint. There is also concern about simplifying technical language in the EPC to make it accessible to all.</td><td>The EPBD recast proposal addresses EPC data from a security and accessibility perspective. It calls for national EPC databases that are user-friendly, digital, and interoperable with other databases. The proposal emphasizes the need for quality data management and suggests exploring differentiated access to EPC databases based on the user's role, while also clarifying GDPR rules regarding building-relevant data.</td></tr>
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According to these aims, EPCs could play a decisive role in the transformation of the building stock, but for this to happen, a thorough update and upgrade on both aspects is needed. This would enable EPCs to:

- Be recognized as reliable information tools across all Member States, and
- Fulfil new purposes linked to other policies, such as MPS, BRPs or financing measures.

Nowadays, the coverage of the building stock with EPCs is still rather low, and there are concerns related to the quality of issued EPCs, which are not acting as reliable information tools. This becomes even more important as a successful rollout of MPS will depend on EPCs whose quality and reliability has to be improved ahead of the first MPS compliance date. The EPBD should therefore require that all buildings get an EPC by a certain date, to increase the coverage.

However, improving EPCs means going beyond their design (e.g., common template). While harmonization in the design might boost the usefulness of the tool amongst real estate investors at cross-border level, what is crucial is that the EPBD ensures all Member States comply with requirements and establishes key quality principles for each aspect of the EPC framework:

- The design should display useful information to the different types of EPC users (prospective buyer, public authority, bank) – finding the right balance between readability/attractiveness on one side and quality/reliability on the other, while always ensuring trust.
- The calculation methodologies should be harmonized and improved, such as by adding complementary indicators like validated actual energy performance, GHG metrics, and indoor air and environmental quality (the latter being especially important for occupants). Overall, the quality of input data should be improved.
- The performance assessment should be based on an on-site audit executed by a skilled certifier.
- Recommendations should be more specific and tailored, include information on costs and benefits, and be linked with advisory services.
- The allowed lifetime of 10 years is too long for the EPC to be considered up to date and should be shortened to five years.

Regarding the quality control of EPCs, a holistic approach should be adopted to improve every stage of the certification process, from training/upskilling of auditors, quality checks of methodologies/software, more frequent ex post quality controls, and more stringent penalties. A significative number of these recommendations can be implemented using digital tools.

3.8. Stakeholders vs EPBD recast proposal analysis

It was decided to carry out an analysis of the differences and coincidences between the vision of the EPBD recast proposal and the answers of the stakeholders (Table 2).

The comparative analysis between the perspectives of the stakeholders and the Energy Performance of Buildings Directive (EPBD) recast proposal highlights both substantial agreements and divergences regarding the implementation and improvement of Energy Performance Certificates (EPC). In relation to the public's understanding of the EPC, stakeholders agree on the need to deploy educational strategies that not only allow for the proper interpretation of the information contained in the EPC but also help the public understand its link to energy savings and the economic benefits derived from higher efficiency. Currently, the EPC is largely perceived as a bureaucratic requirement necessary for real estate transactions, without fully understanding its impact in terms of energy savings or carbon emissions reduction. In contrast, the EPBD recast proposal introduces technical improvements, such as the use of a common EU template and the inclusion of indicators on primary energy use and greenhouse gas emissions, but it does not advocate for educational policies aimed at improving public understanding of the EPC.

Regarding the drivers of the EPC, both stakeholders and the EPBD agree that mandatory policies have been crucial to the adoption of the certificate. The EPBD recast proposal suggests extending this obligation to new scenarios, such as the renewal of rental contracts and major renovations, which aligns with the stakeholders' view of the key role of public policies and economic incentives in driving the adoption of the EPC. However, stakeholders also point out that conjunctural factors, such as the economic crisis and the war in Ukraine, have increased public awareness of energy costs, further incentivizing the implementation of energy efficiency measures. On the other hand, the EPBD focuses on improving the quality of the EPC by incorporating additional indicators, such as real energy performance and indoor environmental quality.

In terms of the barriers to EPC implementation, there is consensus between the stakeholders and the EPBD in identifying the lack of homogeneity in certification services as a significant limitation. Stakeholders emphasize the variability in certification quality, which generates public distrust. The EPBD addresses this issue by proposing a comprehensive approach to improving the certification process, including auditor training, more stringent quality controls, and stricter sanctions. However, stakeholders also identify other barriers, such as the complexity of the procedures for accessing renovation subsidies and the high upfront costs of energy-efficient buildings, which are not specifically addressed by the EPBD.

A particularly relevant issue is the risk of social exclusion that EPCs could pose for vulnerable populations. On this point, stakeholder opinions diverge. Some warn that the costs associated with energy renovation could exacerbate social exclusion, while others believe that the EPC does not have a direct relationship with exclusion, as it merely provides transparent information about a building's energy performance. Although the EPBD does not directly address the EPC as a factor of exclusion, it acknowledges the need to improve conditions for those living in poorly performing buildings and establishes that Member States must pay special attention to vulnerable households when implementing minimum energy performance standards.

Finally, stakeholders express concern about the quality and accessibility of the information provided by the EPC. They criticize the current technical approach, which prioritizes active solutions over passive ones, such as the building's surroundings or orientation, and suggest the inclusion of additional indicators like air quality and noise levels. Although the EPBD does not directly address these issues, it proposes the creation of national EPC databases that are accessible and digital, which could improve the quality of information and its interoperability with other databases, addressing some of the concerns raised by stakeholders.

3.9. Current initiatives in the future of the EPC

With the evolution of technological advancements and data systems, EPC frameworks have faced challenges that have driven the development of forward-looking perspectives to ensure their continued relevance and effectiveness.

In this regard, by their static nature, current EPCs provide a snapshot of a building's energy performance at a specific point in time, without taking into account occupancy patterns or potential technological upgrades, leading to discrepancies between predicted and actual energy performance. The EU-funded TIMEPAC project addresses this problem by moving from static certification to a more holistic and dynamic approach, considering buildings as dynamic entities that continually change over time.

Furthermore, current EPCs are not equipped to integrate data obtained through smart meters, IoT devices or advanced energy management systems, limiting their ability to provide accurate and up-to-date assessments. The Dˆ2EPC project aims to advance the assessment of the energy performance of buildings by developing dynamic EPCs that adapt to real data, thereby improving user awareness and promoting sustainable construction practices.

In addition, it should also be considered that variations in the implementation of EPCs in different Member States hinder their comparability and reliability. Faced with this, the QualDeEPC project seeks to improve the quality and trans-European convergence of EPC schemes, thus improving their reliability and effectiveness.

Finally, other remarcable initiative is the SmartLivingEPC project, which aims to deliver a certificate which will be issued with the use of digitized tools and retrieve the necessary assessment information for the building shell a nd building systems from BIM literacy, including enriched energy and sustainability related information for the as designed and the actual performance of the building. The new certification scheme will also expand its scope, covering aspects related to water consumption, as well as noise pollution and acoustics. SmartLivingEPC certificate will be fully compatible with digital logbooks, as well as with building renovation passports in order to allow the integration of the building energy performance information in digital databases. A special aspect of SmartLivingEPC will be its application in building complexes, with the aim of energy certification at the neighbourhood scale.

3.10. Integrating macro and micro views

Recent studies analyzing the situation in various countries in Latin America and the Caribbean (LAC) have found that financial incentive policies for renewable energy development not only boost economic activity in the region but also contribute to reducing gender inequality (Koengkan et al., 2024). Along similar lines, Kazemzadeh et al. have examined the impact of energy complexity on energy intensity, determining that this relationship follows an inverted U-shape. In this context, an increase in energy complexity initially leads to higher energy intensity, which subsequently decreases as energy complexity becomes more established (Kazemzadeh et al., 2023).

The review of these studies suggests that, to mitigate harmful gas emissions, policymakers should implement financial incentives for renewable energy development through strategies that accelerate the transition from lower to higher levels of economic complexity, while minimizing, as much as possible, the duration at intermediate levels. These findings provide valuable insights for policymakers in designing macro strategies aimed at achieving a sustainable and efficient energy transition.

Also at the macro level, some researchs analyze both the positive impacts of environmental technologies and policies as well as the negative effects of pollution and economic growth (Dao et. al., 2024). On the one hand, their study confirms that environmental technologies (such as clean or energy-efficient technologies) and green financial policies (such as economic incentives for sustainable projects) have a positive impact on environmental protection. Similarly, energy uncertainties (such as fluctuations in fossil fuel prices or instability in energy supplies) can also indirectly contribute to ecological sustainability by encouraging the transition to more sustainable energy sources.

On the other hand, they note that despite the potential benefits of these technologies and policies, increasing pollution can counteract these positive effects, diminishing the effectiveness of the measures implemented. According to the authors, uncontrolled economic growth and a high dependence on revenue from natural resources, such as oil, gas, or mineral extraction, lead to environmental degradation, highlighting a conflict between economic development and environmental sustainability.

However, stakeholders interviewed during the course of our work emphasized social considerations, whose spected and unspected impacts are more apparent at the micro (and even, the meso) level. They warned that poorly designed policies could leave the most vulnerable sectors behind in the energy transition process, exacerbating existing inequalities.

Addressing EPCs from a micro perspective highlight the importance of promoting policy formulation that combines energy efficiency measures with socially oriented policies addressing energy consumption. This approach ensures that the benefits of energy efficiency improvements in buildings are accessible to all, particularly disadvantaged communities and low-income households (Zuhaib et al., 2022). The results of this work offers relevant insights for constructing a vision that integrates both the macro and micro levels of the challenges associated with implementing energy efficiency certificates in the construction sector.

4. Conclusions

This research focused on the opinion of stakeholders linked to the EPC chain, seeking to further identify key aspects of the development and implementation of these certificates. The results found highlight that there is a broad consensus among stakeholders on the need for standardised methodologies and better data quality in Energy Performance Certificates, in line with the objectives set out in the proposed reformulation of the EPBD. In particular, stakeholders and policy makers recognise the value of harmonising energy performance metrics, ensuring consistency across the European Union and integrating EPC information with complementary databases. This coincidence underlines the role of reliable and comparable data in shaping effective renovation policies and unlocking financial incentives that stimulate the widespread adoption of energy efficiency measures.

However, significant differences emerge regarding the social implications of implementing EPCs. While the EPBD reformulation proposal emphasizes mandatory certification and data transparency, some stakeholders argue that EPCs may reinforce socioeconomic disparities, especially among low-income populations. Concerns focus on the high costs of retrofitting inefficient housing, potential tax or penalty structures for non-compliant buildings, and the risk of rent increases following property upgrades. Instead, the EPBD reformulation proposal primarily addresses the security and interoperability of EPC databases, rather than the socioeconomic dimensions of such policies.

Finally, it should be noted that, in the opinion of those surveyed, for Energy Performance Certificates to have a real impact on the green transition, it is necessary to aim for an improvement in the quality and standardization of data and methodologies for calculating EPCs, in combination with an approach from a social perspective, in particular, with a focus on citizen participation strategies that promote social co-responsibility in the maintenance and updating of buildings.

In this context, a possible recommendation to facilitate the adoption of EPCs would be for policymakers to work on designing new financial schemes that, beyond conventional subsidies, include incentives appropriate to the different socioeconomic profiles of households, with the aim of reducing the risk of exclusion or excessive increases in rental prices.

Conflict of interest

The authors of the submitted manuscript hereby declare that there are no conflicts of interest related to the work presented for consideration in Urban Governance.

CRediT authorship contribution statement

Aitziber Mugarra: Conceptualization. **Cruz Borges:** Formal analysis. **Leandro Ferrón:** Writing – original draft. **Oxana Soimu:** Investigation.

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