EUB
SuperHub

European Building Sustainability performance and energy certification Hub

D1.3 - Next generation energy certification: stakeholders' needs and expectations

This project has received funding from the European Union's H2020 research and innovation programme under Grant Agreement No. 101033916.

Project no. 101033916

Project acronym: EUB SuperHub

Project title: European Building Sustainability performance and energy certification Hub

Call: H2020-LC-SC3-B4E-4-2020

Start date of project: 01.06.2021

Duration: 36 months

Deliverable title: D1.3 - *Next generation energy certification: stakeholders' needs and expectations*

Due date of deliverable: 31 March 2022

Organisation name of lead contractor for this deliverable: CSTB (08)

1. table

Name	Organization
Andrea MORO *Paola BORGARO* *Elena BAZZAN*	*iiSBE Italia*
Adriano Ferrara *Cristina Di Maria* *Elena Mocchio*	*UNI*
Letizia ROCCAMENA *Lilia GALAI DOL* *Sylviane NIBEL*	*CSTB*
Peter Gyuris	*GEO*
Ahmed Khoja	*HM*
Sabie Erber *Michael Braun*	*EIV*
Breffni Lennon *Lauren Quinlivan*	*UCC*
Marina Malinovec Puček	*EIHP*

2 table

Dissemination level		
PU	Public	x

3. table

History			
Version	Date	Reason	Revised by
01	11/04/2022	1st draft	CSTB
02	14/04/2022	2nd draft	HM, UNI
03	20/04/2022	Final draft	CSTB
04	30/11/2022	Review, Submitted	GEO

Table of Contents

Executive summary

This deliverable D1.3 is part of Work Package 1 (Baseline assessment and definition for EuB SuperHub) more specially of Task 1.3 (national policies, initiatives, and current transition challenges: needs of stakeholders in relation to next generation EPCs). This task has run M2 to M10 in the project and consists of the identification of needs and expectations of public institutions and market actors in relation to next generation EPC.

The process by which these exploitable results have been identified is the following:

- Policy papers, initiatives, articles, conference papers, results of EU projects were analysed with a combined contribution from all partners involved in this task through a unified shared document (State of the art - Fichiers).
- Each partner has identified the key national stakeholders for the future EPC and has conducted an interview to collect feedbacks:
    - IISBE and UNI for Italian actors,
    - GEONARDO for Hungarian actors,
    - HM for German actors,
    - EIHP for Croatian actors,
    - EIV for Austrian actors,
    - UCC for Irish actors,
    - CSTB for French actors.
- Based on the various results of the literature analysis and interviews, a list of the thematic areas has been identified for the KPI study carried out in T1.2.

The literature reviews at national level mainly reflect governmental needs and recommendations. Interviews have been therefore essential to complement this vision with other stakeholders' points of view.
European projects, including part of EUB SuperHub sisters project (ePanacea, D2EPC, QualDeEPC, U-Cert and X-tendo.), have proposed ways of improving the EPC fitting. These directions already provide some proposals to address the recommendations identified in this literature review and has been listed into this document.

The interviews have been conducted regarding six questions with the aim of fostering an open discussion:

- In your opinion, have EPCs helped you in your day-to-day work? Has it been successful?
- How can we make EPC more attractive/ more useful?
- What kind of indicators and information can we include in the EPC, in addition to energy?
- To which extent do you think it is necessary to improve the process of EPCs
- and their quality / credibility, knowing that it could be more expensive?
- How do you imagine an EU building passport? What should it look like and how to use it?
- Free comments and suggestions

Task 1.3 has played a key role for the identification of the thematic areas considered the most relevant for the next generation of EPCs, necessary in Task 1.2 activity to finally get an accurate list of selected indicators for evaluating the energy performance, sustainability and smartness of buildings in the next generation of Energy Performance Certificates (EPCs).
The interlinking of these two tasks has been very powerful through the overall development activity, as highlighted in D1.2, and this has guaranteed the achievement of the expected results from both sides.
More in detail, Task 1.3 has contributed to the identification of the thematic areas considered the most relevant for the next generation of EPCs in Task 1.2, by preparing a concise user-friendly Survey, capable of providing feedback from the stakeholders whose suggestions about next generation of EPC are considered very relevant for the activity.
This survey helped in checking the priority of each of the thematic areas identified, through a “bottom-up” approach, by considering the opinion of the stakeholders involved, coming from different European countries. This crucial activity of Task 1.2 has been carried out in conjunction with T1.3 which has contributed to its end - result.

To conclude, this document produces recommendations and reference strategies for improving the framework conditions for fostering the implementation of the next generation of EPCs. These recommendations, based on the literature review and interviews, have been organized according to the 4 key-concepts of the project: improvement, extension, harmonisation and reliability.

Introduction

This deliverable presents the work done in Task 1.3: "EU/national policies, initiatives, and current transition challenges: needs of stakeholders in relation to next generation EPCs". This task aims to identify needs and expectations of public institutions and market actors in relation to next-generation Energy Performance Certificates (EPCs).

As a reminder, within the frame of Task 1.1 "Mapping of EPCs and sustainability certifications - Evaluation of effectiveness and impact on the market", the analysis of the level of trust perceived by stakeholders towards EPCs and Sustainability Certificates and of the role that these certificates play in purchasing decisions was made. The study was carried out based on a series of focus group meetings that was organized in the partners' countries and regions covering a wide array of stakeholders. The results of the focus group meetings reflected the need to shift the scope of the EPCs from covering energy aspects into a more holistic sustainability certification that looks at buildings from an environmentally and end-user-conscious perspective. The participants also highlighted the fact that existing EPCs lack transparency, which undermines the trust in its credibility.

In order to obtain in-depth and comprehensive stakeholders' feedback, the Task 1.3 was divided into three main parts.

In the first part, national and transnational policy papers, initiatives, articles, conference papers, and results of EU projects about stakeholders' feedback, needs and expectations on EPCs were collected and analysed.

In the second part, main stakeholders were interviewed about their experiences and expectations on EPCs within the framework of bilateral meetings or during the national Local Advisory Team (LAT) meetings (organized as part of EUB SuperHub Task 6.4) organized in the project partners (PP) countries and regions. The answers to the specific guiding questions asked during these meetings were collected and enriched with the analysis of the level of trust perceived by stakeholders towards EPCs carried out as part of EUB SuperHub Task 1.1.

In the third part, the prioritization of the thematic areas of interest for the next-generation EPCs was made by sending a "Fast-Effective Survey" to relevant stakeholders: it was asked to the participants to give a priority level from 1 (low) to 3 (high) to the thematic areas highlighted for the next generation of EPC and their answers were subsequently collected and analysed.

This deliverable is organized into 4 main chapters:

- The first chapter presents a cross-analysis of national and transnational policy papers, initiatives, articles, conference papers, and results of EU projects about stakeholders' feedback, needs and expectations on EPCs,

- The second chapter provides an overview of stakeholders' experiences and expectations towards EPCs collected during their interviews,
- The third chapter presents the design of the "Fast-Effective Survey" and the results obtained through its deployment,
- Finally, in chapter 4, recommendations, and reference strategies for improving the framework conditions for fostering the implementation of the next generation of EPCs are suggested. They are based on the analysis of information collected during the three phases of Task 1.3.

1. Analysis of policy papers, initiatives, articles, conference papers, results of EU projects

To identify the needs and expectations of the building industry regarding the new Energy Performance Certificate, a literature review was conducted. This study is divided into two parts. A first look at the national level with feedback from stakeholders for France, Italy, Hungary, and Germany, complemented by the national study conducted in the framework of the ePanacea project for Spain, Belgium, Finland, Greece, Austria, and Germany. Then a second look at the European level, including feedback from the European EPC sisters' projects.

1.1 National analysis

Firstly, a summary of the articles' contents is made. Then these articles are analysed to identify the needs and expectations of the different actors targeted by the references, and then the recommendations.

FRANCE
The French EPC, called the DPE (Energy performance diagnosis) has been recast to make it more reliable, more readable, and to consider climate issues [1]. Provided for the 2018 ELAN French law, the recast of the DPE has been applied on July 1st, 2021, the date on which the DPE has become opposable. This revision is part of a wider context of accelerating the energy renovation of buildings, of which the DPE is one of the key tools. It is now possible to use it as a reference for regulations or specific support depending on the level of performance of the housing. Thus, in the framework of the law project to prevent climate change and to improve resilience to its effects, the government plans to prohibit from 2028 the rental of "energy slums", which are the most energy-consuming dwellings which correspond to the letters F and G of the scale of this new DPE. With the new DPE calculation, "Union Nationale des Propriétaires Immobiliers" (National Union of Property Owners) has noted a deterioration in the scores of nearly 800,000 homes [2]. After the launch of the new DPE in July 2021, changes on the calculation method for housing were operated and then reactivated on November 1 [3]. The opposability of the device generates a real legal risk to be addressed.
Needs and expectations
Government actors: • A more precise and unified method of calculation by eliminating the so-called "on-bill" method • Make the DPE legally opposable • A more comprehensive DPE (French EPC), for the benefit of users, that better considers the climate issues **These needs have been translated into the "new" French DPE framework, in force since July 2021.** **Property owners:**

- Revision of the timetable for renovation objectives with a precise impact study on the consequences of mandatory measures and the reform of the measurement system (DPE)
- Suspension of the opposability of the DPE to secure legally all parties
- Establishment of a ten-year plan of aid for renovation including strong signals:
    - Definition of a stable fiscal and regulatory framework favourable to investment
    - Remove the tax penalty from aid and subsidies for landlords
    - Reform of the ANAH agreement (Rent Affordable) as a powerful tool to encourage renovation with acceptable tax abatements and moderate rents.
    - Introduction of the energy renovation vacation
    - Introduction of a property tax stability pact for owners carrying out energy renovation work
    - Compensation by the State for property tax abatements for energy renovation voted by local authorities.

More generally, the need is a good estimation of the national labels repartition linked to a political program.

Recommendations

- The DPE is now based only on the physical characteristics of the dwelling, such as the building frame, the insulation quality, the window type, or the heating system, and uses more reliable input data. In addition, the new method integrates new parameters that will provide a more representative assessment of the building's performance: energy consumption for lighting and auxiliary equipment, updated weather scenarios, consideration of the latest equipment and improved thermal calculations.
- In the same way as other building diagnosis, such as those relating to the state of electrical installations or the presence of asbestos or lead. **The role of the DPE in the real estate acquisition process will be reinforced. The opposability of the DPE will make the backing of the energy label of regulatory provisions** (such as the ban on renting the most energy-intensive housing via the definition of the decency of a dwelling) **or specific aid**.
- **The design of the document has been revised to make it more reader friendly**, **easier to understand for users.** The front page will offer a summary of the most important information and will keep the label translating the energy performance as the French already know it. The climate label, which details the greenhouse gas emissions related to the home will be displayed in addition. To increase transparency, the estimated average amount energy bills will be displayed in a more visible and simpler way. These three elements:" **energy label, climate label and estimated bill**" will also **be mandatory display** on real estate ads as of January 1st, 2022 (provision of the 2019 energy and climate law).
- **Take into account the feedback from associations representing DPE or EPC** users before its recast.

- Develop a **methodology to estimate the difference or the conditions of label decrease**
- Establish **a scalable policy to allow time for owners to react and for public authorities to estimate the necessary support**, as supports to reduce the impact of the building stock on climate change

HUNGARY
For the development of the Hungarian building sector the following national strategies are essential in terms of energy policy, legislation and workflows (buildings energy efficiency and measures): the objectives and pillars of the National Building energetics Strategy, for the upcoming period (up to 2030), concerns the renovation of the Hungarian building stock, the lowering its energy consumption, suitable for publishing later actions plan, programmes, and intervention framework [4]. Published in November 2017, the National Energy-efficiency Action Plan specifies policy framework and interventions: energy audits, energy metering, buildings energy efficiency, public buildings, governmental buildings, and renovation strategy [5]. The National Energy strategy for 2030 is an energy carriers market overview, decarbonisation strategy, with specific focus on greening and energy efficiency in the economy, transport sector and in households (interventions, indicators, financing, responsible organization, and timeframe) [6]. Since the 2006 the national regulation follows the recommendation of the actual EPBD as written deliverables D1.1. For the actual EPCs and certification in Hungary, the latest relatively substantial alteration (2021) by the law sets the following changes: the 25% renewables condition for newly built buildings can be offset with elevated energy efficiency (insulation) and more energy efficient appliances (boilers etc.), room temperature conditioning is mandatory above 12sqm, for newly built buildings electronic charging points are mandatory, there are certain indoor air quality regulations updates. The IT system for certificates access (view/download) in a central database are restricted, but aggregates numbers can be requested. An energetic review system for units greater than 70 kW power (effective nominal rating of heating and air conditioning systems) is well coordinated and mandatory for energy optimization and energy efficiency reasons. Mandatory built-in control system above 290kW effective nominal capacity has been set for threshold based on the energy label for all system.
Needs and expectations
The main objective of the national energy strategy is to strengthen energy sovereignty and energy security, to maintain the results of the governmental bill-subsidy system (applied on energy too) and to decarbonize energy production. On political level, the needs and expectations are to strengthen fundamental interest on renewable energy resources applications (photovoltaic), heating/cooling solutions powered by clean energy technologies and the implementation of the Green District Heating Program. Another high-level ambition is reducing energy consumption in public, industrial and transport purposes. Citizens, the consumers of energy, are in the focus point of energy strategy, also energy diversification and energy supply need to be re-affirmed. It is expected that support will be intensified towards electromobility and solutions.

Recommendations
The actual general recommendations: • review of current incentives for energy, energy infrastructure, • renewal of the regulatory environment, • transform production and procurement portfolios, • establishing an energy advisory system, • fund awareness-raising programs and, • mandatory use of an energy officer for energy-intensive business entities. Planned direct incentives for investing into energy efficiency (2021 – 2027): • growing impact of the Obligatory Energy Efficiency System in issuing energy saving certificates • strengthening the ESCO services for public and private buildings for effectively applying energy efficiency measures.

ITALY
Two decrees provide a reference for the national EPC: • The decree n°192/2005 promotes the improvement of the energy performance of buildings taking into account local and external climatic conditions, as well as the requirements relating to indoor climate and cost-effectiveness [7]. • Since June 2015, the ministerial decree EPC, provides a guide for EPC [8] In recent years, the high energy consumptions and the excessive use of fossil fuels has led the European Community to adopt new policies aimed at reducing greenhouse gas emissions. In particular, the Energy Performance Certificates (EPCs) were introduced in the first European EPBD Directive in order to improve the level of energy efficiency of buildings reducing energy consumptions and relative emissions. In this work an analysis on the database of EPCs of residential buildings was performed. The objective of this EPC analysis [9] was to evaluate the type of retrofit action and the impact retrofit interventions for the Piedmont Region and for the city of Turin. The data used for this analysis were extracted from the EPC database of the Piedmont Region with 867,131 certificates in about 10 years. Geo-referencing of the EPCs it was also possible to correlate the energy performance of the buildings with other variables such as building and climate characteristics. The results of this work show that, through retrofit interventions 33-48% energy savings can be achieved. Moreover, there is still a high potential because the 33-48% of energy savings affects less than 6% of the total certified buildings, which are about 50% of the total buildings. The last annual report on energy certification of buildings describes the state of the art of the energy certification of the national building stock, including statistical analyses on various parameters extracted from the EPCs issued in Italy during last year [10]. The 2021 Report includes the analysis of qualitative information on the perception of EPCs and related processes, acquired through a questionnaire filled in by officials and decision-makers of Regions and Autonomous Provinces. The investigation concerns crucial issues relating to the application of energy

certification and suggestions for future legislative and regulatory work. Furthermore, the report summarizes the needs and recommendations for improvement expressed by other categories of stakeholders, in particular property owners and tenants and the credit/financial operators.

The document on the national strategy for the energy requalification of the national building stock [11], analyses the current energy requalification rate and the target one, also highlighting the opportunity to conduct an energy requalification with an integrated approach (energy performance and improvement of the seismic risk class of buildings) that improves the effectiveness of the relationship between costs and benefits.

The Integrated National Energy and Climate (INEC) plan [12] describes the policies and measures that Italy will adopt and implement to accelerate the decarbonisation process by setting 2030 as an interim milestone for achieving full decarbonisation of the energy sector by 2050 and integrating environmental factors in other public policies.

Needs and expectations

Application of EPC, information instruments and relationship between public and private stakeholders.

- EPC can be used to create energy performance modelling do not indicate specific parameters regarding thermal comfort and air quality, which are re-cognized to be the most important indicators to homeowners,
- make the EPC more useful, less administrative burden,
- Integrate more indicators that are important to improve the quality of life and wellbeing,
- Improve reliability and credibility of EPC,
- Improve occupant's behaviour, awareness and understanding,
- EPC were too complicated and technical for consumers to understand,
- Renovation recommendations are vague guide for potential improvements

Owners/tenants

The main shortcomings reported concern: low credibility of the certification system as a whole and difficulties in reading/using EPC data. In general, the EPC is perceived by the owners/tenants as a mere bureaucratic fulfilment that must be issued in order not to incur penalties and not as a valid tool for obtaining an objective evaluation of the building energy performance.
This generalized situation is practically reversed when the owner is able to adopt the financial incentive called "Super Bonus 110%", available in Italy from 01/07/2020. In fact, in this case the EPC assumes great importance for all the actors involved in the process and above all for the final consumer who perceives it no longer as a mere bureaucratic fulfilment, but as a useful and indispensable tool for evaluating and planning interventions of energy efficiency. This clearly demonstrates the key role those financial incentives can play in increasing and improving the use of the EPC.

Local authorities (Regions and Autonomous Provinces) express the following gaps:

- lack of uniformity at national level in managing EPC processes
- poor valorisation of the EPC in the real estate market
- need to integrate information currently missing in EPCs

Financial operators

The EPC is the key document to identify the green share of their real estate portfolio. However, many shortcomings are highlighted. The main one concerns the lack of homogeneity between the different regions in the format of the EPC and in the methods of accessing the EPCs databases.

Recommendations

Recommendations from owners/tenants

- Improve quality and credibility of the certification system: this could be achieved by increasing and improving the EPC processes controls to identify critical situations, such as the issue of the certificate without the on-site visit by the certifier.
- Regulate and standardize the rates applied by certification bodies a general revision is necessary. Very different tariffs currently are applied. The high number of certifiers increases competition and therefore lowers the cost of the operation, but in no way, this should compromise the credibility of the system.
- Provide the end users with a "toolbox" that facilitates knowledge of the regulatory and voluntary EPC. Synthetic extracts aimed at disseminating practical knowledge such as, for example, the lists of qualified professionals, regional toll-free numbers to contact, etc. could be a useful support.

Recommendations from local authorities (Regions and Autonomous Provinces)

- Adoption of a common national procedure for the control of issued EPCs: this approach would allow greater uniformity of verification of the EPCs issued, would guarantee a homogeneous treatment of energy certifiers, and would allow the comparison of results throughout the national territory. Furthermore, 90% of the interviewees would be willing to participate in a national discussion table on the topic.
- Make the average cost for drafting the EPC more homogeneous: remains among the still open issues as it is characterized by significant variability on the national market. Over 70% of respondents believe that it is necessary to define an indicative average cost of the EPC, involving professional representatives.
- Enhancement of the information contained in the EPC: they should be used more both by real estate agencies and through information campaigns aimed at strengthening the awareness of end users to the potential of the certificate.
- Integrate additional information into the EPC: over 50% of respondents believe it is necessary to integrate additional information into the EPC such as, for example, that relating to indications on real consumption or, alternatively, the notification of the presence of an energy diagnosis. The Smart Readiness Indicator (SRI) is seen as another essential element to be included. Indoor comfort (Indoor Air Quality - IAQ) is also a critical issue,

and suggestions have been received that the EPC should integrate information on indoor emissions of materials and on the embodied energy (grey energy).

Purpose of promoting the homogeneous and coordinated application of the energy performance certification of buildings.

- Provide **a guide for EPC**
- Provide the **instruments for the cooperation between State and Regions**
- Creation of **a common information system for the whole national territory** for the management of a national cadastre of energy performance certificates and heating systems
- Create BIM based EPCs
- **Include comfort and wellbeing indicators** (air, thermal, acoustics, etc.),
- **Create a user-friendly EPC** data-sharing platform,
- Provide **additional training for EPC auditors** and ensure only officially approved and verified software can be applied for certification
- **Include smartness** rating for the building,
- Providing more **tailor-made recommendations** for the cost-effective upgrading of the buildings,
- Developing clear guidance on the EPC presentation to make the information accessible and to enhance public awareness on energy efficiency.

The main measures pointed out in the national strategy for the energy requalification of the national building stock are the following:

- continue and strengthen the provision of financial incentives and consolidate tax relief, while promoting a simplification and speeding up of the bureaucratic procedures for accessing these measures
- **incentivize deep renovation interventions** using the integration of multiple financial incentives (for example eco-bonus and sismabonus)
- **implement targeted monitoring of energy consumption** to correctly identify the properties to be redeveloped as a priority
- **implement greater integration of energy efficiency measures** with the procedures and prescriptions of territorial urban planning tools
- **promote training and information campaigns for end users**
- **develop advise and planning tools for citizens**: these tools must be accompanied and supported by database-based IT systems that integrate all the information available to the Public Administration regarding the national building stock, such as building land registers, plant registers and energy performance certificates.

The significant potential for efficiency in the building sector is pointed out in the INEC Plan.
Regarding EPCs, the following measures are planned:

- the reinforcement of minimum and harmonised regulatory approaches
- the introduction of measures to improve the quality of energy performance certificates (EPCs)
- promoting the purchase of residences in a high energy class

- promoting the use of demand-response technology, ICT systems and home automation which permit the monitoring and control of building performance
- improving tests for verification of compliance with regulations and technical standards
- improving integration among rules for energy efficiency and renewable sources in buildings
- evaluating the possibility of introducing energy efficiency obligations in the event of renovations, where justified in terms of the cost-benefit ratio, and introducing new limits on the use of cooling installations.

GERMANY
The German climate action plan aims to drop the GHG emissions of the building sector by two thirds by 2030. As a result, a new German GEG law was introduced in 2020 [13]. The law aim is to reduce bureaucracy and to harmonize, modernize and simplify energy-saving legislation for buildings. Thus, the new GEG law replaces the two old sets of regulations that governed the energy-related requirements for buildings (Energy Conservation Act (Energieeinsparungsgesetz, EnEG) and the Energy Saving Ordinance (Energieeinsparverordnung, EnEV). Moreover, the new GEG law outline a national definition of net zero energy buildings as per the EPBD requirements. The new GEG law allows now for the energy saving requirements to be met for serval buildings jointly within the neighbourhood. Furthermore, the law demand that carbon dioxide emissions resulting from primary energy demand or primary energy consumption of a building are to be entered in energy performance certificates and it makes it obligatory for buyers or owners to undergo an energy consultation when single- or two-dwelling buildings are sold or are to undergo major renovation.
Needs and expectations
• Drop the GHG emissions of the building sector by two thirds by 2030 • Improve the transparency and clarity of the EPCs and reduce bureaucracy • Harmonize the national energy related laws • Include other indicators beyond energy
Recommendations
• Allow for a **neighbourhood scale energy consideration**, • **Phase out old energy intensive** and climate unfriendly heating systems (oil based), • **More options/ flexibility** for meeting energy standards, • **Carbon dioxide emissions are included in the EPC**, • **Make it obligatory for buyers or owners** to undergo an energy consultation.

In February 2021, a report resulting from stakeholder interviews and online workshops, carried out in the framework of the **ePanacea** European project showed the feedback of end users and other stakeholders of the EPC in 6 countries: Spain, Belgium, Finland, Greece, Austria, and Germany [14].

		Spain	Belgium (Flemish Region)	Finland	Greece
End users	**EPC perception and knowledge**	• A mere bureaucratic procedure/legal requirement for selling/buying or renting a building • End users do not pay much attention to the EPC since energy costs are low	• Mandatory document in the handover process of houses and apartments • Marketing tool	• Perceived importance of the EPC varies from "undervalued" to "not important" • Expensive, required document • A rather unimportant factor for decision making when buying/renting a building • Importance of EPC was bigger if it was for a newly built building	• Most interviewees had not seen the EPC before, not even in the public sector • Obligatory document but the actual meaning of information is not clear • Most end users became aware of the EPC because it is related to funding schemes • Perceive the EPC as extra costs or another building tax
	Critiques and needs	• EPC lacks actual household energy consumption • Interest in estimated annual heating costs • Lack of individual recommendations • Advice for every-day life is missing	• Need: indication of main influencing factors on the EEC of a building • Building target values • Inadequate energy consumption data (not individualized) • Interest in average consumption of the last 5 years (both electricity and fuel) • EPC is already complete • Interest in energy saving tips • Need for more comprehensive renovation information (e.g. information on available subsidies and contact lists for EPC certifiers)	• Indications about CO_2 emissions as well as indoor air quality • Interest in hints on how to change daily energy related practices • Information about innovative technologies • Environmental impact associated with the EECs	• Actual (annual) energy consumption of the building and the recommendations associated with it are missing • Recommendations should e.g. include a list of more energy-efficient technologies, further links to find appropriate installers and information on the user behavior • End users would prefer if the EPC became digital
Other stakeholders	**EPC perception**	• Important instrument to promote transparency regarding EE in the buildings sector and to adjust grant programmes for building renovations	• Useful policy tool to attain the long-term goals for 2050 • EPC currently is irrelevant during the occupancy of the property	• Tool to compare buildings	• EPC is mandatory by law but also an important tool to learn about the as-built situation. • EPC indirectly as a basis for the building energy management and as a tool for the mitigation of energy poverty
	Critiques and needs + suggestions for improvement	• Reliable and personalized recommendations to end users • Databases with continually updated information about "measures, investment costs and energy costs" • The user dimension (i.e. actual use) should be taken into account in order to engage end users → a customizable EPC (dynamic for user profile) could be interesting • Dividing the EPC into a section with technical information for experts and a user-related section for end users (double EPC report)	• Consider circularity of building sector • Including information about solar gains and innovative technologies • Divergent opinions about the provision of real-time energy consumption to end users • Inclusion of thermal images was perceived as rather useful • Illustrating the EPC by exemplary user profiles • Current EPC is "rather complete for users" but too simplified for professionals → dividing the EPC into a simplified part for the user and a more technical part for experts	• Make the EPC more dynamic • Base the EPC on facts that the end user can understand • EPC is comprehensive already • Express energy consumption in relation to a monetary value/compared to equivalent costs of other activities. • Using an additional tool to "interpret" the numbers in the EPC according to one's consumption behavior and household composition • Benchmarking for separate construction components • Cover other additional information in an additional tool	• EPC should be issued before selling/renting a building • A quality control mechanism which conducts extensive site visits and the certification of energy auditors would improve the quality of EPCs • EPC should become digital and real consumption data should be displayed, including costs • Demand: add the SRI, the fraction of RES production and the air quality • The EPC should become dynamic
	Communication about the EPC and EEMs	• Intermediaries (e.g. EPC certifiers, building companies, selling agencies, town councils and property managers) should translate technical information from the EPC to end users; other intermediate links: websites and one-stop-shops • End users' decisions regarding EEMs should always be supported by experts in order to make the most proper decisions.	• EPC certifiers should receive regular training • For end users it is important to find contact persons, who are trustable and objective		• End users are suspicious regarding the energy auditor. Instead, they trust the local installers and would rely on the reference from other citizens or simply copy EEMs that were introduced in the neighbourhood

Figure 1: ePanacea - feedbacks of end users and other EPC stakeholders – table 1

		Austria	Germany
End users	**EPC perception and knowledge**	• Not aware of the EPC and cannot relate to it • Expected mistakenly that it would include an indication about annual heating costs and data about electricity consumption	• The majority had never seen the EPC and did not know if there existed one for the building they are living in • Expected mistakenly that it would include an indication about annual heating costs and data about electricity consumption • Did not consider the EPC when searching for a building for rent because the housing market is so scarce in the cities
	Critiques and needs	• Indications about the energy/heating costs would be the most important information	• EPC is totally standardized and not individual • Additional hints for everyday energy behavior • Interest in annual heating costs and electricity consumption • Interest in life cycle indicators regarding the building
Other stakeholders	**EPC perception**	• Important because it is a control instrument for building regulations and funding requirements	• Important factor in the consumer information' • A 'foreign body' to end users • Too complex for end users and professionals
	Critiques and needs + suggestions for improvement	• Regulation for building construction should be tightened • Develop a common EPC versions for end users for EU MS/ participating countries in ePANACEA • EPC for new buildings should have to be updated when plans for the construction change • Certifiers come from different sectors and therefore have different competencies. This constitutes a problem for the comparability of the EPCs and the recommendations • EPC is not comparable in the national context because results can be either too imprecise or overly accurate → streamline calculation method • Environmental and building life cycle indicators (e.g. recyclability, environmental impact and grey energy) are missing • Including more building use information in the EPC for end users (e.g. hints for energy saving in every-day life). • Simple benchmarks of the EEC would help end users' to put the information about the EEC into context • Information about renovation steps should be provided to end users • Split the EPC in two different parts: user-friendly and relevant information for the end user, detailed technical results in a different part, content of the EPC could be reduced for end users because the EPC in Austria covers a lot • The fGEE indicator, which is often not understood by end users could be left out in the version for end users. → Focus on streamlining the EPC for end users instead of adding additional information (e.g. consumption data)	• Critique: EPC is issued before the building is constructed (changes are not taken into account) • Critique: requirements to issue an EPC are rather low and broad, so that experts with different backgrounds are allowed to issue EPCs • Quality monitoring should be enforced for the EPC because an audit can be avoided by not indicating a registration number in the EPC • Site-visits should become mandatory for issuing an EPC • Energy standards should be lowered but quality checks should be implemented • Two versions of EPC in Germany is confusing and unnecessary (demand based and consumption based EPC) • Use less complex calculations to obtain more comparable results • EEC is calculated with regard to the climate conditions in Potsdam, no matter where in Germany the building is located • The area used for the calculation and as indicated in the certificate is not understandable for end users • The indicator "primary energy demand" is not understandable or useful for end users. • Additional hints for everyday energy behavior • Information about the thermal insulation in summer, life cycle assessment indicators and an annex with e.g. information about the data used for calculation of the EPC is missing • Inclusion of electricity consumption data in the EPC • Different units should be presented in the EPC, together with a benchmark, so that the reader Can choose in what unit he/she wants to receive information.
	Communication about the EPC and EEMs	• Building projects should always be accompanied by comprehensive, neutral consultancy	• The EPC alone should not be used to implement EEMs because recommendations are not detailed enough. • Suspicious of the idea that an improved EPC could replace the energy consultancy by experts. • Energy consultancy depends on the professional background of the advisor and energy consultancy might often not be objective. In the best case energy advisors would be able to give holistic recommendations.

Figure 2: ePanacea - feedbacks of end users and other EPC stakeholders – table 2

The available literatures at national level mainly reflect governmental needs and recommendations. For some countries, such as Austria and Croatia, this literature review was not possible due to lack of documentation. For other countries, such as Hungary, a document base exists but without any expression of needs or recommendations.

Interviews are therefore essential to complement this documentary vision and to include other stakeholders' points of view.

1.2 European analysis

In this section, results of European projects and scientific articles present the needs, expectations and recommendations concerning the EPC at the European level.

Among the European projects, 5 sisters projects on EPCs have published stakeholders feedback studies: ePanacea, D2EPC, QualDeEPC, U-Cert and X-tendo.

The analysis of deliverables and articles was carried out as for the national vision study. Firstly, a summary of the articles' content is made. Then these articles are analysed to identify the needs and expectations of the different actors targeted by the references, and then the recommendations.

ePANACEA
The objective of the ePANACEA project is to develop a holistic methodology for energy performance assessment and certification of buildings that can overcome these challenges for building sector: lack of accuracy, a gap between theoretical and real consumption patterns, absence of proper protocols for inclusion of smart and novel technologies, little convergence across EU schemes, lack of trust in the market and very little user awareness related to energy efficiency. This ePANACEA report [14] presents the research findings from more stakeholder interviews and online workshops with end users and other stakeholders of the EPC. The report provides insights on study participants' knowledge, perception, and use of the EPC, as well as their critiques and needs regarding it. The collected critiques and needs from research participants address different levels of the EPC (implementation, generation, and use of the EPC). A second ePanacea's deliverable [15] contains the stakeholder analysis developed from the end user perspective within the ePANACEA project, in order to identify EPC end-users and other stakeholders who are more or less directly involved with EPCs and may influence end user behaviour and decision making in relation to the energy performance of their buildings.
Needs and expectations

Collected feedback from interviewees, participants of the user-needs workshops and REB meetings regarding the completeness of the stakeholder map. However, the following roles could be added:

- In the South-Eastern REB the relevance of the energy auditor was mentioned: participants thought that the role of “energy auditors” and energy consultants should be more important in the public perception to achieve the energy transition. For instance, the energy auditor has to explain the EPC data and values to the end user; why the energy consumption is high and what actions can be done to reduce it. However, this role could be also allocated to the EPC certifier. Non-residential buildings can implement the EMAS which is conducted by an energy auditor. During an energy audit, the energy auditor often issues an EPC if does not exist yet.
- Moreover, the role of technology providers of e.g., PV systems, smart home installations or the building envelope was considered to be important by members of the South-Eastern REB. For technology providers it is important that their technologies are mapped as realistic as possible in the EPC and that the use of technologies are apparent to end users. Many calculations software for the EPC do not develop as fast as the market development of technologies. For instance, it would be crucial to consider EVs or smart homes in the EPC (e.g., what CO2 coefficients and default values are used?).
- It became evident that also research is a stakeholder of the EPC and end users, too. In line with this, participants of the South Eastern REB mentioned that R&D is a key factor for future innovative technologies.
- Diverse chambers (labour, agriculture…) and their advising services and energy efficiency lines were considered to be important to be added to the stakeholder map by participants of the East-Southern REB meeting. We can comprehend that diverse chambers and energy efficiency lines might have an impact on the decision of end users regarding EEMs.
- Finally, the role of town councils in translating technical information of the EPC to end users was mentioned by an interviewed Spanish policy maker. Therefore, they can be considered as informants about the EPC and EEMs. During the German workshop a professional remarked that property managers and landlords are also end users of the EPC, who use the EPC for real estate management. Therefore, they are end users and multipliers of the EPC. The complemented stakeholder map is presented in Figure bellow.

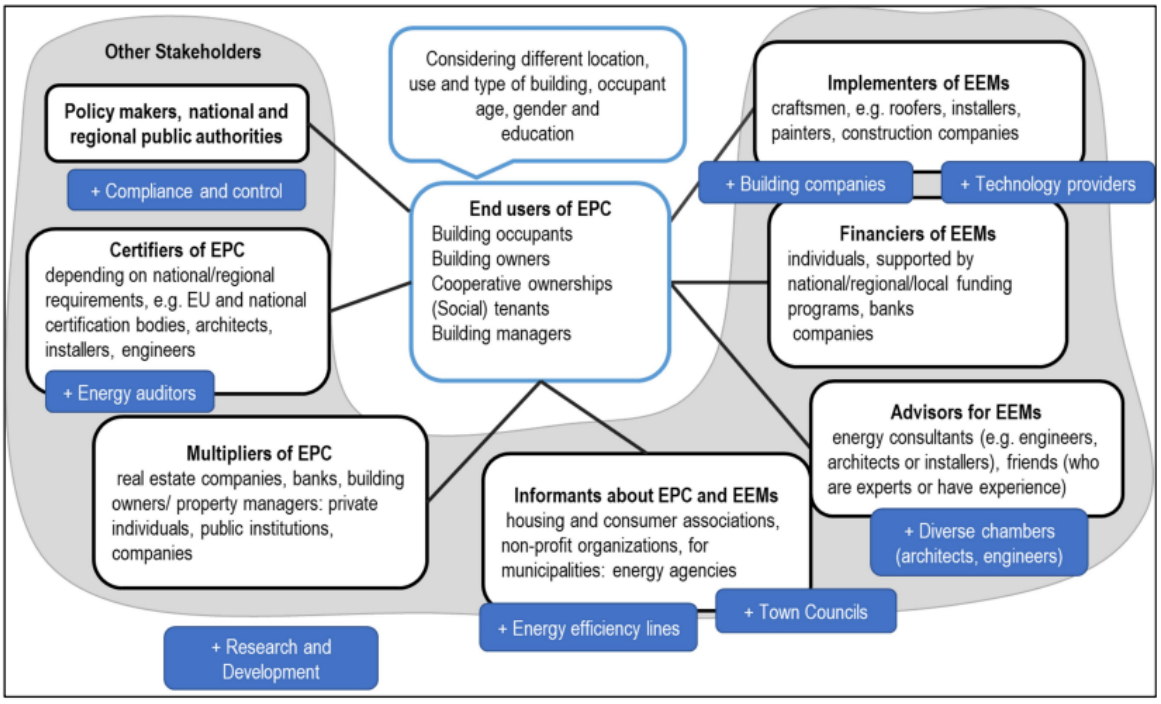

Figure 3: Adjusted Stakeholder Map

Based on the stakeholder interviews it can be concluded that there is room for improvement regarding the EPC in all pilot countries (Spain, Finland, Belgium, Austria, and Greece) and Germany, although the EPCs differ, regarding the calculation methodology, completeness of information and visualization.
In most countries awareness about the EPC is low (Spain, Finland, Belgium, Austria, and Greece). In the first place, end users from all considered countries perceive the EPC as legally mandatory. Only in DE end users do not even know if the EPC is legally mandatory or not. It is evident that other factors than the EPC, like costs and location of a building, play a bigger role in decision making in the process of renting/buying a building. Most often, interest in energy costs related to using a building with a certain EEC is mentioned by end users; however, energy demand is not yet expressed in e.g., €/month or €/year on the EPC. Two common points of interest, which can be identified based on stakeholder interviews, is the interest in hints for every-day life to save energy and the need to be informed about one's real energy consumption. However, the latter was not mentioned by participants from Germany (perhaps because the EPC based on energy consumption exists). In Germany the EPC based on energy consumption was rather criticized by stakeholders because it would not allow a comparison of buildings due to the strong influence of the building occupants' energy behaviour. Therefore, it might be a good idea to provide data about energy consumption in addition to the EPC, but not exclusively evaluate the EE of a building based on energy consumption data. First and foremost, the methodology for the calculations needs to deliver accurate indicators which need to be communicated in an understandable way to end users, if the EPC should become more accepted and useful.

- **End user**: Owners consider it as handicap that they do not know about the financial implications of owning a building with a certain energy efficiency

class, The lack of trust may be one reason for the discrepancy between recognising the EPC and using the provided information

- **Policymakers, national and regional public authorities:** Information from EPC databases can be used by local authorities and policy makers to analyse the housing quality, to improve subsidy programmes, make targeted retrofit investments and promote support schemes in the process of designing policies
- **Certification bodies**: issue the EPC, Certification of possibly many dwellings
- **EPC informants:** energy agencies and housing associations act as informants about the EPC, also engage in lobbying activities: Want that customers can make informed decisions, fulfilling legal requirements
- **EPC multipliers:** Real estate companies, private individuals, and banks contact as multipliers of EPCs: Want that customers can make informed decisions, fulfilling legal requirements, use the EPCs marketing tool
- **Financers of energy efficiency measures**: standardization of EPC calculation methods and inclusion of econometric parameters: request of cross-border comparability; return of investments
- **Advisors of energy efficiency** (EE)measures: Implementation of EE measure
- **Implementers of energy efficiency measures**: Implementation EE measures, interested in technical data and features of the building

Recommendations

Criteria-set for an adequate EPC

Criteria (EPC should be…)	**Indicator** (level of EPC)	**Recommendation/ Example**	**Need expressed by**	**Need expressed in**
1) Reliable	Competent and objective certifiers (1)	Tighten the requirements for EPC certification; train prospective EPC certifiers	Other stakeholder + end user	BE, AT & GR
	Mandatory site-visits (1)	On-site visits must take place when an EPC is issued	Other stakeholders	DE, FI
	Enforcement and quality monitoring (including site-visits) (1)	e.g. EPCs should be registered with a central institution and the EPC should be controlled after construction including a site-visit	Other stakeholders	AT, DE, GR

2) Comparable a) In the national context	Reduce diversity of experts who is allowed to issue the EPC (1)	Tighten the requirements for EPC certification	Other stakeholders	AT, DE
	Only one version of EPC (1)	No demand-based and consumption-based EPC in parallel	Other stakeholders	DE
	Simpler calculation methods which might deliver inaccurate but comparable results (2)		Other stakeholders	AT, DE
b) In the international context	A standardized EPC version for end users (1, 3)		Other stakeholders	AT
3) Binding (individual) energy rating	Allowing the recognition of the building, (approaching individual situation, (2))	Use a common unit area (which is obviously related to the building area)→ international comparability	End users and other stakeholders	DE
		Normalize energy demand for the building location (weather data)	End users and other stakeholders	DE
4) Understandable for end users	Non-technical information for end users (3)	e.g. no primary energy demand indicator, no annex with technical details	End users, other stakeholders on behalf of end users	Expressed in all participating countries
	Visualization of information (3)	e.g. 3D schematic representation of building components, thermal images	End users, other stakeholders on behalf of end users	Expressed in all participating countries
		Fraction of energy from RES	Other stakeholders and end users	GR, ES
	Communication with experts (3)	Translation of technical information, energy advice	OS on behalf of EU	ES, DE, AT
5) Tangible (useful for end users because it refers to real life)	Customizable EPC (2, 3)	Interpretation of EPC based on user profile (digital solutions)		ES, BE, FI
	Information about real energy consumption (3)	Real-time feedback from BMS, including electricity consumption	End users and other stakeholders	Expressed in all participating countries, but

		of e.g. appliances, heat pump, EVs		opposed by other stakeholders from AT & FI
	Allowing assumptions about running costs (3)	Choice of units (e.g. €/ month or year)	End users	Expressed in all participating countries
	Individual recommendation with cost indications (3)		End users	BE, GR, ES
	Hints on every day behavior to save energy (3)	e.g.: Tips for avoiding overheating in summer such as window ventilation at night and sun protection during the day	End users and other stakeholders	BE, DE, AT, ES, GR
	Reference to context (3)	Benchmarking and reference to targets for different indicators and construction components	End users and other stakeholders	FI, DE, BE, AT
6) Comprehensive regarding information	Considering the climatic and technical developments and regulative changes: additional indicators needed (3) → basis to relate EPC with other policy tools	e.g. innovative technologies, solar gains, air quality, RES, life-cycle analysis indicators, CO_2 emissions, air quality, electricity generation/demand (PV systems, EV) (3)	Other stakeholders, the latter: other stakeholders and end users	Expressed in all participating countries
7) Adequate	Regarding the original purpose (1)	Comparability of EE of buildings should be priority	Other stakeholders	AT
	For the target group (3)	Content, language & length should be adequate) → Split the EPC (3), reduce content for EU	Other stakeholders	FI, AT, ES
8) Dynamic	Regarding various aspects: energy rating, user behavior, changing information, recommendations (3)	Interpretation of EPC based on benchmarking/targets and user profile, information about technologies and prices, staged and deep renovations → digital solutions (3)	End users and other stakeholders	Expressed in all participating countries

End user: make the EPC transparent and link the EPC energy values to monetary values

D^2EPC
D^2EPC (Dynamic Digital Energy Performance Certificates) aims to set the grounds for the next generation of dynamic Energy Performance Certificates (EPCs) for buildings. The proposed framework sets its foundations on the smart-readiness level of the buildings and the corresponding data collection infrastructure and management systems. It is fed by operational data and adopts the 'digital twin' concept to advance Building Information Modelling, calculate a novel set of energy, environmental, financial, and human comfort/ wellbeing indicators, and through them the EPC classification of the building in question This report on "Next-generation EPC's user and stakeholder requirements & market needs" [16] aims to identify current drawbacks of EPCs and future trends of the market and relevant stakeholders. The results of this research are anticipated to identify the needs and requirements for the successful implementation of next generation EPCs. The report followed two types of methodologies including desk research and field research. The desk research committed as a set of statements with questions relevant to challenging matters of (i), Efficiency of EPC methodologies, (ii) Potential EPC methodologies to overcome past drawbacks (iii) Efficiency of EPC data collection tools and procedures (iv), penalties and sanctions currently in force for EPC non-compliance (v) current EPC databases and access. The statements were answered with as a set of questions relevant to current and future challenging matters of EPCs. Concerning the field research, the circulation of two types of questionnaires was conducted according to the 'Stakeholder identification and prioritization' section to a list of stakeholders. The purpose of the field research was to identify current drawbacks and future trends of EPCs from the end-users and technical stakeholder's perspective. The results of both desk and field research resulted to a set of challenges and recommendations for the next generation EPCs.
Needs and expectations
List of user requirements: • The language used on the EPC must be simplified for easier understanding by an ordinary user. • Information on a building's energy efficiency, comfort, and cost savings, will impact the usability of EPCs as well as purchasing and rental decisions. • Valuable guidance for energy renovation measures is needed. • Security surrounding the use of IoT devices, sensors and building management systems. • Protection of sensitive data when sharing energy related data with third parties. • Exclusion of exact building location, i.e., only postcode, and personal data in a public database. • Incentives for installing smart building technologies for housing companies, real estate agencies and users, especially those who are not owners of the building. • Users value receiving information on the actual performance of their buildings via a real time platform.

- Provision of Comfort indicators including thermal conditions, air quality, visual and acoustic comfort.
- Provision of environmental related indicators
- There is a need to further educate and inform people about the advantages of smart technologies especially for older age groups.
- Introduction of smart readiness indicators (SRI) in EPCs. Users will be informed on the ability of buildings to process information and communication technologies and electronic systems and to adjust building operation to needs of occupants and the grid.
- Monetary indicators of the whole life cycle cost of heating, cooling, lighting, and appliances.
- Visualization of generated EPCs in a GIS environment, empowering users to perform various types of spatial and attribute queries. information about financial grant
- User control of different building aspects especially indoor thermal comfort conditions, indoor air quality and building system's energy efficiency.
- The use of a combination of graphical and text representation of information
- Information on estimated return of investments, cost of renovation measures, the impact of renovation options on thermal comfort conditions and information related to the maintenance and operational cost of renovation measures.
- Available financing options presented with a brief description, application instructions or contact information, or a combination of any of these representations.
- The preferred frequency of building energy class indication ranges from annually, quarterly, monthly and upon request, with annually being the most preferred option.

List of technical requirements:

- Capability of assessing individual apartments in multi-storey buildings.
- Defined input values for new technologies and systems.
- Easy-to-use collection tools that recognize more building characters.
- Complementary energy audit for existing and renovated buildings, and to assess energy performance of non-standard building use.
- Energy consumption of lighting systems, electrical appliances calculated by use of actual (non-default) values
- Internal gains calculated by appropriate means, e.g., solar gains.
- Dynamic energy consumption databases for operational rating.
- Data from utility providers or public authorities.
- Use of both asset and operational methodologies
- Reduced delays by incorrect project documentation.
- Legislative frameworks that advance prior regulations.
- User-friendly EPC data, consultation with EPC owner and an increased certification cost.
- Both building operators and owners informed about savings and efficiency.
- Authorization of further processing of user owned consumption data.
- Prioritization of quality checks linked to user behavior and more onsite inspections.
- Through national EPC databases and a pan-European EPC database.

- Adaptation of data model to include input data, comfort indicators, statistics of building and technical characteristics, system fuel types, accompanying actual energy consumption and renovation dates and details where applicable.
- Categorization by building profile and number of occupants.
- Digital links to other databases
- Polluter pay penalties for both user and the building designer after verification using a comparison tool to assess real consumption against the EPC.

Through policy that registers energy data per VAT number, region, and energy use.

Recommendations

- Establishment of an **operational dynamic EPC** issued on a regular basis.
- Establishment of **EU standards on the classification requirements of buildings**.
- Establishment of **novel set of indicators covering environmental, financial, human comfort and technical aspects of new and existing buildings**.
- The issuance of **EPCs based on real-time data and advanced BEPS tools integrated into BIM**.
- The **integration of smart readiness indicators into the building's energy performance assessment and certification.**
- **Intelligent operational digital platform for dynamic EPCs issuance and real-time building performance monitoring and improvement.**

QualDeEPC

The QualDeEPC project aims to enhance the quality and cross-EU convergence of Energy Performance Certificate (EPC) schemes, and the link between EPCs and deep renovation.
QualDeEPC will work on EU-wide convergence of the building assessment and the issuance, design, and use of quality-enhanced EPCs as well as their recommendations for building renovation. The aim is to make these recommendations coherent with deep energy renovation towards a nearly-zero energy building stock by 2050.

Deliverable D2.3 of QualDeEPC project [17] analyses the gaps and shortcomings in the current EPC schemes in the QualDeEPC country partners (Germany, Bulgaria, Greece, Sweden, Hungary, Latvia, Spain) and national priority approaches to their resolution. Improving the recommendations on energy renovation that have to be included in the EPCs along with actions to use these recommendations in marketing of deep renovation to investors, but also improving the user-friendliness of the EPCs and other actions to improve their use in building markets were seen as priorities in most countries.

Needs and expectations

The collected gaps/needs are organized in five categories: 1. Assessment and certification, 2. Requirements for qualified experts, 3. Independent control systems, 4. Use of EPC data, 5. Embedding EPCs in wider policies and public activities to stimulate deep renovation.
Assessment and certification:

- Online tool for comparing EPC recommendations to deep energy renovation recommendations
- To include default values or validity ranges for input parameters in EPC software
- On-site inspection during EPC assessment
- Improving the renovation recommendations towards deep renovation
- High user-friendliness of the EPC

Requirements for qualified experts

- Regular mandatory EPC assessor training on assessment and recommendation required for certification and registry
- Regular events and workshops on innovative solutions for deep renovation

Independent control systems

- Quality control of both EPCs and assessors
- Performing automatic validity check of EPC assessments
- Reporting of errors in EPC assessments, from controls, for learning
- Deeper control and monitoring of implementation of renovation recommendations

Use of EPC data

- Controlling and enforcing the mandatory use of EPCs in real estate advertisements
- Linking EPC database to other buildings or energy-related databases
- Guidelines for use of EPCs in advertisements of sales/rentals of buildings/dwellings

Embedding EPCs in wider policies and public activities to stimulate deep renovation

- Monitoring the implementation of recommendations given in the EPCs

Recommendations

- To have a deeper control and monitoring (a set-up of quality control scheme) of whether building owners implemented the energy efficiency actions suggested in EPC, especially for public buildings; easy if EPC is linked with financial incentive/financing schemes, or if recommendations are stored in an EPC database.
- Improve the renovation recommendations provided on the EPC so that they become the first step towards individual buildings deep renovation passports/roadmaps. Assessment software tools should provide such high-energy efficiency options in high quality as their output for the renovation recommendations. **The first pages of the EPC should present an overview of such recommendations and (if possible) energy savings, together with links for further information and financial support.**
- Make available **an online tool that compares energy consumption and recommendations** as per EPC with market average/typical buildings; with specific deep energy renovation recommendations, which are consistent with typical elements of an individual deep renovation passport/roadmap.
- Creating Deep **Renovation Network Platforms providing one-stop-shops for deep renovation linked to EPCs**, including administrative, energy advice, financial, and supply-side information to building owners, with active marketing of deep renovation and EPC, and coordinating supply-side actors and supporting their marketing, training, and quality.

- **Improve user-friendliness of various aspects of EPC, such as energy consumption, presentation of rating and recommendations, potential energy (and cost) savings and other benefits.**
- **Improve the involvement of building owners during EPC assessment**; foresee on-site inspections and interview/consultation with the owner.
- **In Assessment Software include practical default values for input data that come close enough to real data of a building, or in other cases, rather than exact default values, certain validity ranges for input parameters.**
- Performing automatic validity/quality check during assessment and/or during upload to EPC database for all EPCs, e.g., through automatic online register to fill in the EPC characteristics and an integrated tool checking these common elements.
- **Performing quality control of both EPCs (random sample – compliance with overall quality criteria) and EPC assessors by an authorised public body**.
- **Reporting errors or faulty procedures in a central database to create statistics of common mistakes for training purposes and identify assessors with high error rates.**
- Regular mandatory EPC assessor training on EPC assessment and on renovation recommendations required for certification and inclusion in registry. Such **training should also enable them to avoid common mistakes.**
- Organisation by the national EPC body of r**egular events and workshops presenting innovative solutions for deep renovation and implementing more intelligent and advanced energy measures.**
- **Linking EPC database to other buildings- or energy-related databases**
- **Energy agencies/public authorities have to produce and update guidelines for use of EPCs in advertisements of sales/rentals of buildings/dwellings, issued by, either for voluntary or mandatory use.**
- Effectively controlling and enforcing the legal requirement to present EPC or at least the EPC rating and value in advertisements of sales/rentals of buildings/dwellings.

U-Cert

The main aim of U-Cert (user-centred energy performance assessment and certification) project is to introduce a next generation of user-centred Energy Performance Assessment and Certification Scheme to value buildings in a holistic and cost-effective manner. U-CERT has a focus on strengthening actual implementation of the EPBD by providing and applying insights from a user perspective and creating a level playing field for sharing implementation experience to all involved stakeholders, facilitated, and empowered by the EPB Center.

The D2.3 report [18] focuses on finding common threads across the scope of EPC profiles and stakeholder groups in search of expectations, needs and suggestions for improved design or improved user-centred contents for future EPCs. The research involved participants from U-Cert partners countries (BG, DK, EE, ES, FR, HU, IT, NL, RO, SE, SI). Some common aspects that emerged from the survey concern:

- Notions of trust, reliability, awareness, and knowledge are central to perceptions of existing EPCs. People often tend to avoid action related to investments and improvements of their property for a variety of reasons, including aversion to change, costs and disruption of life, lack of knowledge and interest, lack of insight into benefits and opportunities, distrust towards key stakeholders involved in the certification process etc.
- Quality control over the method, work of EPC issuers, and overall compliance with existing regulation in the construction sector has been reported as one of the principal weaknesses of the existing EPC systems.
- Education of EPC issuers and their professional performance, particularly in their interaction with clients, have often been reported as one of the principal weaknesses of existing EPC schemes. As such, these aspects must be seen as important factors regarding perceived quality of EPC schemes, and furthermore, as an integral part of EPC product and services.

Needs and expectations

Main gaps identified by the research's participants are the following:

- Ineffective public policies. Public policies often fail to drive demand for EPC services, making it hard for the market to properly develop.
- Lack of motivation and interest on the side of experts in construction and renovation. Architects and designers are reportedly often not interested and/or motivated to integrate energy efficiency as a priority in their work.
- Lack of reliable information. Not enough information is reaching the end users and investors to drive/create demand for specialized (EPC related) services. In part this is due to passive market players – brokers, sellers, experts in construction and renovation – who fail to promote such services. Similarly, there is no sufficient information from the side of public authorities regarding the need and benefits to have or consult an EPC.
- Fragmentation of construction and renovation sector. The construction and renovation sector are fragmented. Individual suppliers of products and/or services are concentrated on their own business success and not on development of working concepts or pursuing collective goals.
- Lack of financial incentives. Current support from banks and other financial institutions for implementation of EPC goals is insufficient, even for financial products based on the European programmes or policies
- Education of EPC issuers and their professional performance, particularly in their interaction with clients, have often been reported as one of the principal weaknesses of existing EPC schemes. As such, these aspects must be seen as important factors regarding perceived quality of EPC schemes, and furthermore, as an integral part of EPC product and services.

Recommendations

- **Access to systematic (public) funding for energy efficiency measures** has been pointed out, particularly on the institutional levels, as a key driver of demand for EPC products and services.
- Developers and implementers of **future EPCs should strive for positive publicity and invest in strategies to raise general awareness** about Energy performance of buildings and the specific role of EPCs in this context. This includes aspects of knowledge transfer, educational contents, promotion, and marketing, all affecting the general public attitudes and opinions regarding the EPC products and services and the underlying policies.

- To enhance the impact of the EPCs on Energy performance of buildings, the certification schemes should evolve to **communicate efficiently key aspects of** human-building interaction in relation to energy performance. They have to provide better content and utilities to the users – including indicators of IEQ, meaningful financial indicators, meaningful improvement measures and renovation guidelines, easy access to expert services etc. – as well as the design of both the **product (the EPCs) and services (the certification process) to make them more interactive, people-friendly, and comprehensive.**
- Promote and campaign: **Set up a promotion and/or marketing strategy** - Launch national (marketing and promotional) campaigns to demonstrate the importance of EPC. Engage mainstream media in the campaign. The aim would be to raise people's awareness on the energy efficiency of their buildings, and for which the EPC could be the tool.
- **Digitalization and automation** are considered to be an important part of the EPC future. Everything that can be digitized and automated should be done. Use of resources should be shifted from the making of the EPCs to consultancy (with regards to securing an optimal output with regards to energy efficiency measures).
- Provide exclusive benefits. Based on as reference points for (successful) investments in energy efficiency, owners who invest in renovation of their property should be given exclusive benefits, such as tax cuts or comparable.

X-tendo
X-tendo (eXTENDing the energy performance assessment and certification schemes via a mOdular approach) aims to support public authorities in the transition towards improved compliance, reliability, usability and convergence of next-generation energy performance assessment and certification of buildings. X-tendo will thus develop a modular toolbox that covers different features of innovative indicators as well as innovative data handling approaches. The analysis presented in this paper [19] was carried out in the frame of the X-tendo project (X-tendo, 2019), which is developing a framework of ten "next-generation EPC features" aiming to improve compliance, usability, and reliability of EPCs. The main objective of this paper is to study the end-users needs and expectations towards the future EPCs through a survey conducted in five European countries (Denmark, Greece, Portugal Poland, and Romania). The X-tendo 10 developed features are (i) smart readiness indicator, (ii) indoor comfort, (iii) outdoor air pollution, (iv) real energy consumption, (v) district energy, (vi) EPC databases, (vii) building logbook, (viii) enhanced recommendations, (ix) financing options, and (x) one-stop-shops. The consumer survey was conducted in April 2020 using online interviewing methodology. A total of 2563 end-users took part in the survey. The target group of the survey were homeowners, landlords and tenants. The focus of the survey was on a very specific audience of people who have bought, rented, sold, let, or renovated property in the past five years.
Needs and expectations
• different frameworks and methodologies exist in the EU; there are also regional differences in some countries

- aspects like indoor environmental quality and smart data usage are not covered in EPCs
- the introduction of new indicators is limited despite the obvious potential of EPCs
- EPC scheme does not enjoy great popularity
- the acceptance of EPCs by the public is very much dependent on the perception, willingness to use, and interest of end-users in EU member states
- EPCs have shown limited use to homeowners

Recommendations

- EPCs **must provide an improved and more reliable service tailored to the end-users**
- inclusion of new EPC indicators within the following:
  - **five technical features: smart readiness, comfort, outdoor air pollution, real energy consumption and district energy,** and
  - **five innovative features to handle EPC data: EPC databases, building logbook, enhanced recommendations, financing options, and one-stop-shops**
- EPCs should support local authorities, real estate agencies and research activities
- **using EPCs to monitor and evaluate policies and develop more impactful future policies**
- EPCs should become instrument in overcoming the **challenges of decarbonisation**, deep renovation, access to finance, tailored advice, healthy buildings, real estate prices, future energy conservation and sustainability as a whole
- EPCs should contain information on the presence of **smart technology,** because smart technology helps to save energy and increase comfort
- EPCs should contain information on **comfort** (e.g., good outdoor air quality, thermal and ventilation comfort, visual comfort, no noise nuisance - acoustic comfort) and outdoor air pollution
- **a monthly overview of energy consumption of each applianc**e in the household is helpful to better manage energy usage
- EPCs should contain information on the **energy use and costs** of previous occupants, i.e., related to their own home
- homeowners want tailored information on how to **reduce energy usage based on real energy consumption**
- **real-time energy use via smart meter** helps to better manage energy usage
- EPCs should contain information on the distance of building to the existing district heating grid and on the current and estimated future efficiency CO2 emissions and share of renewables in the closest district heating system
- EPCs should contain information on **energy performance score of similar buildings** nearby
- the presence of **building logbook** is very important for those who are buying/renting property, or for building owners and tenants that are conscious about their energy use
- **building logbook should contain the following information: property's condition especially condition of walls and roofs, window glazing and insulation, the equipment age, maintenance activities, the contact**

details of previous contractors and transaction prices, renovation activities completed up to date • EPCs should contain information on previous energy renovations, on available measures and relevant recommendations - cost related information for each renovation measures would be most useful • EPCs should contain information on financial support for the end-users, on how to access different financing options for renovations • **one stop shop for renovation-related questions: calculations, advice and price quotes for renovation measures, estimation of future (energy) cost savings from renovation measures**

Building Energy Performance Certificates for the people (Webinar)
In order to understand what people (experts and general users) really think about the EPCs, experts and researchers from BEUC, the European Consumer Organisation, and seven Horizon 2020 sister projects of the Next Generation EPCertificates cluster came together in this web workshop to share their knowledge [20]. This event came to crown two months of prior exchange of insights and experience as an attempt to make a collective step towards people centred EPCs. Previously, focus groups have been organized in 12 European countries (Bulgaria, Denmark, Estonia, Spain, France, Hungary, Italy, Netherlands, Romania, Slovenia, and Sweden), involving a total of 88 EPCs experts and 103 general users. The questions for the experts panel were related to how to improve the EPCs quality and to make them more useful for the people and more user-friendly, while the questions for the general users panel were about their experience and their opinions about the EPCs.
Needs and expectations
The results obtained showed that, even if in theory the EPC is seen as a useful tool with a great potential, in practice it is perceived as “expert biased” and very difficult to be understood by general users and as an administrative necessity more than a reliable tool.
Recommendations
EPCs should be meaningful in the everyday life, having an impact on the choices linked to energy use, being more intuitive, including stress aspect such as health, safety, well-being, etc. and enabling a facilitated a systematic learning progression of users. They should be more digitalized and should improve the user’s experience thought a more attractive and easy-to-use design adjusted to different publics and reducing the complexity of data contextualization. Also, the quality of certification services should be improved. They should stimulate an efficient coordination and collaboration between the key stakeholders. They should be a strong public awareness support, using positive promotion and publicity and should have a more practical real-life value being a starting point (roadmap) of maintenance and renovation and suggesting scenarios for typical user profiles, case-specific improvement measures and reliable estimation of resources and impacts.

In the following, research articles complement the analyses carried out by the EUB SuperHub sister's projects.

Commission guidance on how to implement revised EPBD provisions on building renovation
Commission guidance on how to implement revised EPBD provisions on building renovation [21] (written on December 2021, after the 8-10 December 2021 CA EPBD plenary meeting) Aiming to ensure a uniform understanding across Member States in the preparation of their transposition measures and effective implementation of the amended Energy Performance of Buildings Directive (EPBD), the European Commission published Recommendations on how EU countries should implement the revised EPBD building renovation provisions into national law.
Needs and expectations
Together with the proposals presented on 14 July, the revised Energy Performance of Buildings Directive supports the development of renewable and less polluting energy systems for our homes and public buildings. They will: • decrease emissions • save energy • tackle energy poverty • facilitate renovation • improve quality of life • generate jobs and growth
Recommendations
Key proposals for homes and buildings: • The revised Energy Performance of Buildings Directive will facilitate and increase building renovation, modernising and decarbonising the EU's building stock. It is an essential part of delivering on the Renovation Wave strategy. • The new Effort Sharing Regulation sets emission reduction targets for all Member States by 2030 for sectors including buildings. • The revised Energy Efficiency Directive and Renewable Energy Directive will make buildings more energy efficient and boost the use of renewable energy in buildings. • Emissions Trading for building fuels will speed up emissions reductions and stimulate investments in renewables and energy efficiency. • The new Social Climate Fund, funded by revenues from emissions trading in road transport and buildings, will provide financial support to citizens, in particular the vulnerable households, to invest in renovation or heating systems and ensure a fair transition.

Territorial Assessment CESBA Alps
CESBA stands for Common European Sustainable Building Assessment and represents a bottom-up initiative towards promoting a harmonization of sustainable building assessment throughout Europe. Its objective is to facilitate the development and implementation of policies and strategies at territorial level based on common assessment tools. Focus of the tools is the relation between the **built environment** and low carbon sustainable territories [22]

In January 2022, Territorial Assessment CESBA Alps wrote recommendations for Decision Makers [23].

As most of the 12 partners were territorial actors, the recommendations made in this bibliography are considered as those of public territorial actors.
Although the recommendations provided are broader than those for the building, they provide an overview of the KPIs identified at the territorial level. A level which may include a variety of buildings as a "built environment".

Needs and expectations

Recommendations

The testing results of the KPIs in the nine regional entities showed that the proposed KPIs should be kept, even though some of them could not be properly calculated so far or had to be modified. In the end, the project partners agreed on a list of 18 mandatory and 11 recommended KPIs. **All KPIs are part of the territorial performance assessment module. Territory and Environment, Energy / Resources, Infrastructure / Service, Society, Economy, Mandatory KPIs**

Mandatory KPIs

Issue	Category	Criterion
Territ. and environment	Land	A1.6: CO2 sequestration through bio-sequestration
	Water quality	A2.4: Good ecological status: surface water bodies
	Water quality	A2.7: Good ground water body chemical status: groundwaters
	Nature/biodiv.	A3.1: Green infrastructure
	Landscape	A4.6: Protected natural heritages
	Landscape	A4.7: Protected cultural heritages
	Waste	A5.6: Recycled share of produced waste
	Emissions	A8.1: Greenhouse gas emissions
	Quality of air	A9.1: Exposure to air pollution
Energy/resources	Energy consumption	B1.1: Final energy consumption
	Energy consumption	B1.8: Primary energy consumption
	Energy consumption	B1.20: Degree of renewable energy consumed
	Water consumption	B3.1: Consumption of water
	Land/building stock	B4.6: Intensity of land use
Infrastructures/Service	Mobility	C1.11: Modal split of public transport
Society	Socio-economic aspects	D2.3: Poverty and social exclusion
	Socio-economic aspects	D2.19 Occupation by gender
	Socio-economic aspects	D2.20 Gross income
Economy	Agriculture	E4.2 Organic farming

Recommended KPIs

Issue	Category	Criterion
Territ. and environment	Exposure to noise	A12.1 Exposure of households to noise
Energy/resources	Land/build. stock	B4.1 Efficiency in the use of existing residential buildings
	Land/build. stock	B4.2 Efficiency in the use of existing non-residential buildings
	Land/build. stock	B4.16 Recycled share of construction waste
Infrastructures/Service	Mobility	C1.2 Performance of the public transport
Society	Demography	D1.1 Population balance
	Demography	D2.27 Employment rate (15-64 year olds)
	Demography	D2.29 Design for all
	Local Economy	E1.17 Assessed sustainable standard
Economy	Tourism	E3.16 Sustainable tourism

Review of building energy performance certification schemes towards future improvement
The next generation EPC should rely on BIM technology, benefit from big data techniques, and use building smart-readiness indicators to create a more reliable, affordable, comprehensive and customer-tailored instrument, which could better represent energy efficiency, together with occupants' perceived comfort, and air quality [24].
Needs and expectations
• EPC do not indicate specific parameters regarding thermal comfort and air quality, which are recognized to be the most important indicators to homeowners, • make the EPC more useful, less administrative burden, • Integrate more indicators that are important to improve the quality of life and wellbeing, • Improve reliability and credibility of EPC, • Improve occupant's behaviour, awareness and understanding, • EPC were too complicated and technical for consumers to understand, • Renovation recommendation are vague guide for potential improvements
Recommendations
• Create BIM based EPCs, • Include comfort and wellbeing indicators (Air, thermal, acoustic, etc), • Create a user-friendly EPC data-sharing platform, • Provide additional training for EPC auditors and ensure only officially approved and verified software can be applied for certification, • Include smartness rating for the building, • Provide more tailor-made recommendations for the cost-effective upgrading of the buildings, • Develop clear guidance on the EPC presentation to make the information accessible and to enhance public awareness on energy efficiency.

Stakeholder expectations on sustainability performance measurement and assessment. A systematic literature review
In light of the large and growing number of publications, this one [25] exposes a major practice-research gap. To explore the gap between the flourishing number of publications and the disappointment of stakeholders, this paper analyses how current literature on sustainability performance measurement and assessment addresses stakeholder expectations. The article proposes a framework, distinguishing expectations related to the six stakeholder roles along the sustainability performance measurement and assessment process.
Needs and expectations
• Standard setters (standardization bodies): aim for easy use and operability, while pursuing scientific, complete, robust approach • Process enabler (experts, rating agencies, specialists, and researchers): expect process to be simple, widely usable transparent. Scientific, verifiable, controllable, and to provide regional differences and create marketable results • Impacted stakeholders (consumer): assessment criteria that reflect people's values and that are legitimate and meaningful

- Information providers: appreciate Clear, simple, relevant, and explicit indicators
- Results user: require reliable, Understandable information, which is accountable, desire accurate, complete, comparable. documented, and consistent data
- Decision makers: clear and manageable amount of indicators or even one aggregated, single measure

Recommendations

- **Balance accuracy** (usually preferred by research) as well as simplicity (usually preferred by practice)
- The framework offers insights into which stakeholder roles exist and provides an indicative overview of their expectations. Integrating these expectations might already increase satisfaction
- Public policy and governance, the framework can draw attention of stakeholders to the necessity to consider the needs of addressees and decision makers in the development of SPMA

Energy Performance Certificate for buildings as a strategy for the energy transition: Stakeholder insights on shortcomings

This work [26] investigates how the governance of the performance certification scheme could be improved with the objective of a more robust EPC scheme. Based on a qualitative study through interviews with energy experts the current EPC system in Switzerland is characterized, allowing to understand important limitations. The insights help to shape a list of recommendations for further development of the EPC scheme.

Needs and expectations

- Integration in the design process: EPC is not used to guide the design but is instead prepared only at the end of the design stage to validate the choices made after the architectural work
- The EPC Expert/ Auditor: lack of adequate up-to-date training
- Monitoring: lack of monitoring of the energy consumption after issuing of the certificate as major limitation of the current certification scheme
- Data quality: low input data quality for existing buildings
- Collaboration between stakeholders: new business models may allow to bring together stakeholders who would otherwise not collaborate
- Subsidies and enforcement of the law; insufficient to incentivize the owner to adopt more expensive energy-efficient measures (the repair alone incurs a much lower cost than of its combined installation with the solar thermal system, hence influencing the choice of the owner) even of not legal they prefer lower cost. due to the very high capital cost and the lack of control by the authorities, this often happens

Recommendations

- **It is recommended to integrate the EPC in the design process, starting from the early design stage and using it as a decision-making tool.**
- It is recommended to enforce and update the training of the EPC Expert, including more demanding exams and mandatory follow-up courses.

• It is recommended to allocate more time to the preparation of the EPC, in order to **give the Expert time to thoroughly examine the building and provide solutions that are more energy efficient**. • It is recommended that especially **larger buildings are monitored as pre-condition** for good maintenance, fine-tuning, and repair, whenever required. • It is recommended **to make use of service contracts, e.g., in the form of an Energy Optimization Contract** (for simple tuning of the installation and its monitoring) or of Energy Contracting solutions (energy supply contracting or energy performance contracting) where good operation is in the contractor's own interest. **In other words, the difference between the expected consumption and the achieved once can be minimized by holding all the actors involved accountable** (economically and morally). • **A stronger commitment** is also required from the national and/or local authorities, which can help to reduce energy consumption through more rigorous controls on the compliance with building codes, by means of sanctions in the case of non-compliance

Linking energy efficiency indicators with policy evaluation – A combined top-down and bottom-up analysis of space heating consumption in residential buildings
Focusing on space heating consumption in the residential sectors for Germany and Switzerland. A major aim of this analysis [26] is to show the contribution of energy efficiency policies (such as thermal building regulation, subsidy programmes, fiscal measures etc.) towards the changes in this indicator. The results show that the progress in energy efficiency (both autonomous and policy induced) in both countries had the greatest effect (-776 PJ for Germany, 42 PJ for Switzerland) regarding the change in energy consumption for space heating in the period from 2000 to 2016. However, the impacts of "technical and comfort" rebounds (+436 PJ for Germany, N/A for Switzerland) and other developments such as societal changes (+316 PJ for Germany, +35.5 PJ for Switzerland) were found to compensate for a significant part of the energy efficiency gains.
Needs and expectations
The societal and technical rebound effects have strongly influenced the energy savings in space heating in Germany's residential sector and eroded a large share of the impact potentially achieved by policy induced and autonomous energy efficiency improvements. **Not only rising room temperatures contribute to this overall rebound effect, but also inappropriate operation of the heating system by the resident, overdesign of the heating system** (i.e., heating loads too low), changes in heating from radiators to underfloor heating ("thermal inertia"). Further reasons can be over ventilating by the residents or technological failures (regarding installation of heating systems or insulation or usage)
Recommendations

The European projects listed in this study present extremely detailed recommendations, going so far as to specify various KPIs that should be considered to meet the needs of the various EPC actors.

The scientific articles open the field to recommendations that go beyond the needs expressed such as the concept of offering new services based on energy optimisation or to review the energy saving in the design phase with a sizing more adapted to the use.

2. Identification of stakeholders needs and expectations

The objective of this project's step was to collect stakeholders' feedback about their experiences and expectations on new generation EPCs. This information adds to Task 1.1 results and aims to establish a complete picture of stakeholders' visions and needs related to EPCs. In the next paragraphs, the Task 1.1 results are quickly summarized (par. 2.1), then the interviews' approaches adopted, and the results obtained are described for each project partner (PP) (par. 2.2). The chapter ends with a summary of collected answers (par. 2.3).

2.1 Task 1.1 focus groups' feedback

Within the frame of Task 1.1 "Mapping of EPCs and sustainability certifications, Evaluation of effectiveness and impact on the market", the analysis of the level of trust perceived by stakeholders towards EPCs and Sustainability Certificates and of the role that these certificates play in purchasing decisions was made. The study was carried out on the basis of a series of focus group meetings that was organized in the partners' countries and regions covering a wide array of stakeholders.

The results of the focus group meetings reflected the need to shift the scope of the EPCs from covering energy aspects into a more holistic sustainability certification that looks at buildings from an environmentally and end-user-conscious perspective. The participants also highlighted the fact that existing EPCs lack transparency, which undermines the trust in its credibility. More feedback is given in the lists below.

About the contents of EPCs:

- Observation of a fragmented nature of EPCs and sustainable certifications (SCs) in the EU
- Need to shift from energy to a more holistic view
- EPC is perceived by the end-user as a mandatory paper and not as an added value
- Lack of transparency
- Information not adapted to non-experts
- Preference of a unique national system and some fear for an EU-wide harmonised EPC
- To include in the certificate a one-page summary, something everyone can understand

In order to boost the credibility of EPCs:

- To introduce quality controls (even random) at a regional level to evaluate certificates data
- Need of a proper training of new professionals (including practice)
- Need of certified professionals (it may help having a national/EU register)
- To promote fiscal incentives for building renovation

- Need of pervasive (and cluster tailored) communication campaign to explain benefits of investing in sustainability
- To use calculations closer to the operation systems of the dwellings
- Low-cost of EPCs leads to low-quality results, that undermines credibility
- Sustainability schemes and related certificates have more credibility than EPCs but are complex and too expensive

2.2 Results achieved through interviews

The stakeholders' interviews took place during the 1st national LAT (Local Advisory Team) meetings or within the framework of bilateral meetings organized and animated by project partners.

The contents of the guiding questions asked during these interviews were determined by all the partners during a general meeting. The 6 questions identified are listed in Table 1. Subsequently, each partner adapted the conduct and mode of the interviews to their own context and needs.

In your opinion, have EPCs helped you in your day-to-day work? Has it been successful?
How can we make EPC more attractive/ more useful?
What kind of indicators and information can we include in the EPC, in addition to energy?
To which extent do you think it is necessary to improve the process of EPCs and their quality / credibility, knowing that it could be more expensive?
How do you imagine an EU building passport? What should it look like and how to use it?
Free comments and suggestions

Table 1: Base for the guiding questions identified for the stakeholders' interviews

The stakeholders invited by each country, the interviews methods adopted, and the results obtained are summarized in the following sub-sections.

2.2.1 Austria

Austrian stakeholders' interviews were held partly during their first national LAT meeting, which took place online on December 12th, 2021, and partly by means of bilateral meetings. In the LAT meeting, 4 participants attended, answering 5 questions defined by the interviewers, after a short introduction describing the EUB SuperHub project. These are marked in Table 2 as interviewees 1 to 4. The rest of the interviews (see participants 5 and 6 in Table 2) were bilateral meetings.

Participant's number	Participant's profile
1	Building physicist / Sustainability assessment "Municipal Building Certificate (KGA)" professional
2	Building physicist / Sustainability assessment "Municipal Building Certificate (KGA)" assessor
3	Representative of the association of Vorarlberg municipalities / Sustainability assessment "Municipal Building Certificate (KGA)" professional
4	Vorarlberg government representative / EPC responsible person
5	Baubook database / Building product researcher
6	Environment Manager of a City (> 30 000 inhabitants)

Table 2: Austrian stakeholders' profiles

Some people represent dual roles because they are already developers, companions, or certifiers in our sustainability assessment "Municipal Building Certificate (KGA)".

The following are the questions asked to the 6 participants, formulated a bit differently compared to the list of Table 1:

1. How can we make energy performance certificates better?
2. How do you imagine an EU building passport?
3. Can you imagine a central administration of European building passports?
4. How would you use it?
5. What should it be able to do?

Austrian stakeholders' collected answers

Regarding the needs for the next generation EPCs, the wishes of the local authorities differ greatly from those of the energy certificate calculators.

How can we make energy performance certificates better?

The Government representative (participant 4) really appreciates current EPCs and emphasizes the fact that, as the EPC's energy demand is calculated using standardized average user profiles, it is perfect for defining user-independent requirements and for the optimization of renovation concepts, which are based on the expected profile of future users (for example, the number of expected occupants has a high influence on the expected domestic hot water heat demand and thus on the economic efficiency of different solution options during a refurbishment). In addition, the target group-oriented presentation of results is easy to understand in case of sale/rental and optimized for consulting in case of thermal renovation measures. The EPCs, for him, are supportive of building authorities and funding agencies in terms of simple and harmonious assessment as well as quick processing.

One of the building physicists (participant number 1), on the other hand, criticizes the fact that currently nine out of ten building services concepts cannot be correctly represented in the energy certificate, since the methodological approaches for a realistic forecast of energy efficiency (can) deviate from the methodological requirements for the building code requirements. To link to their previous answer, building physicist 1, who also accompanies the processes in the KGA, says that they would like to see a presentation of the "realistic" building performance and the building code verification with a comparability of the building in one tool.

The other participants added that they would like to find in EPCs:

- A calculation method where the calculator cannot choose between simplified calculation with default values and detailed input. In his opinion, there would then be fewer possibilities to influence the result and the calculations would be more comparable and legally secure.
- A central and unambiguous key figure, which the user can compare with his meter reading (electricity, gas meter). The other key figures should fade into the background for the user. The benefit for tenants, buyers, and owners should be strengthened.
- A real digital energy certificate, whose data could be used for further calculations, e.g., for a refurbishment.
- A representation in the building assessment that shows the degree of target fulfilment. This target fulfilment would be differently easy to achieve depending on the region and different climates. For example, a building in Southern regions easily achieves a low heating demand but has difficulties solving the summer case with little energy.

In addition, the fact that EPCs are not trade law requirements, enables the issuance of energy performance certificates to a broad field without further training measures even if well-trained assessors should be essential for the high quality of this certification. Another problem linked to the fact that it is not mandatory is its high cost. For participant 3, the costs and effort of the evaluation system must remain in good proportion. It should be possible to certify buildings with a justifiable effort from approx. 1 million construction costs in order to be effective on a broad scale.

How do you imagine an EU building passport?

For most participants, an EU building passport will be a common tool supported by technically sound EN standards, able to link different values for good performance with different climates using region-specific harmonized conversion factors.

Can you imagine a central administration of European building passports?

While for participants 1, 2, 3, and 4, it is possible to use one energy certificate all over Europe, the managing director of the baubook platform and product researcher (participant 5) considers it useful to highlight the status quo and the challenges of

the European non-harmonization in the field of energy performance certificates and life cycle assessment in the building sector and possible ways towards harmonization.

For her, there are currently two basic approaches to life cycle assessment throughout Europe: the horizontal standards of CEN/TC 350 Sustainability of Buildings and the Product Environmental Footprint (PEF) developed by the European Commission. The two approaches have been harmonized regarding the indicators to be reported and the underlying impact assessment methods, but still differ in methodological details.

In the building sector, the horizontal standards of CEN/TC 350 (i.e. General product categorization rules for the preparation of environmental product declarations (EPDs) of building products) and EN 15978 (Calculation method for the assessment of the environmental quality of buildings) have been more widespread so far. Both standards are not specified in such a way that uniform LCA rules result from them. The LCA rules are applied nationally or even EPD-specifically and thus the results in the indicator values differ considerably as a result.

As for her, there is no harmonized European approach either to energy performance certificates or to life cycle assessment in the building sector, the goal of installing a Europe-wide tool is therefore doomed to failure from the outset.

How would you use it?

If there were a European digital energy certificate, the data could be used for further calculations. For example, a GIS representation of an entire neighbourhood/city with integrated renovation could be done, to increase the renovation rates through a comparative representation of existing buildings. A representation that makes it possible to link energy producers and energy consumers in order to show solutions of e.g., district heating networks, would also be interesting.

But there can be problems as to who should commission and pay for the calculations. In addition, it is questionable in what form energy certificate manufacturers will be willing to make the data collection, which involves a lot of effort, available to the general public (for example, owners of non-refurbished buildings have no incentive to show their building in comparison). It must also be clarified who will assume liability for the correctness of the data of existing buildings, since there are generally uncertainties, especially in the case of component structures.

What should it be able to do?

In addition to energy, for the Government representative, the climate impact of the building materials and technical equipment used, both for initial installation and for cyclical maintenance and renewal should be included in the European building passports. In a further step, it would also be desirable to have an indicator that provides information on the further usability after the end of the utilization phase (cradle to cradle). This assessment should also include components outside the

conditioned building envelope - at least in a simplified form (a possible underground parking garage, for example, via the number of parking spaces). In the sense of best possible information, indicators can help clarify essential spatial planning aspects that have a high impact on infrastructure costs (land development, etc.) and a high impact on mobility behaviour (connection to public transport).

Any SRI should also include an assessment of grid efficiency. It is important that the SRI does not overestimate the impact of smart home regulations in relation to their ability to save energy. In the worst case, the SRI would contribute to the fact that mostly limited available funds flow into short-lived electronic gimmicks instead of being able to have a long-term effect in an energy-efficient building envelope/building technology.

The representative of the association of municipalities adds that the system could be adapted to regionally available building materials. A high rating would be given if regionally available building materials are predominantly used. He also mentions the criteria of climate change adaptation.

2.2.2 Croatia

Croatian stakeholders' interviews were held during their first national LAT meeting, which took place online with 15 participants (most professionals and a few non-experts). During this session, an online survey was conducted with the main aim to collect feedback about the needs and expectations of public institutions and market actors in relation to a next-generation EPC.

After a short introduction describing the EPBD, the Energy Certification process in Croatia and the EUB SuperHub project, a link to an online survey prepared using Google Forms was forwarded through chat to the LAT members. The prepared online survey covers the following two topics:

Current building certification process in Croatia (10 questions)

1. Are you satisfied with the current building certification process in Croatia?
2. Explain your answer to the previous question?
3. To which degree do you trust the calculated energy values (useful, delivered, and primary energy) presented in your national EPC? Explain your answer?
4. Which rating method would you find it more trustworthy (asset ratings or operational ratings)?
5. Explain your answer to the previous question?
6. Would an EU wide unified EPC be more or less trustworthy than a national one?

7. In your opinion, what are the key success aspects for using EPCs in Croatia?
8. In your opinion, what are the key barriers for using EPCs in Croatia?
9. How can we make the existing energy certificate in Croatia MORE USEFUL? What is missing in the existing energy certificates in Croatia? What else could / should we add to the existing energy certificate in Croatia (apart from energy and CO_2emissions)?
10. What data, currently listed in the existing energy certificate in Croatia, should be changed and how?

Future building certification process in Croatia (2 questions)

11. What should be considered in the next-generation EPC to make the energy certificate more useful?
12. Based on your needs, describe how you imagine the next-generation EPC? What should the next-generation EPC comprise? How do you imagine the next-generation EPC?

There were in total 12 questions related solely to the building certification process, current, and future.

The total duration of the online survey was 20 minutes, but it was possible to fill out and send the survey later. The facilitators decided to conduct solely an online survey and not to discuss with all of LAT members at once about their needs and expectations in relation to a next-generation EPC, to avoid the situation where some members are influenced by other members' opinions.

Participant's number	Participant's profile
1	National policy maker
2	National policy maker
3	Public authority
4	Financial institution
5	Real estate agency
6	Energy assessor
7	Building manager
8	Energy assessor
9	Energy assessor
10	Sustainability assessor
11	Energy assessor

Participant's number	Participant's profile
12	Energy assessor
13	Private building owner
14	Private building owner
15	Private building owner

Table 3: Croatian stakeholders' profiles

Croatian stakeholders' collected answers

1. Are you satisfied with the current building certification process in Croatia (Yes, No, or Partly)?

Only two of fifteen LAT members are satisfied with the current building certification process in Croatia. One member is an energy assessor and another one is a private building owner with no real knowledge about the whole building certification process in Croatia.

2.Explain your answer to the previous question?

No:

- Because there is too much work for too low price, and due to usefulness of EPCs,
- Because there is no actual energy consumption data,
- Because the whole building certification in Croatia is too complicated,
- Some energy assessors do not have required expertise,
- Some building owners say that they just need that "paper" and won't pay a lot for that "piece of paper",
- Because quality control rate is too low,

Yes:

- The building certification process in Croatia is well established, with intensified quality control, better EPC quality can be achieved,

Partly:

- Due to inconsistency in EPC quality,
- There are no penalties for non-compliance with the legal obligation of issuing an EPC, penalties are prescribed with the building act (Official Gazette 153/13, 20/17, 39/19, 125/19) but no one checks that.

3. To which degree do you trust the calculated energy values (useful, delivered, and primary energy) presented in your national EPC? Explain your answer?

- Low trust due to poor calculation quality and poor calculation methodology,
- High trust to approximately 50 % of EPC based on experience gathered during EPC quality control,
- Trust to my calculations and the calculations of my colleagues, but not to the calculation of most energy assessors in Croatia,

- Partly trust due to differences in calculation results caused by using different software tools,
- Low trust based on the experience gathered through insight into already issued EPCs in Croatia,
- High trust because the topic is too important in the case of building renovations.

4. Which rating method would you find it more trustworthy (asset ratings or operational ratings)?

40 % of interviewed members (six of fifteen) find asset ratings more trustworthy, while 47 % (seven of fifteen) find operational ratings more trustworthy. Two non-experts stated that they do not know because they are not experts in this field.

5. Explain your answer to the previous question?

Asset rating:

- Because measured actual energy consumption is the result of the way building and technical building system are used, and not a property of the building,
- Unified method of determining building energy label is the best, buildings are comparable,
- Asset rating is certainly not the best rating method, but operational rating as a rating method is certainly even worse, because operational ratings describe the habits of end users or sometimes energy poverty, and not the quality of the building,
- In a long-time span of approx. 5-10 years, a large fluctuation of the population within the building is possible, so measuring the actual consumption does not have to give a realistic picture of the condition of the building.

Operational rating:

- Because actual energy consumption is the only relevant data that end users (building owners) take into account,
- The calculation based on actual energy consumption is more realistic but at the same time less comparable,
- The actual energy consumption is more relevant and accurate than calculated.

6. Would an EU wide unified EPC be more or less trustworthy than a national one?

33 % of interviewed members think that an EU wide unified EPC would be more trustworthy than a national one, while 67 % (ten of fifteen) think an EU wide unified EPC and current EPC in Croatia would be equally trustworthy.
No one thinks that an EU-wide unified EPC would be less trustworthy than a national one.

7. In your opinion, what are the key success aspects for using EPCs in Croatia?

The key success aspects for using EPCs in Croatia are:

- Simplicity (e.g., EPC design should look like the label for home appliances, providing more useful and meaningful information),
- Comprehensibility,
- Comparability,
- Credibility,
- Data accuracy,
- Data reliability,
- Incentives to promote savings and reduce consumption,
- Continuous training and education of energy assessors,
- Training of investors, and all actors within the construction chain,
- Informing the public about EPC and the whole process of building energy certification,
- Education of citizens/building owners,
- More accessible information for all citizens/building owners on energy saving potentials with emphasis on possible energy efficiency measures and step-by-step renovation plans,
- Insight into construction quality.

8. In your opinion, what are the key barriers in using EPCs in Croatia?

The key barriers in using EPCs in Croatia are:

- Usefulness of the EPCs,
- Questionable quality of EPCs – distrust in EPCs,
- Unreliability of the certificate in certain situations,
- Insufficient public information on the meaning of EPCs,
- Complex system, lack of information,
- Different quality of EPCs,
- Different quality of energy audit reports,
- Owner's lack of knowledge and understanding of EPC,
- Lack of expertise on the part of energy assessors,
- Recommendations are not clearly explained, and homeowners cannot understand them,
- Incorrect data on EPCs,
- Remote building energy certification,
- Insufficient transparency,
- Insufficient quality control,
- Too complicated process of building energy performance certification,
- Disinterest of users (building owners).

9. How can we make the existing energy certificate in Croatia MORE USEFUL? What is missing in the existing energy certificates in Croatia? What else could / should we add to the existing energy certificate in Croatia (apart from energy and CO_2 emissions)?

- Completely different EPC design primarily tailored to citizens/building owners,

- LCC and LCA assessments,
- Quality control,
- Electricity consumption for common areas within a building reduced per gross area,
- The current EPC should be simplified to end user because there is already too much data,
- Information on the building lifespan and how EE measure can extend the building lifespan,
- Approximate value of property without and with EE measures implemented,
- Calculation of the potential for obtaining green energy (e.g., amount of possible electricity generation in kWh from solar energy according to the available roof surface, amount of possible electricity generation in kWh produced from wind energy at the building location),
- Clearly highlighted benefits for building owners giving understandable and concrete information also to building owners (e.g., in this building you will save 20 % of electricity consumption, and 55 % of energy for heating and DHW preparation…),
- Comparison to a typical example of a "good" building.

10. What data, currently listed in the existing energy certificate in Croatia, should be changed and how?

- Most of the data contained within EPC should be changed including also design change,
- Reduce the amount of data within an EPC.

11. What should be considered in the next-generation EPC to make the energy certificate more useful?

- Actual energy consumption,
- The usefulness of the data presented,
- LCC and LCA assessments,
- The existing EPC should be primarily simplified,
- Accessibility to citizens/building owners,
- Education of citizens/building owners/investors,
- Information on the building lifespan and how EE measures can extend the building lifespan,
- Approximate value of a property without and with EE measures implemented,
- Inclusion of sustainability within existing EPC,
- Comparability with a typical building

12. Based on your needs, describe how you imagine the next-generation EPC? What should the next-generation EPC comprise? How do you imagine the next-generation EPC?

- Simplified procedure, as much as possible based on actual energy consumption,

- Comparability with other EU certificates,
- Introduce as many consumption-related indicators as possible,
- Simplify the whole process of an EPC issuing,
- National central EPC database should be more user-friendly,
- Tools for performing the calculation of primary energy (e.g., KI ExpertPlus) should be easy to use,
- Clear and understandable description of all suggested measures with step-by-step guidance how to implement them providing also possible source of funding for suggested measures,
- Opportunities for electromobility,
- All necessary information (about EPC, suggested measures, step-by-step renovation plan, source of funding) should be provided to normal citizens/building owners, who are non-expert in this field
- By entering necessary data required to issue an EPC, all once entered data are automatically entered into all relevant databases for the purposes of reporting, analysis or whatsoever.

2.2.3 France

French stakeholders' interviews were held during their first national LAT meeting, which took place online. After a short introduction describing the EUB SuperHub project, the 4 participants, listed in Table 4, answered the 6 guiding questions defined by all the partners during a general meeting (the guiding questions are listed in Table 1).

Participant's number	Participant's profile
1	Founder of a consulting firm on buildings' energy efficiency and sustainability
2	Technical expert / Energy efficiency and sustainability consultant
3	Social landlord
4	Research and consulting engineer / Expert in French thermal regulation

Table 4: French stakeholders' profiles

French stakeholders' collected answers

1. In your opinion, have EPCs helped you in your day-to-day work? Has it been successful?

While other participants only know the contents of EPCs but they don't really use it in their day-to-day work, for the social landlord it represents an important tool to identify the need for retrofit actions and to calibrate the budget to provide them, quite apart from being a major expense dictated by regulatory requirements. Nevertheless, it has been noticed that often the EPC labels don't match with the energy performance calculation results. This discrepancy influences the credibility of the tool. The expert in French thermal regulation (RT 2012 and RE 2020) recalled

that the main role of the EPC is to allow a comparison of the performance of different buildings using the same occupancy scenario (benchmarking), so it is normal that comparing regulatory and energy calculations cannot give the same results.

2. How can we make EPC more attractive/ more useful?

- Transforming it into a "100% digital" EPC with only open and accessible input data (to verify their accuracy), easy to fill and to update.
- Digitizing and automating the certifications and the information exchange between different data sources to reduce the gap between the buildings and their digital twin.
- Making it a tool able to perform dynamic simulations, that would allow considering the energy behaviour of the building according to the changes that occur on it (sale, retrofit, structural changes, etc.).
- Using less "standard" and more "measured" data, useful for calibrating numerical models, making the EPCs more accurate.
- Turning it into an automated tool, which does not require requesters to provide a huge amount of data to EPC assessors.
- Facilitating the filling of the tool, making it more automatic and faster.

3. What kind of indicators and information can we include in the EPC, in addition to energy?

- Comfort-related parameters such as indoor air quality, visual comfort, acoustics, and summer comfort.
- energy consumption detailed for each usage (artificial lighting, auxiliary systems, etc.)
- A more precise idea of the costs related to energy consumption.
- Carbon footprint covering the entire life cycle of buildings.
- Measured ventilation rate in existing buildings.

4. To which extent do you think it is necessary to improve the process of EPCs and their quality/ credibility, knowing that it could be more expensive?

The participants agree that the fact that the new French EPC is 'opposable' already provides more credibility. However, in the future, they would this tool to be more reliable and clearer, based on more easily verifiable and objective inputs, and capable of giving the same result even if made by another assessor.

5. How do you imagine an EU building passport? What should it look like and how to use it?

For all participants, the next generation European building passport should be easy to fill and to update, as they currently consider that too many inputs and thus too much time of the assessors are needed to use certification tools. Artificial Intelligence could be used in order to simplify and automate their filling, using, for

example, data from the examined buildings that already exist (EPCs, BIM data, information about renovation, etc.)

2.2.4 Germany

German stakeholders' interviews were held partly during their first national LAT meeting, which took place online, and partly by means of bilateral meetings. In the LAT meeting, 4 participants attended, answering the 6 guiding questions, listed in Table 1, after a short introduction describing the EUB SuperHub project. These are marked in Table 5 as interviewers 1 to 4. the rest of the interviews (participants 5 to 8 in Table 5) were bilateral meetings, lasting between 45 minutes and one hour.

Participant's number	Participant's profile
1	Energy advisor/ Architect / Researcher/ LCA specialist / sustainability auditor (BNK)
2	Public building owner / Researcher / Sustainability auditor (DGNB)
3	Public building owner
4	Energy advisor / Sustainability consultant/ LCA specialist / Researcher
5	Asset manager / Sustainability auditor (DGNB/ LEED)
6	Energy advisor / Researcher
7	Energy advisor / Researcher
8	Board member Bavarian Chamber of Architects / Energy advisor / Sustainability professor / Sustainability assessment system scheme operator / Sustainability auditor (DGNB/ BNK)

Table 5: German stakeholders' profiles

German stakeholders' collected answers

1. In your opinion, have EPCs helped you in your day-to-day work? Has it been successful?

7 out of 8 respondents regularly use the EPCs in their day-to-day work. It is generally considered a useful tool as it allows comparing buildings' energy performance and raises awareness about the buildings' energy aspects, but it is not used to guide the decision-making process as it is not considered reliable enough. Furthermore, the EPC is hard to understand to an end-user as it reflects values and units (kWh/m².y) that the end-user finds hard to relate to and understand.

2. How can we make EPC more attractive/ more useful?

- It should include more information beyond energy (like sustainability), moreover, the EPC should be more holistic and include the whole energy life cycle and not only the energy in the operation phase.

- It should be simpler and faster in development (especially for small owners) and easier to communicate with the end-user.
- Due to the high complexity of developing an EPC, normal owners should be helped find and approach the correct energy advisor as it's a very specialized topic that they are not used to and do not know what to expect.
- The EPC should be more user-friendly, understandable, and easy to read (e.g., the units should be easier to understand related to the end-user, not every user can understand the unit kWh).
- It should be entirely digital and based on dynamic data (based on monthly or even less energy consumption values) that allow for a more detailed analysis of the building performance. Moreover, it should allow the end-user to compare the building EPC values with other similar buildings and give a ranking about the building energy performance in comparison to other similar buildings and the deviation between actual and design EPC values.
- For the EPC to be a successful tool for the future it needs to contain more information about the building history (renovations done, materials used, running costs, etc.) and technical components as well as how to best operate them: it should include a user manual that can guide the user about how to use the building in order to achieve the designed performance.

3. What kind of indicators and information can we include in the EPC, in addition to energy?

- The EPC should cover the whole life cycle of the building (LCA-based) and not just the operational phase of the building and the unit should be changed from kWh/m²·y to kg CO_2 equivalent /m².y, as this is the main climate change indicator.
- It would be interesting to include an indicator about the amount of onsite produced renewable energy that is consumed within the building the amount of energy that is exported to the net.
- Indicators about materials used (e.g., % of local resourced material used in the building), water usage, share of reclaimed water and air quality should be added.
- Next to the energy consumption per area unit, it would be interesting to see also the energy consumption per user, as the same building might have the same energy class and size, but one is more efficient as it hosts double the number of occupants.
- Information about the share of energy with other buildings (either actual or theoretical) and the presence of recharging stations for electrical vehicles should be added.

4. To which extent do you think it is necessary to improve the process of EPCs and their quality/ credibility, knowing that it could be more expensive?

- Auditors should have access to more training, in order to improve the quality of the EPCs they assess.

- The information contained in the EPCs should be part of a larger building passport that covers more information beyond energy (material passport, sustainability performance, etc.). It should be a "building information certificate".
- In order to do not make them too expensive, EPCs could be supplied in two versions: a simple one, that is somewhat close to the existing one and is offered at a low price, and a more advanced EPC, supplied for an extra cost, which covers additional information or KPIs that reflect the user interest (life cycle cost or indoor air quality, etc.).

5. How do you imagine an EU building passport? What should it look like and how to use it?

More than half of the stakeholders interviewed (five out of eight) had no positive opinions about the possibility of creating a European building passport. They consider this project too complex, because of the big differences linked to national climates, energy systems, building materials, etc.

On the other hand, the owner of a large cooperate real estate portfolio across the EU and the two energy advisors (participants number 5, 6, and 7) considered the idea of a harmonized European passport as necessary. In addition to information on energy performance, the European passport could be enriched with information on sustainability performance, retrofit actions carried out, construction materials used, running costs, etc., or it could just show the sustainability rate linked to the building's CO_2emissions (something like the environmental badge for cars).

6. Free comments and suggestions

Regardless of how advanced and complicated the next generation of EPC is, the end-user won't benefit much from it if it is not simple and easy to understand. Such complicated systems can be used for complicated buildings. For "normal people", the EPC needs to be simple, easy to understand and provide a clear added value.

2.2.5 Hungary

Hungarian stakeholders' interviews were held during their first national LAT meeting, which took place online. After a short introduction describing the EUB SuperHub project, the 2 participants, listed in Table 6, answered the 6 guiding questions defined by all the partners during a general meeting.

Participant's number	Participant's profile
1	Energy engineer
2	Environmental and mechanical engineer

Table 6: Hungarian stakeholders' profiles

Hungarian stakeholders' collected answers

1. In your opinion, have EPCs helped you in your day-to-day work? Has it been successful?

While participant 1 carries out energy audits and delivers certificates as a routine and considers EPCs as a straightforward process, the 2nd participant does not use EPCs often, so he has no opinion about their effectiveness.

2. How can we make EPC more attractive/ more useful?

Participant number 1 considers EPCs as administrative requirements (e.g., useful for applying for funding) so he does not see the importance of making it more attractive. Anyway, both participants say that currently EPC is a tool for engineers and professionals, so to make it more interesting for a wider audience, a lot of changes should be applied, starting from the choice of indicators, display options and information on how EPCs are done. Also, participant number 2 added that better metrics would be needed and more meaningful application fields.

3. What kind of indicators and information can we include in the EPC, in addition to energy?

- Materials used in the construction/renovation/end of life,
- Information related to maintenance (a bit more on the operation of the building),
- Global Warming Potential and related matters that focus on sustainability issues.

4. To which extent do you think it is necessary to improve the process of EPCs and their quality/ credibility, knowing that it could be more expensive?

For the first participant, it depends on what type of project, what building type, size, etc. we are talking about: the more complex the project is, the more precise work needs to be done.
The second participant considers that there could be mandatory elements free of charge and optional more sophisticated descriptions of systems and information about energy.

5. How do you imagine an EU building passport? What should it look like and how to use it?

Both participants see the EU building passport as a useful tool: it would make things easy for building owners and managers as they could facilitate many processes from investments, bidding, contracting, etc. Passport should be digital, accessible, and ready to be exploited for analysis, either for individual buildings/flats or looking at the wider real estate portfolio of cities or property owners.

The 6th question on free comments and suggestions was asked, but no response was provided.

2.2.6 Ireland

The Irish stakeholders' interviews comprised of participants who engaged with the first national LAT meeting, which took place online on December 8th, 2021. This was done to leverage other EUB SuperHub related work and enable a certain streamlining of participants' time-commitment to the project. In the LAT meeting, six participants attended, contributing to three sessions comprising an introduction to the project, discussions on the EUB SuperHub Web Platform, and a workshop session cover EPCs more generally. These are marked in Table 7 below as interviewees 2 to 7.

In addition, this effort was complemented with a seventh interview (see participant 1 in Table 7) which was carried out in-person.

All interviewees were either industry professionals or had experience with the EPC process in Ireland.

Participant's number	Participant's profile
1	Expertise: Residential, education, and commercial, BER
2	Expertise: Residential, education, and commercial, including passive house
3	Expertise: Energy management; Sustainable energy project development
4	Expertise: Energy efficiency retrofits, BER assessor, EPC expert (Ireland)
5	Expertise: Circularity, Sustainability, Built Environment
6	Expertise: Energy Management, Sustainable Construction, Water Treatment, Nearly Zero Energy Building (nZEB)
7	Expertise: Procurement, managing service providers, increasing load etc.

Table 7: Irish stakeholders' profiles

Some participants represent dual roles, being both industry professionals and/or working in other sectors including education. The line of questioning in the interviews adhered to the list of questions in Table 1 and were also informed by other lines of questioning from other EUB SuperHub related activities, including a focus group meeting conducted early on in the project.

Irish stakeholders' collected answers

The following section outlines the responses from interviewees to the different questions.

1. In your opinion, have EPCs helped you in your day-to-day work? Has it been successful?

All the interviewees expressed dissatisfaction with the EPC programmes they engage with. While acknowledging their usefulness for communicating with the general public, most interviewees suggested there were a number of inherent weaknesses in the process too. For example, one interview remarked on the EPC process being too complicated and that this can turn people off the process. Or as another interviewee indicated, it can make it "hard to communicate with clients effectively" at times. Another interviewee noted that "up to now, buildings have been built with a 'least cost' attitude rather than with environmental sustainability in mind". This would have to change, and, in this regard, the current EPC programme had not been as successful as it could have been. While another

interviewee spoke of the current EPC process as still feeling “quite theoretical” since it doesn’t really capture how a building is used.

Practical considerations were also questioned with regards to the overall accuracy of EPC programmes, particularly with regards to Ireland’s Building Energy Rating (BER) certificate for domestic buildings, with more than one participant questioning the accuracy of the calculations involved. The example given was that the performance for some older buildings was far greater than expected or indicated in the BER and that this gap was not being captured in current EPC programmes. One participant suggested the Passive House Planning Package (PHPP) model seems to be more accurate tool for some practitioners.

2. How can we make EPC more attractive/ more useful?

This question stimulated a lot of different responses and reflected the focus of individual participants and their professional experiences. The need to simplify the process was common for a number of participants. One interviewee suggested introducing EPC at a much earlier stage for all courses (architecture, engineering, etc), while another indicated the “ideal EPC should include the idea of embodied energy, for example it should take into account shipping materials from China etc. and ideally [it should] encourage [a return to] building with locally sourced materials”.

Airtightness was another commonly shared topic for improving EPCs, with a number of interviewees expressing an interest in making air tightness a more important component in the process. At present by not considering the embodied energy of a building many saw this as a significant weakness of current EPC programmes. In addition, the non-factoring of carbon was a major concern with the example given whereby the carbon coefficient is calculated from 'typical' house built in 2005, which does not accurately reflect the majority of housing stock in Ireland. While it was acknowledged the 2005 baseline was there in an effort to bring older buildings up to more recent building standards it often ignored better performing older stock. This issue did provide a strong response from some participants with one suggesting to scrap current EPC programmes altogether and “set up a proper detailed system that uses accurate site specific data (weather data) and include much of what is used on PHPP system” that also factored in the embodied energy dimension too.

3. What kind of indicators and information can we include in the EPC in addition to energy?

This was another question that generated much discussion on the part of most interviewees. Some responses acknowledged that there were other indicators already available to practitioners in current EPC programmes, e.g., payback, etc. and therefore they could not think of anything else to add. However, others suggested a more comprehensive list was needed, including airtightness, embodied energy, local sourcing of materials, indicators that would encourage the use of reclaimed materials, and reduce the need for mechanical systems. Also, approaches that would encourage the use of competent designers to “deal with

the basics such as building orientation (bounteous glazing to south etc.)" was very much needed with one interviewee noting that the use of Dwelling Energy Assessment Procedure (DEAP) used by BER assessors gives false results because it is too basic and simplistic.

4. To which extent do you think it is necessary to improve the process of EPCs and its quality/credibility, knowing that it could be more expensive?

One interviewee noted that the process "is becoming more forensic in detail" and that minor changes can have significant knock-on impact on assessments as a result. The process, therefore, needs to be simplified according to some interviewees and subsequently there should be better overlap between building control and the Sustainable Energy Authority of Ireland (SEAI) – the state body responsible in Ireland – because certain sections of national legislation has led to contradictions arising in the application of EPC programmes for practitioners. The same interviewee noted that, from what they could see, there "practically no enforcement of legislation to have say have a valid BER displayed before advertising a house for purchase. This clearly did not help with the programme's credibility in the real estate market.

Another interviewee suggested a complete overhaul of the system was needed and should include "accurate data for existing wall build-ups etc." Also, site-specific weather data was seen as essential to this and linking into the national weather service, Met Éireann, was seen as positive step forward in improving both the quality and the reputational credibility of the programme. By better utilising the tools of the State and allowing greater transparency with national datasets would also translate into better buildings and would discourage the construction of poor-quality buildings, according to other interviewees.

Another suggestion was to modify the EPC to say a three-year period that would then need re-evaluation after the set period had elapsed to both capture any new additional improvements made to the building, but also to potentially encourage further investment into property upgrades.

5. How do you imagine an EU building passport? What should it look like and how to use it?

Envisioning what an EU building passport should look like also generated much discussion. It "should indicate what progress the building owner has made in previous five years to improve efficiency", again linking to the previous point of setting a time-limit of certificate validity before requiring a renewal. Any iteration must provide a more accurate history of the building than has here-to-fore been the case, that is useful to both the building user and to practitioners. Otherwise, in the words of one interviewee "it does not matter what it looks like" the data will continue to be "inaccurate and meaningless."

6. Free comments and suggestions

Two interviewees had additional comments to make. One suggested that the "commercial BERs are affected greatly by activities in adjoining premises which is

outside control of the owner. Could there potentially be a dual rating which includes an indication that one rating is taking into account activities of adjoining premises and other is not?".

While the other stated that "the EU and the State needs to act like there is a climate emergency, old approaches will not work, encourage less building and less heating, conservation of energy being most important, focus on airtightness and insulation rather than 'skip filling' exercises [i.e., generating more building waste] which seems to be the EU policy to energy upgrades.

2.2.7 Italy

Italian stakeholders' interviews were held during their first national LAT meeting, which took place online. Feedback received from the stakeholders involved has been collected by UNI using a system of collecting data based on an online survey with SurveyMonkey, completely anonymously. Subsequently, the issues were discussed in a choral manner altogether.

The following are the questions asked to the 9 participants (see Table 8):

1. Which contents existing to date in the EPC should be changed and how? (ex. building information about the envelope, the energy aspects, the graphs of the document making it more user-friendly, etc.).
2. Which are the important aspects missing in the EPCs to date and, consequently necessary to be added in the Next Generation of EPCs? (ex. real consumption, LCA and LCC aspects, building resiliency, well-being, thermal comfort indicators, etc.).
3. How is it possible to make the Next Generation EPC more useful and interesting?
4. Free comment on the issues addressed.

Participant's number	Participant's profile
1	Engineer / Representative of the companies producing thermal insulation material
2	Engineer
3	Freelance Architect / Researcher
4	Researcher
5	Freelance Engineer / Expert in Protocollo ITACA
6	Architect
7	Engineer
8	Consultant / Freelance Engineer

Participant's number	Participant's profile
9	Architect expert in sustainable construction material

Table 8: Italian stakeholders' profiles

Italian stakeholders' collected answers

1. Which content existing to date in the EPC should be changed and how?

- Some respondents highlight the necessity to introduce, in the next generation EPC, content related to the sustainability assessment system. It is necessary to better clarify how buildings are classified considering also the "reference building" used in the Italian EPC. It is also relevant to be able to understand quickly what information the EPC can deliver to the final user.
- Many stakeholders stressed the fact that the final user of the building greatly influences the performance of the building because of his behaviour; so. It's important to take into account also the user behaviour and make aware the final user that the information within the EPC they do not take into account this aspect, they reflect only the status of the building as it is and are not influenced by the user behaviour.
- Within the Italian EPC there is a lot of information difficult to understand for non-experts, the simplification of content could be an added value, allowing greater readability of the EPC by a "common" user.
- All the participants agree about the necessity to find a set of information of interest for all the European countries in order to be able to have a more standardized structure of the EPC at the European level.
- Concerning the changes to be made to the actual EPC, the suggestion from one stakeholder is to give different weight and different roles to the „active systems" (energy production) and to the „passive systems" (insulation), to promote clarity of reading by the end-user. Moreover, could be useful to introduce the evaluation of the thermal/comfort benefits which may result from certain construction solutions; this could help the design process in making choices.

2. Which are the important aspects missing in the EPCs to date and, consequently necessary to be added in the Next Generation of EPCs?

- The Next Generation EPCs should be very clear in content, easy to be understood even by non-technical users and they must incorporate key harmonized parameters comparable at the European level.
- They are supposed to be easily readable in the aspects related to the building performance and consumption, the building envelope, type of building-plant system, also taking into account any possible improvement measures and their cost-effectiveness.
- For what concern summer energy demand, it would be appreciated the introduction of a more refined evaluation and related consumption, currently inadequate.

- Of great interest is also the introduction of sustainable assessment system indicators, more related to the site location, accessibility of the building, resiliency, etc. More to the point, concerning the resilience of the building, this aspect is strongly recommended to be introduced because it shows the ability to respond to the diverse needs of various building users.
- Renewable energy is strongly considered also for what concerns sustainable mobility (for ex. the presence of electrical charging stations). This aspect is strongly related also with the costs of the building in operation, due to the presence of renewable energy production.
- Finally, it is crucial to consider the user behaviour in the management of the building.

3. How is it possible to make the Next Generation EPC more useful and interesting?

The point of view of most of the stakeholders involved in the LAT about the way to be followed to make the Next Generation EPC more useful and interesting is to ensure its reading is intuitive also from a non-expert, making it simple and communicative. One of the proposals is to prepare a specific summary section that allows making it more readable for a "non-professional" user while leaving all the technical data in the rest of the document, readable from technicians.

It is recommendable to set up a communication campaign addressed to “non-expert” users, to raise their awareness of the issues inherent in the EPC, and to explain that the EPC has a relevant role in giving a higher value to the property.

The EPC is useful when it is adherent to the actual operation of the building; for this reason, the recommendation is to take into account the complete life cycle of the building, from the construction to the end of life.

Another fundamental aspect highlighted by the respondents to improve the usefulness of the EPC concerns the cost of the certification. To be able to produce a consistent and detailed EPC, the professional must be paid in an appropriate manner.

4. Free comment on the issues addressed

- Are to be preferred data illustration providing clarity and unambiguous interpretation of the EPC values.
- Strong emphasis on "raising awareness" about the content of the EPC that very often are not considered by the final user.
- More consistency controls: it does not make sense that in the market you can buy certificates for a few euros.
- Introduce the variable of the user behaviour: its role is crucial and can change a lot the „numbers in play” for the EPC.

2.3 Summary of the collected answers

Even if the participants decided to ask a different number of questions during their interviews, the core questions that each project partner asked are:

How can we make EPC more attractive/ more useful?
What kind of indicators and information can we include in the EPC, in addition to energy?
How do you imagine an EU building passport? What should it look like and how to use it?

While the first two questions address the issue of stakeholders' needs and expectations on the national certification system and the indicators taken into account in EPCs, the third question gathers actors' expectations on the EU building passport. In order to extract main stakeholders' needs and expectations about national and European next generation EPCs, the analysis and comparison of the answers to these questions has been realized.

The result of this analysis can be found in this section.

2.3.1 Stakeholders' needs and expectations about national EPCs

Question 1. How can we make EPC more attractive/ more useful?

- **It should become a 100% digital tool, easy to fill**

  It should be possible to retrieve information from several sources to make the filling fast and automatic.

- **It should provide information on the real consumption of buildings and not only on consumption given by regulatory calculations**

- **It should be usable as a basis for other calculations**

  The tool should be able to perform dynamic simulations, allowing considering the energy behavior of the building according to the changes that occur on it.

- **It should allow the performance of the building to be compared with the performance of other similar buildings or with target values**

  A ranking should be given about the building energy performance in comparison to other similar buildings / a typical example of "performant building".

- **It should be easy to understand for non-experts / building occupants**

  The content of the certificate should be explained in a simple and intuitive way. A specific summary section that allows making it more readable for a

"non-professional" users could be added, leaving all the technical data in the rest of the document.

- **It should provide the user with information on the impact of energy performance on the value of the building**

  Information on the correct way to use the building should also be given

- **It should consider other aspects, apart from energy**

  It could include, for example, information about building's sustainability performance, green energy production, etc.

- **It should consider the building's whole life cycle**

  LCC and LCA should be added

- **It should be reliable**

  Quality control would be desirable, as well as a precise calculation methodology that does not make the result of calculations dependent on the assessor

- **Its cost should be proportional to the effort involved**

  To be able to produce a consistent and detailed EPC, the professional must be paid appropriately

- **It should only be carried out by qualified assessors**

  Well-trained assessors should be essential for the high quality of this certification

Question 2. What kind of indicators and information can we include in the EPC, in addition to energy?

- **Sustainability indicators**

  Ex: Climate impact of the building materials and technical equipment used, accessibility of the building, resiliency, water usage, share of reclaimed water and air quality, etc.

- **Comfort indicators**

  Ex: Indoor air quality, visual comfort, acoustics, summer comfort, etc.

- **Smart Readiness Indicators**

  Including an assessment of grid efficiency

- **Life Cycle Assessment**

  The EPC should cover the whole life cycle of the building, giving Information on the building lifespan and how EE measures can extend the building lifespan

- **Energy consumption per user**

  As the same building might have the same energy class and size, but one is more efficient as it hosts double the number of occupants

- **Energy consumption per usage**

  Ex: Artificial lighting, auxiliary systems, summer energy demand, etc.

- **Measured data**

  Ex: Actual energy consumption, measured ventilation rate in existing buildings, etc.

- **Onsite produced renewable energy, energy shared with other buildings and presence of recharging points for electromobility**

- **Information on the impact of energy performance on the value of the building**

  Approximate value of a property without and with energy efficiency measures implemented should be added

- **Comparison of the building performance with the performance of other similar buildings or with target values.**

- **Costs related to energy consumption**

- **Proposed energy improvement measures**

  Clear and understandable description of all suggested measures with step-by-step guidance how to implement them providing also possible source of funding for suggested measures and considering their cost-effectiveness

- **Comparability with other EU EPCs**

2.3.2 Stakeholders' needs and expectation about European Building Passport

Question 3. How do you imagine an EU building passport? What should it look like and how to use it?

The answers to this question varied widely: while for some stakeholders an EU building passport will be a common tool supported by technically sound EN standards, able to link different values for good performance with different climates using region-specific harmonized conversion factors, others had no positive opinions about the possibility of creating a European building passport, as they consider this project too complex, because of the big differences linked to national climates, energy systems, building materials, etc.

One respondent from Austria (managing director of the baubook platform and product researcher) gave as an example the differences in LCA methodology at

national and European level. She argued that, as there is no harmonized European approach either to energy performance certificates or to life cycle assessment in the building sector, the goal of installing a Europe-wide tool is therefore "doomed to failure from the outset". On the other hand, 33 % of Croatian interviewed members think that an EU wide unified EPC would be more trustworthy than a national one and, from Germany, the owner of a large cooperate real estate portfolio across the EU and two energy advisors considered the idea of a harmonized European passport as necessary.

In general, the interviewed stakeholders expressed the need for an instrument easy to fill and to update, in which artificial Intelligence could be used to simplify and automate their filling, using, for example, data from the examined buildings that already exist (EPCs, BIM data, information about renovation, etc.). The European passport could be enriched with information on sustainability performance, retrofit actions carried out, construction materials used, running costs, etc., or it could just show the sustainability rating linked to the building's CO_2 emissions (something like the environmental badge for cars). Passport should be digital, accessible, and ready to be exploited for analysis either for individual buildings/flats or looking at the wider real estate portfolio of cities or property owners.

3. Identification and prioritization of Thematic Areas of interest for the next generation EPC

In order to be able to select, with a "*bottom-up*" approach, the thematic areas considered the most relevant for the next generation of EPCs, a very concise and user-friendly Survey has been prepared by iiSBE, CSTB and UNI (Annex).

The aim of this Survey is to get feedbacks from the relevant stakeholders, about the priority of each of the thematic areas identified.

The survey opened on February 4th, 2022, and closed on February 14th, 2022.

3.1 The thematic areas identified

The criterion for the selection of the thematic areas included into the "Fast-Effective Survey" is based on the results achieved by Task 1.2 and Task 1.3 activities.

Below is the list of the thematic areas identified for the Task 1.3 "Fast-Effective Survey":

Thematic Area
Site – Location
Infrastructure - Transport - Services proximity
Resiliency (risk of extreme weather, seismic and flood events)
Energy consumption
Life-cycle Global Warming Potential
Resource Consumption
Renewable Energy
Material efficiency
Greenhouse Gas Emissions
Indoor Air Quality and Ventilation
Thermal comfort
Daylighting and visual comfort
Noise and Acoustics
Smart Readiness Indicators
Home automation systems
B.A.C.S.
Design for adaptability and renovation
Accessibility for persons with disabilities
Social, Cultural and Perceptual Aspects
Operating and maintenance cost
Life-cycle cost
Broadband communication network

Table 9: List of the thematic area

3.2 Survey methodology

The survey was written in English and shared, through the project partners, with all potential stakeholders interested in the topic. These stakeholders were selected from a large sample of European countries corresponding to the country of origin of the project partners. To be more specific, representatives of companies/organisations and research centres from France, Hungary, Italy, Germany, Croatia, Ireland, and Austria were involved in the survey.

UNI has taken care of sharing the survey also within the standardization community. Indeed, the survey was shared with some potentially very relevant national technical bodies: UNI CT 058 Cities, communities and sustainable infrastructures (mirroring of ISO TC 268 Sustainable cities and communities), UNI CT 33 / GL2 Building sustainability (mirroring of CEN TC 350 Sustainability of construction works).

Overall, we counted 83 active participants. Respondents were asked to identify themselves in the field in which they operate, this categorisation allowed for a sample analysis of the main stakeholder categories involved in the survey. The categories of stakeholders who participated in the survey are listed in Table 10.

Stakeholder involved	%
public authority	13,4%
managing EPCs	3,7%
building professional/designer	25,6%
energy assessor	15,9%
public or private asset manager	2,4%
private or public building owner	7,3%
building occupant/user	1,2%
public or private investor	0%
*other	30,5%

Table 10: Stakeholder categories

** The data in the field "other" (30,5%) are mostly related to stakeholders who identified themselves as certification bodies, consultants, and private associations.*

3.3 Summary of the results

Among a total of 83 participants, 68 actively participated in the feedback part concerning the thematic areas to be prioritised. The results are given in Table 11.

	1 (Low priority)		2 (Medium priority)		3 (High priority)	
Site - Location	25.00%	17	36.76%	25	38.24%	26
Infrastructure - Transport - Services proximity	26.47%	18	38.24%	26	35.29%	24
Resiliency (risk of extreme weather, seismic and flood events)	26.47%	18	39.71%	27	33.82%	23
Energy consumption	10.29%	7	11.76%	8	77.94%	53
Life-cycle Global Warming Potential	11.76%	8	29.41%	20	58.82%	40
Resource Consumption	14.71%	10	32.35%	22	52.94%	36
Renewable Energy	10.29%	7	26.47%	18	63.24%	43
Material efficiency	17.65%	12	42.65%	29	39.71%	27
Greenhouse Gas Emissions	11.76%	8	26.47%	18	61.76%	42
Indoor Air Quality and Ventilation	13.24%	9	35.29%	24	51.47%	35
Thermal comfort	14.71%	10	30.88%	21	54.41%	37
Daylighting and visual comfort	22.06%	15	41.18%	28	36.76%	25
Noise and Acoustics	25.00%	17	36.76%	25	38.24%	26
Smart Readiness Indicators	29.41%	20	39.71%	27	30.88%	21
Home automation systems	41.18%	28	27.94%	19	30.88%	21
B.A.C.S.	39.71%	27	36.76%	25	23.53%	16
Design for adaptability and renovation	27.94%	19	38.24%	26	33.82%	23
Accessibility for persons with disabilities	23.53%	16	42.65%	29	33.82%	23
Social, Cultural and Perceptual Aspects	39.71%	27	47.06%	32	13.24%	9
Operating and maintenance cost	14.71%	10	44.12%	30	41.18%	28
Life-cycle cost	17.65%	12	39.71%	27	42.65%	29
Broadband communication network	35.29%	24	35.29%	24	29.41%	20

Table 11: Results of the "fast-effective survey"

Almost 80% of the participants agree that the issue of energy consumption is of the highest priority, followed by other priority thematic areas such as:

- Renewable Energy
- Greenhouse Gas Emissions
- Life-cycle Global Warming Potential
- Thermal comfort
- Resource Consumption
- Indoor Air Quality and Ventilation
- Life cycle cost
- Noise and Acoustics
- Site – Location

The survey results have been more deeply analysed in EUB Superhub deliverable **D1.2 - Transnational indicators for the next generation energy certification.**

4. Recommendations and reference strategies for improving the framework conditions for fostering the implementation of the next generation of EPCs

The different approaches used in this task 1.3 lead to various recommendations and conclusions, reflecting the opinions of different types of stakeholders.

The recommendations, drawn from the 3 main approaches implemented in this task, may be linked to the driving concepts of next generation EPCs in EUB Superhub:

- Improvement
- Extension
- Harmonisation
- Reliability

4.1 Recommendations drawn from the literature analysis

The literature analysis has revealed policy-oriented ambitions and research-oriented analysis, leading to the following recommendations and conclusions. This analyse has been leaded linked to the 4 key-concepts of the project. The recommendations from the literature reviews address only three of them: improvement, extension and harmonization.

According to the EPC **IMPROVEMENT**
– Facilitate Phasing out old energy intensive and climate unfriendly heating systems – Create a user-friendly EPC data-sharing platform – More options/ flexibility for meeting energy standards – Update the EPC for new building at the end of the construction – A digital EPC – Tools to compare buildings

According to the EPC **EXTENSION**
– Creation of a common information system for the whole national territory for the management of a national cadastre of energy performance certificates and heating systems – Create BIM based EPCs – Include smartness rating for the building, – Include comfort and wellbeing indicators (air, thermal, acoustics, etc.), – Allow for a neighborhood scale energy consideration, – Information about thermal comfort in summer

- Double the EPC report with a section for expert including technical information and a user-related section for end users
- Information about innovative technologies, life cycle and renewables

According to the EPC **HARMONISATION**

All European countries show a disparity in the level of national EPC requirements. Some countries want to see changes those others have been introducing for many years, such as **the obligation of an EPC for buyers and owners with the display mandatory of the energy label, climate label and estimated bill.**
in these countries accustomed to EPCs and their regular adaptation, **a scalable policy to allow time for owners to react and for public authorities to estimate the necessary support** has been recommended.
More broadly, the common recommendations proposed integrating the elements included in some national EPCs are:

- Provide a guide for EPC
- Provide the instruments for the cooperation between Countries, State and Regions
- Provide additional training for EPC auditors and ensure only officially approved and verified software can be applied for certification
- Provide a renovation strategy
- Providing more tailor-made recommendations for the cost-effective upgrading of the buildings,

European projects, including part of EUB SuperHub sisters project (ePanacea, D2EPC, QualDeEPC, U-Cert and X-tendo.), have proposed ways of improving the EPC. These directions already provide some proposals to address the recommendations identified in this literature review:

- The first pages of the EPC should present an overview of such recommendations and (if possible) energy savings, together with links for further information and financial support.
- Make available an online tool that compares energy consumption and recommendations with typical elements of an individual deep renovation passport/roadmap
- Creating Deep Renovation Network Platforms providing one-stop-shops for deep renovation linked to EPCs
- Improve user-friendliness of various aspects of EPC, such as energy consumption, presentation of rating and recommendations, potential energy (and cost) savings and other benefits
- Improve the involvement of building owners during EPC assessment
- In Assessment Software include practical default values for input data that come close enough to real data of a building, or in other cases, rather than exact default values, certain validity ranges for input parameters.

- Performing automatic validity/quality check during assessment and/or during upload to EPC database
- Performing quality control of both EPCs (random sample – compliance with overall quality criteria) and EPC assessors by an authorised public body
- Reporting errors or faulty procedures in a central database to create statistics of common mistakes for training purposes and identify assessors with high error rates.
- Training should also enable them to avoid common mistakes
- Regular events and workshops presenting innovative solutions for deep renovation and implementing more intelligent and advanced energy measures
- Linking EPC database to other buildings- or energy-related databases
- Energy agencies/public authorities have to produce and update guidelines for use of EPCs in advertisements of sales/rentals of buildings/dwellings, issued by, either for voluntary or mandatory use
- Establishment of EU standards on the classification requirements of buildings
- Establishment of novel set of indicators covering environmental, financial, human comfort and technical aspects of new and existing buildings
- The issuance of EPCs based on real-time data and advanced BEPS tools integrated into BIM
- The integration of smart readiness indicators into the building's energy performance assessment and certification
- Intelligent operational digital platform for dynamic EPCs issuance and real-time building performance monitoring and improvement
- Provide an improved and more reliable service tailored to the end-users
- Inclusion of new EPC indicators within the following:
    - five technical features: smart readiness, comfort, outdoor air pollution, real energy consumption and district energy,
    - five innovative features to handle EPC data: EPC databases, building logbook, enhanced recommendations, financing options, and one-stop-shops
- Using EPCs to monitor and evaluate policies and develop more impactful future policies
- The comfort is equivalent to good outdoor air quality, thermal and ventilation comfort, visual comfort, no noise nuisance - acoustic comfort and outdoor air pollution
- A monthly overview of energy consumption of each appliance to manage energy usage
- Reduce energy usage based on real energy consumption
- Real-time energy use via smart meter helps to better manage energy usage
- EPCs should contain information on energy performance score of similar buildings nearby
- The presence of building logbook with the following information: property's condition especially condition of walls and roofs, window glazing and insulation, the equipment age, maintenance activities, the contact details of

previous contractors and transaction prices, renovation activities completed up to date
- One stop shop for renovation-related questions: calculations, advice and price quotes for renovation measures, estimation of future (energy) cost savings from renovation measures

Beyond this study, some literature authors have identified the need to enlarge the map of the EPC stakeholders in order to adapt it to the new additions that will be made to meet the different needs and recommendations.

4.2 Recommendations drawn from the interviews

The interviews, carried out in the 7 countries involved in the project, mainly through LAT meetings and some bilateral exchanges, lead to recommendations classified according to the main questions asked. These questions can be linked to the 4 key-concepts of the project: improvement, extension, harmonisation and reliability.

How can we make EPC more attractive / more useful? ▪ Question linked to **IMPROVEMENT**
– It should become a 100% digital tool, easy to fill – It should provide information on the real consumption of buildings and not only on consumption given by regulatory calculations – It should be usable as a basis for other calculations – It should allow the performance of the building to be compared with the performance of other similar buildings or with target values – It should be easy to understand for non-experts / building occupants – It should provide the user with information on the impact of energy performance on the value of the building – It should consider other aspects, apart from energy – It should consider the building's whole life cycle – It should be reliable <u>Consequences in terms of recommendations and suggestions</u>: ▪ Digitalization and automation can reduce the time spent in collecting data (by the EPC expert and the building owner) and can offer new functionalities, for example EPC data and results may be stored in a national database for future uses (simulations of renovation, renewal of EPC, aggregation of EPCs at the scale of a portfolio, etc.) ▪ If energy regulation for buildings (new or renovated) is digitalized, input data and information for EPC could be drawn from regulation calculation. ▪ EPC issuing should be accompanied by advice, proposal of services, financial incentives, fiscal cuts, etc. in order to stimulate energy efficiency actions

- To store and secure data and information concerning the history of the building (extensions, renovation, technical changes, etc.)
- For the EPC assessor/expert: to spend less time to making the EPC and more time to specific advice to occupants and owners, consultancy, tailored services to end-users
- To improve the access of citizens to national EPC databases and provide educational contents simultaneously.

What kind of indicators and information can we include in the EPC, in addition to energy?

- Question linked to **EXTENSION**

- Sustainability indicators
- Comfort indicators
- Smart Readiness Indicators
- Life Cycle Assessment
- Energy consumption per user
- Energy consumption per usage
- Measured data
- On-site produced renewable energy, energy shared with other buildings and presence of recharging points for electromobility
- Information on the impact of energy performance on the market value of the building
- Comparison of the building performance with the performance of other similar buildings or with target values.
- Costs related to energy consumption
- Proposed energy improvement measures, and related costs

<u>Consequences in terms of recommendations and suggestions</u>:

- To adopt a relatively limited number of indicators and thematic areas
- To distinguish between mandatory and optional indicators
- To increase gradually the number of mandatory indicators, drawing in the basket of optional ones, as soon as all EU MS are sufficiently mature to implement them
- To distinguish indicators belonging to the EPC and other indicators belonging to the building passport
- See next sub-section about the prioritization of thematic areas
- Place indicators that are currently difficult to calculate in certain Member States, as LCA related indicators, like life cycle GWP, in the optional section
- For energy and CO2 indicators, and additional ones, give reference values and/or define a letter-rating scale, to be able to interpret and benchmark them
- To define indicators of costs, able to raise awareness, to aid decision and to trigger energy efficiency works or optimization actions

- To clarify what needs to be measured and what needs to be calculated, with normalization of users' behaviour and climate correction, in order EPC represents the intrinsic energy performance of the building or part of it.
- To add the measured energy consumption due to occupants, expressed in terms that allows a comparison with the calculated / modelled energy performance, so as the owner or occupant can see a possible gap between the energy what is actually consumed by the building and what is supposed to be consumed given the characteristics of the envelope and systems. This measured data and gap value are only given to the occupants and considered as private data.
- To increase knowledge and awareness of citizens regarding energy efficiency, return on investment, responsible behaviour, sustainability issues and concrete actions, necessary pathways towards carbon neutrality in 2050, etc.

How do you imagine an EU building passport? What should it look like and how to use it?

- Question linked to **HARMONISATION**

There is no consensus about the necessity to develop such an EU building passport. The opinions expressed are diverse and somewhat extreme:

- Installing a Europe-wide tool is therefore "doomed to failure from the outset"
- EU wide unified EPC or passport is perceived more trustworthy than a national one
- A harmonized European passport is necessary for large cooperate real estate portfolio across EU
- Data and results collected should be publicly available
- Some stakeholders are opposed to the publication of consumption data and other information that they consider as private

Among the needs and expectations:

- An EU building passport should be a common tool supported by technically sound EN standards,
- Comparability with other EU building passports, using harmonized conversion factors and other common conventions and methods
- To avoid complexity in the passport
- To find the good compromise / balance between accuracy (preferred by researchers and engineers) and simplicity (usually preferred by practitioners and end-users)
- It should be an instrument easy to fill and to update, in which artificial Intelligence could be used to simplify and automate their filling, using, for example, data from the examined buildings that already exist (EPCs, BIM data, information about renovation, etc.).

- The European passport could be enriched with information on sustainability performance, retrofit actions carried out, construction materials used, running costs, etc.

Consequences in terms of recommendations and suggestions:

- To establish clear guidelines for establishing an EU building passport including EPC.
- To define what comparability really means, and under which conditions
- To facilitate comparison by graphs, ratings, rules, etc.
- For harmonized EPCs and building e-passports in EU, to write technical specifications for each national database hosting EPCs and possibly e-passports, so as each database is built on the same architecture and data organization and give public access to data (excepted private occupants data), with the capacity to send information to a central web platform (the future Hub and one-stop-shop of EUB SuperHub) on request, in a defined and strict harmonized format (xml for instance). In that way, the Hub will be able to send requests to any national database and extract data for further calculation, visualization, comparison, aggregations, statistics, reporting, training, etc.
- To harmonise also data quality rules and training quality across Europe
- Organize meetings where MS could share experience and feedback, for the benefit of the less mature MS, in order to make closer the skills in each country.

To which extent do you think it is necessary to improve the process of EPCs and their quality / credibility, knowing that it could be more expensive?

- Question linked to **RELIABILITY**

- EPC should be reliable
- Its cost should be proportional to the effort involved (low-cost meaning low-quality)
- It should only be carried out by qualified assessors
- It should be mandatory to inspect the building in-site, forbid remote EPC
- Input data should be checked, at least by consistency rules

Consequences in terms of recommendations and suggestions:

- To better train EPC assessors, including regularly controlling the quality of their EPC production
- To find a compromise, a good balance between accuracy (usually preferred by researchers) and simplicity (usually preferred by practitioners)
- To adopt a simple EPC for simple buildings (reasonable cost) and a more comprehensive one for complex buildings (more expensive)
- To rely on a building logbook to store data and keep the history of the building with successive renovations, technical changes, extensions, etc.
- To rely on products and systems databases to get input data
- To include in EPC software and/or in EPC national databases adequate consistency checks of input data in order to detect possible mistakes of inconsistencies in the analysis of building characteristics by the EPC assessor.

- To set-up in each country a control system of the validity / reliability of EPCs and organize exchanges of feedback across countries, to provide complementary training or update to EPC assessors making too frequent mistakes
- When possible, connect EPC data and results with data issued from regulation calculation (for new buildings or after a substantial renovation), if possible, expressed in a standardized format. The same if the building received an energy label or a reward.
- The building logbook, possibly connected with a BIM model, should collect, and store all the data related to the building and its history.
- To correlate the cost of EPC with the size and complexity of the building and of its systems
- To establish 2 levels of EPC assessor qualification: normal and advanced, the latter one being used for complex buildings.
- To clarify the responsibility of actors contributing to EPC, i.e., the building owner and the assessor/expert. Useful in case the EPC is a legal, juridically "opposable" document.

4.1 Recommendations drawn from the prioritization of the thematic areas

The third approach has consisted in establishing a **list of thematic areas**, then submitting it to a relatively large group of professionals in order they prioritise these areas.

Given the table of results (see paragraph 3.3), we suggest that the issues rated "high priority" by more than 50% of the respondents may be mandatory in next generation EPCs. This corresponds to **energy** and **GHG** topics, plus **IAQ** and **thermal comfort** which interact with energy choices. **Resource** consumption also falls in this category, it is not really consistent because Material efficiency is judged as less important.

Life cycle GWP was also selected as of "high priority" but is much more difficult to calculate than operational GHG emissions. Some Member States are ready to include this indicator into new buildings related EPCs, because they have already developed EPDs databases and building LCA tools, or even integrated it in their regulation, or are about to do so, but the majority of MS can't calculate it. The ability to calculate and widely implement this indicator will take time (several years) for many of them. According to the EPBD recast proposal, LC GWP will become mandatory for new buildings, starting with large buildings of over 2000 square metres as of 2027, and applying to all buildings after 2030. To meet these deadlines and accelerate the process, Member States with experience on this topic should actively share their knowledge and feedback with less mature ones.

What is more surprising is the low or medium priority given to "smart" devices making energy systems more intelligent and more efficient, as **SRI**, **Home**

automation systems and **BACS** (Building Automation and Control Systems). If they are well designed, well installed and correctly set-up, these devices can optimise the whole energy system, including the local grid, and contribute immediately to less energy consumption and less GHG emissions. But translating their performance in easy-to-understand terms is probably difficult, knowing that their effect will be logically included in energy and GHG indicators. Anyways, these "smart" thematic areas are part of European policy and of some national laws (example of "BACS decree" in France). A European SRI platform was launched in December 2021, and SRI is included in the EPBD recast proposal.

Cost information is generally easier to understand by end-users than energy indicators or GHG emissions. If cost information (including cost linked to the present energy consumption, cost linked to energy renovation works, life cycle cost, return on investment period, higher building market value after renovation) is well presented and reliable, it can trigger renovation decisions, that is indeed the objective of EPCs. In our opinion, some indicators of cost are very important to include into EPCs, to be coupled with financial incentives for building owners, to maximise impact.

Annex

Purpose of the "Fast-Effective Survey"

In order to be able to select, with a "*bottom-up*" approach, the thematic areas considered the most relevant for the next generation of EPCs, a very concise and user-friendly Survey has been prepared by iiSBE, CSTB and UNI.

The aim of this fast but effective Survey is to get feedback from the relevant stakeholders involved, about the priority of each of the thematic areas identified. It is asked to the participants to give a priority level from 1 (low) to 3 (high) to the thematic areas highlighted for the next generation of EPC, to successfully proceed with the indicator's selection activity in T1.2.

The selectable levels are as follows:

1	Low priority	2	Medium priority	3	High priority

For each thematic area, the respondent is highly required to provide, within the dedicated box at the end of the survey, the reasons why of the priority selected and any comment deemed appropriate by the respondent; anyway, the field is not mandatory to fill in.

The "Fast-Effective Survey" is available in English and it has been structured on SurveyMonkey platform. Below the link to be used:

https://www.surveymonkey.com/r/FastEffectiveSurvey_v2

The "Fast-Effective Survey" shall be forwarded to the stakeholders whose suggestions about next generation of EPC are considered very relevant for the activity; neither a minimum, nor a maximum number of respondents is required.

Feedback could be collected until February 14th.

All the feedback acquired through the "Fast-Effective Survey" with SurveyMonkey platform will be collected and analysed by UNI; the objective is to identify the thematic areas considered the most relevant for the next generation of EPCs in order to successfully complete the T1.2 activity.

Selection criterion of the Thematic Areas identified

The criterion for the selection of the thematic areas included into the "Fast-Effective Survey" is based on the results achieved by the first step of T1.2 and T1.3 activities.

Furthermore, the "*Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the energy performance of buildings (recast)*" of the European Commission, dating back December 15th, 2021, has been taken into account.

Thematic Areas identified

Below the list of the thematic areas identified for the T1.3 “Fast-Effective Survey”:

Thematic Area	**Priority Level** (from 1 to 3)
Site - Location	
Infrastructure - Transport - Services proximity	
Resiliency (risk of extreme weather, seismic and flood events)	
Energy consumption	
Life-cycle Global Warming Potential	
Resource Consumption	
Renewable Energy	
Material efficiency	
Greenhouse Gas Emissions	
Indoor Air Quality and Ventilation	
Thermal comfort	
Daylighting and visual comfort	
Noise and Acoustics	
Smart Readiness Indicators	
Home automation systems	
B.A.C.S.	
Design for adaptability and renovation	
Accessibility for persons with disabilities	
Social, Cultural and Perceptual Aspects	
Operating and maintenance cost	
Life-cycle cost	
Broadband communication network	

References

[1] Le nouveau diagnostic de performance énergétique (DPE), Press release from French ministry on ecology transition, Barbara Pompili, Emmanuelle Wargon, Febuary 2021, https://www.ecologie.gouv.fr/sites/default/files/2021.02.15_ew_dp_dpe.pdf

[2] Nouveau DPE : les recommandations des professionnels de l'immobilier, Press release, October 2021, https://www.dimmozor.com/dimmo-mag/nouveau-dpe-2/

[3] Nouveau DPE : Constat d'un accident industriel, Press release from National Union of Real Estate, UNPI France, October 2021, https://www.unpi.org/fr/1/21/836/Nouveau-DPE-Constat-d-un-accident-industriel.html

[4] National Building energetics Strategy, policy paper, Hungarian government, February 2015

[5] IV. National Energy-efficiency Action Plan, policy paper, Hungarian government, November 2017

[6] National Energy strategy 2030, outlook to 2040, policy paper, Hungarian government, January 2020

[7] Italian Decree n. 192/2005, Italian Official Journal, Italian government, September 2005, Gazzetta Ufficiale

[8] Ministerial Decree EPC, Italian Official Journal, Italian government, June 2015, https://www.mise.gov.it/index.php/it/normativa/decreti-interministeriali/2032968-decreto-interministeriale-26-giugno-2015-adeguamento-linee-guida-nazionali-per-la-certificazione-energetica-degli-edifici

[9] Energy performance certificates analysis in Piedmont Region (IT). A new oil field never exploited has been discovered , Article, G. Mutani, C. Gabrielli, G. Nuvoli, Tecnica italiana-Italian Journal of Engineering Science, Vol. 64, No. 1, pp. 71-82, DOI 10.18280/ti-ijes.640112, March, 2020, Energy Performance Certificates Analysis in Piedmont Region (IT). A New Oil Field Never Exploited Has Been Discovered | IIETA

[10] ENERGY CERTIFICATION OF BUILDINGS - ANNUAL REPORT 2021, Annual report drafted by ENEA - National Agency for Energy Efficiency and CTI - Italian Energy and Environment Thermotechnical Committee, December 2021, https://www.efficienzaenergetica.enea.it/pubblicazioni/

[11] NATIONAL STRATEGY FOR THE ENERGY REQUALIFICATION OF THE NATIONAL BUILDING STOCK, National Policy Paper, Italian Ministry of Economic Development, November 2020, https://www.mise.gov.it/images/stories/documenti/STREPIN_2020_rev_25-11-2020.pdf

[12] INTEGRATED NATIONAL ENERGY AND CLIMATE PLAN, National Policy Paper, Italian Ministry of Economic Development, December 2019, https://www.mise.gov.it/index.php/it/198-notizie-stampa/2040668-pniec2030

[13] Germany's Buildings Energy Act 2020, Federal Law Gazette, federal ministry of interior building and community, 3 August 2020,

[14] ePanacea, Insights on user perceptions and needs regarding the Energy Performance Certificate (EPC), Laura Muhr (IZES), 01/02/2021, https://epanacea.eu/results/

[15] Stakeholder analysis report, Laura Muhr (IZES), Sven Clanzett (IZES), Jan Hildebrand (IZES), September 2020, https://epanacea.eu/results/

[16] Next-generation EPC's user and stakeholder requirements & market needs, Christiana Panteli, Michelle Duri, Detlef Olschewski , Egle Klumbyte, Andre Delft, European Project "Next-generation Dynamic Digital EPCs for Enhanced Quality and User Awareness D2EPC - Dynamic Digital Energy Performance Certificates", Febuary 2021, https://www.d2epc.eu/en/Project%20Results%20%20Documents/D1.2.pdf

[17] EPC shortcomings and national priority approaches to their resolution, QualDeEPC project - D2.3 Report, Sriraj Gokarakonda (Wuppertal Institut) Co-authors: Dr. Stefan Thomas, Maike Venjakob (Wuppertal Institut); Daniela Kostova (EAP), April 2020, https://qualdeepc.eu/wp-content/uploads/2020/04/QualDeEPC_D2.3_EPC-shortcomings-and-national-priority-approaches_final-20200422.pdf

[18] U-Cert project -D2.3 Report on users' perception on EPC scheme, Domen Bančič, Jure Vetršek & Dan Podjed for IRI UL, SI + other project partners contributors, February 2021, https://u-certproject.eu/media/filer_public/3c/30/3c30cb41-517f-4625-811c-0381eb745caa/u-cert_d23.pdf

[19] Next-generation energy performance certificates: End-user needs and expectations, Sheikh Zuhaib, Senta Schmatzberger, Jonathan Volt, Zsolt Toth, Lukas Kranzl, Ina Eugenio Noronha Maia, Jan Verheyen, Guillermo Borragan, Claudia Sousa Monteiro, Nuno Mateus, Rui Fragoso, Jerzy

Kwiatkowski, Energy Policy, Volume 161, February 2022, https://www.sciencedirect.com/science/article/pii/S0301421521005899

[20] Building Energy Performance Certificates for the people, webinar, Domen Bančič and Jure Vetršek (authors involved in the U-Cert project), March 2021, https://www.rehva.eu/rehva-journal/chapter/people-centred-energy-performance-certificates-for-buildings

[21] Making our homes and buildings fit for a greener future, commission guidance on how to implement revised EPBD , European Commission: factsheet about EPBD, December 2021, https://ec.europa.eu/commission/presscorner/detail/en/FS_21_6691

[22] CESBA Alps - Guide to the adoption of territorial assessment tools, deliverable written by all the partners, March 2019, https://alpine-space.org/projects/cesba-alps/deliverables/d.t3.3.1_guide_regpiem_march2019.pdf

[23] Territorial Assessment CESBA Alps, Common European Sustainable Built Environment Assessment, January 2022, Booklets politicians short.indd (filesusr.com)

[24] Review of building energy performance certification schemes towards future improvement, Yu Li, Sylvain Kubicki, Annie Guerriero, Yacine Rezgui, Renewable and Sustainable Energy Reviews, June 2019, https://www.researchgate.net/publication/335827022_Review_of_building_energy_performance_certification_schemes_towards_future_improvement

[25] Stakeholder expectations on sustainability performance measurement and assessment. A systematic literature review, Samanthi Silva, Anne-Katrin Nuzum, Stefan Schaltegger, Journal of Cleaner Production, April 2019, https://www.sciencedirect.com/science/article/pii/S095965261930229X

[26] Energy Performance Certificate for buildings as a strategy for the energy transition: Stakeholder insights on shortcomings, Stefano Cozza et al 2020, IOP Conference Series: Earth and Environmental Science, https://iopscience.iop.org/article/10.1088/1755-1315/588/2/022003/meta

[27] Linking energy efficiency indicators with policy evaluation – A combined top-down and bottom-up analysis of space heating consumption in residential buildings, Matthias Reutera,⇑, Kapil Narulab, Martin K. Patelb, Wolfgang Eichhammer, Energy and Buildings, august 2021, https://www.sciencedirect.com/science/article/pii/S0378778821002711?via%3Dihub