ePANACEA

Smart European Energy Performance Assessment & Certification

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Insights on user perceptions and needs regarding the Energy Performance Certificate (EPC)

Criteria-set for an adequate EPC and recommendations for EPC authorities for the next generation of EPCs

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OVERVIEW OF THE EPANACEA PROJECT

After 10 years of track record, the current EPC schemes across the EU face several challenges which have led to a not full accomplishment of their initial objectives: 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 Europe, lack of trust in the market and very little user awareness related to energy efficiency.

The objective of the ePANACEA project is to develop a holistic methodology for energy performance assessment and certification of buildings that can overcome the above-mentioned challenges. The vision of ePANACEA is to become a relevant instrument in the European energy transition through the building sector.

ePANACEA comprises the creation of a prototype (the Smart Energy Performance Assessment Platform) making use of the most advanced techniques in dynamic and automated simulation modelling, big data analysis and machine learning, inverse modelling or the estimation of potential energy savings and economic viability check.

A relevant part of the project is to have a fluent dialogue with European policy makers, certification bodies, end users and other stakeholders through two types of participatory actions: a feedback loop with policy makers, carried out through the so-called Regional Exploitation Boards (REBs) covering EU-27+UK+Norway on the one hand, and dialogue with end users, established by means of specific thematic workshops, on the other.

Thanks to these participatory actions, the acceptance of the ePANACEA approach will be tested and validated in order to become aligned with and meet the needs of national public bodies, end users and other stakeholders.

ePANACEA will demonstrate and validate reliability, accuracy, user-friendliness and cost-effectiveness of its methodology through 15 case studies in 5 European countries.

EXECUTIVE SUMMARY

In order to complement the stakeholder analysis carried out in the ePANACEA context, stakeholder interviews were conducted, primarily with the purpose to learn about end users' knowledge, perception, use and interests regarding the EPC, as well as their behavior regarding EEMs. Therefore, interviews were conducted on the one hand, with end users (building occupants, owners, (social) tenants and building managers) and other hand, with other stakeholders (policy maker, EPC certifier, EPC informant, EPC multiplier, energy advisor, installers) who are expected to have an influence on end users' use of the EPC and decision making regarding EEMs. Interviews were conducted in the five pilot countries of ePANACEA (i.e. Spain, Belgium-Flemish Region, Finland, Austria and Greece and in Germany. The interviews provided first insights on end users' and other stakeholders' interests and needs regarding the EPC which contributed to the concept for the subsequent user-needs workshops.

In order to take a participative approach for the development of the next generation of EPC, the ePANACEA project seeks to consider aspects that make the current EPC schemes more useful for end users. Therefore, user-needs workshops, aimed at focusing on participants' critiques and needs regarding the EPC, and were conducted with end users and other stakeholders in the five pilot countries and Germany. We anticipated that different (types of) of end users and stakeholders would have different needs.

Based on the conducted research we can conclude that end users know little about the EPC, perceive it as a mandatory document which they use for contractual actions such as deep renovation, selling or renting among pilot countries. Other stakeholders show a rather positive perception of the EPC, being aware of its original goal as a policy instrument to contribute forwarding the energy transition in the building sector. One of the most obvious common needs among end users from pilot countries + Germany (also partially supported by experts) is the interest in feedback about real energy consumption, connected to the need to receive reliable cost indications for running the building and individual recommendations. However, experts (mainly from Austria) consistently point out the original purpose of the EPC – a tool to compare the EE of buildings - which is in contradiction to giving information about real energy consumption. End users' need to monitor real energy consumption could therefore only be fulfilled by an additional tool, but not by the conventional EPC.

Besides, experts recommended to make the EPC more dynamic – which could be realized in various ways, e.g. by connecting the EPC to databases e.g. on fuel costs, policy targets and conversion factors; by using roadmaps for staged deep renovations and/or by making the EPC customizable (dynamic regarding the consideration of different user behavior). The latter could be an alternative to providing feedback about real energy consumption. By implication, this would mean that (part of) the EPC would need to become digital in order to display current, updated information.

Looking at all expressed critiques and needs, we can categorize them into three levels of the EPC: implementation of the EPC as a policy tool, generation of the EPC and use of the EPC – therefore ranging from broad to detailed. A criteria-set for an adequate EPC was developed based on the collected critiques and needs. According to this, an adequate EPC is reliable, ideally comparable in the national and international context, understandable (for end users), tangible (for end users because they can refer information to real life), comprehensive (considering regulative and technical developments), adequate and dynamic.

Furthermore, recommendations for EPC authorities for the next generation of EPC were derived from this. The formulated recommendations are separated into recommendations addressing EPC in general (covering all three levels) and recommendations for the EPC version for authorities and end users, addressing the third level (use of the EPC) respectively. In addition, recommendations draw attention to the potential of other stakeholders to improve communication about the EPC. Particularly, assessors, construction companies, selling agencies, property managers and town councils could become active as intermediate links by translating technical information from the EPC to end users. Energy advisors play a crucial role by

providing service-neutral energy advice to end users. Hence, next to the EPC schemes, the actors who get in contact with the EPC and end users, play a crucial role in fostering the awareness and understanding of the EPC as well as the uptake of EEMs.

GLOSSARY

The following abbreviations are used in this report.

BMS Building management system

EE Energy efficiency

EEC Energy efficiency class

EEM Energy efficiency measures

EMAS Eco Management and Auditing Scheme

EnEV *Energiesparverordnung* (Engl. German Energy Saving Regulation)

EPBD Energy Performance of Buildings Directive

EPC Energy performance certificate

EV Electric vehicle

GEG Gebäudeenergiegesetz (Engl. German Energy Act for Buildings)

GHG Greenhouse gas

IHD In-home display

MS Member states

POPD Protection of personal data

REB Regional exploitation board

RES Renewable energy sources

SRI Smart readiness indicator

1 INTRODUCTION

Energy efficiency (EE) and decarbonization are the most important tools to reduce primary energy consumption and greenhouse gas (GHG) emissions. Buildings consume 40% of the total energy consumption in the EU (deutsche Umwelthilfe e.V.). Therefore, it is important to implement policy tools that improve the EE of the new and existing building stock (Burman, Mumovic & Kimpian, 2014). EU member states (MS) need to comply with the Energy Performance of Buildings Directive (EPBD) since January 2009. One of the requirements of the EPBD is the introduction of Energy Performance Certificates (EPCs). The EPC is an information and market tool for climate protection. The EPC allows potential renters and buyers to compare the EE of buildings. Furthermore, the EPC should allow to estimate the costs for heating (and cooling) the building. Besides, the EPC can foster the market for energy efficient living space as it gives an impulse to users and owners of the building to implement EEMs (deutsche Umwelthilfe e.V.). EPCs shall be issued when a building is built, sold or rented, or undergoes a major renovation. EPCs are also issued for buildings occupied by public authorities and buildings frequently visited by the public above a specific useful floor area threshold. The EPBD sets general mandatory requirements but leaves a degree of freedom on how these requirements are implemented, so that MS can fit the requirements to their national context (BPIE, 2010). This leads to a wide range across the EU of calculation methods for the energy assessment of buildings, training and accreditation schemes of energy experts, communication and promotion actions for the EPC, as well as quality control, enforcement and penalty procedures, and financial handling of the EPCs (Ibid.). However, a study about the use of the EPC in Germany shows that end users do not frequently use the certificate, although they are aware of it. End users often do not trust the information or do not remember it. This may be e.g. due to the fact that the EPC does not show the financial implications which end users are interested in (Hermann, 2011). An update of the EPBD could probably increase the use of the EPC, its relevance and trust, where a redesign should consider the highlighting of financial implications of EE for end users (Ibid.). In order for the EPC to become more effective, end users' (and other stakeholders') critiques and needs regarding the EPC should be considered during the development of the next generation of EPC. Critiques and needs probably differ among EU MS and different types of stakeholders due to different EPC schemes in MS and different knowledge and use of the EPC among stakeholders.

1.1.1 Objective of this report

This report combines part of the Stakeholder Analysis and the User-Needs Analysis carried out in the ePANACEA context. The purpose of the first is to identify *who* gets in contact with the EPC (and end users). For this, stakeholder maps have been developed (cf. *Stakeholder Analysis Report: General and country specific stakeholder maps, DOI: 10.5281/Zenodo.4501327*). In order to complete the stakeholder analysis, interviews have been conducted in the pilot countries (i.e. Spain, Belgium – Flemish Region, Finland, Austria, and Greece) + Germany. The results are presented and discussed in this report. The insights from the stakeholder interviews constitute a basis for the user-needs analysis for which online user-needs workshops have been conducted in pilot countries + Germany. The aim of the workshops was to find out *what* stakeholders' critiques and needs are regarding the current EPC schemes. Based on the combination of insights from stakeholder interviews and the user-needs workshops a criteria-set for an adequate EPC was developed and recommendations for EPC authorities are derived.

1.1.2 Outline of this report

This report is structured as follows: chapter 2 provides the theoretical background for the research, then the methodology is presented in chapter 3. Next, the empirical chapters 4-5 follow. Chapter 4 describes the knowledge, perception and use of the EPC, as well as critiques and needs of and end users and other stakeholders. Chapter 4 is based on the stakeholder interviews and serves as an introduction to the main topic of chapter 5: critique and needs regarding the EPC, differentiated by stakeholders. In chapter 6 the highlights from chapter 4 and 5 are presented and discussed regarding the repetition/contradiction of perceptions and needs. Chapter 6 also suggests a criteria-set for an adequate EPC and derives

recommendations for EPC authorities for the next generation of EPC. This report ends with chapter 7, summarizing the research outcomes and providing an outlook.

2 THEORETICAL BACKGROUND

This chapter provided the theoretical background for the research. It contains information about the implementation and generation of the EPC, energy behavior of end users and suggestions to improve the current EPC

2.1 Implementation and generation of the EPC

National and public authorities shape the EPC implementation scheme by standardising the energy performance calculation method, accrediting certifiers, controlling the EPC quality and possibly enforcing EPC schemes through penalties in case of non-compliance. Thereby, national and regional authorities ensure the quality of the EPC in the respective country (Arcipowska *et al.,* 2014). Public acceptance and trust in the labelling scheme is fostered by a coherent quality assurance system. Also, the design of a labelling scheme should foresee a continuous evaluation and the option to adjust the scheme (Brohmann, Cames & Gores, n.d.). The EPC should only be issued by certified institutions, so that quality differences neither affect the comparability, nor the transparency. However, the responsibilities for the implementation of recommendations in order to improve the EE are not clearly regulated e.g. by the EnEV (German Energy Saving Regulation). Hence, the regulative requirements would need to be extended or concretized, in order to guarantee the conduction of controls through a clear assignment of responsibility (Steininger *et al*., 2017).

Often, there is a discrepancy between the actual energy use of a building and the calculated energy demand under the EPBD framework (Burman, Mumovic & Kimpian, 2014). Four major sources cause the discrepancy:

- Inaccuracies and uncertainties associated with modelling inputs
- Inadequacies of modelling methods and tools
- Procurement issues including construction process and building commissioning
- Building management and operational inefficiencies (Ibid.)

2.2 Energy Behavior

This subchapter is about energy behavior. It contains a section on factors which influence the energy behavior, motivations and barriers regarding the implementation of EEMs and the impact of the EPC on end users. The subchapter finishes with a section about the role of advisors in fostering the uptake of EEMs and thereby influencing end users' behavior.

2.2.1 Factors influencing energy behavior

Different factors influence the energy behavior of households. According to Huebner *et al*. (2015) building variables: explain 39% of the variability in energy consumption; socio-demographic variables explain 24%, **heating behavior 14% and attitude and other behaviours only 5%.** The choice of dwelling characteristics can also be considered as a type of behavior (Huebner *et al*., 2015). In addition to this, Brohmann, Cames and Gores (n.d.) explain that consumer behavior is based on individual choices, which however are largely influenced by external factors such as economic incentives, supply-side measures and appropriate infrastructure (Brohmann, Cames & Gores, n.d.). Also, the socio-political framing influences the individual decision, e.g. the existence of emission trading and eco-labelling. Hence, the EPC as a policy instrument could have an influence on individual decisions, too.

According to Trotta (2018) electricity consumption varies more directly with household composition and social standing compared to residential gas consumption for space heating, which is mostly dependent on the structural dwelling characteristics.

There are some variables which cannot easily be changed through EEMs, such as the floor area, dwelling type, climate and weather. These fixed factors are most important in determining the energy demand (Huebner *et al*., 2015**). But, as the quality of thermal properties improve, the role of building characteristics will decrease, so that occupant behavior becomes more important in determining energy demand (Mora, Carpino & De Simone, 2015).** Working from home – as many people do during the COVID-19 pandemic - significantly increases the gas and electricity usage (Huebner *et al*., 2015).

2.2.2 Motivations for an energetic renovation

Taranu and Verbeeck (2018) point out that EEMs can be motivated by environmental aspects which address the intrinsic motivation and monetary aspects which address extrinsic motivation. Regarding the decision to renovate, often other reasons than environmental protection play a role such as embellishment, living comfort, providing for old age, technical interest; climate protection is rather seen as a positive side-effect. Therefore, also the effect of renovation on other aspects such as living comfort should be pointed out to end users (Fokken, Noll & Rogalla, 2017). Next, an interplay of motives is relevant regarding complex topics such as living (in a building). A central motive for renovation is energy savings (and therefore cost savings). This motivation is combined with the wish to increase the building's market value (Ibid.).

2.2.3 Barriers of energy efficient behavior

According to Brohmann, Cames and Gores (n.d.) there are four main barriers towards the implementation of EEMs. On the individual consumer level, there are transaction costs, lack of information and motivation or a lack of knowhow and awareness and inadequate provision of appliances and infrastructure. Moreover, barriers occur regarding experts and policy instruments: lack of knowledge (by owners, installers, advisers, and consumers), lack of financing mechanisms and the lack of capacity of the craftsmen present barriers for the uptake of EEMs by end users (Ibid.). In addition, Winther and Gurigard (2017) report that a lack of financial capacity to initiate EEMs as well as lack of confidence in the profitability of such measures present barriers to energy saving in private households and institutions.

2.2.4 Impact of the EPC on energy behavior

Regarding the interpretation of the information of the EPC, occupants might have heuristic and rational thinking. Factors that foster heuristic thinking are complexity of information, choice overload and lack of salience. These factors are also applicable to the EPC. Biases in end users' interpretation of the information are common (Taranu & Verbeeck, 2018). Likewise, Steininger *et al.* (2017) report that despite the generally high level of awareness of the EPC, the understanding of the terminology and parameters as well as knowledge about the scope of the submission obligations for consumers are not yet fully available. Referring to Schuitema, Aravena and Denny (2019) buyers and renters of buildings often recognise the EPC but do not use it. The provided information may change end users' knowledge and awareness but does not necessarily impact their behaviour. Accordingly, Schuitema, Aravena and Denny (2019) mention that the **EPC is often not considered in the decision process of renting or purchasing a building because the information of the EPC is too complex and other attributes such as price and location of the building are more important factors.**

Trust is a key determinant of their attitude towards EPCs. The lack of trust may be one reason for the discrepancy between recognising the EPC and using the provided information (Schuitema, Aravena & Denny, 2019). Trust is recognised as a multi-dimensional construct, comprising aspects like competence, fairness, and transparency. The perceived credibility of the source is an underlying reason for trust in EE labels. The perceived source credibility refers to the extent to which people believe a party has expertise (Ibid.).

However, Tigchelaar, Backhaus & de Best-Waldhober (n.d.) report that owners of buildings which have been labelled/certified carry out energy saving measures more often than owners of buildings which are not certified. Likewise, householders who are aware of EPC recommendations are found to be twice more likely to initiate EEMs, compared to households that are not aware.

This means that either the awareness of EPC recommendations triggers the uptake of EEMs or that people who are interested in EE topics are more aware of EPC recommendations (Ibid.).

2.2.5 The role of advisors in fostering energy efficiency measures

The contact to advisors and implementers of EEMs is important in order to establish communication about EE (Fokken, Noll & Rogalla, 2017) **and the EPC because they are likely to suggest and influence refurbishment measures** (Arning, Zaunbrecher and Ziefle, 2019). Decisions concerning the renovation process are heavily influenced by intermediaries' advice, especially craftsmen and energy advisors. Intermediaries can be powerful actors because they share knowledge, shape the scope and quality of EE retrofits and affect the consumption pattern in the residential sector. **The taking and acceptance of advice depends on the trust in the advisor as a person and in his/her competence** (Ibid.2015). Arning, Zaunbrecher and Ziefle (2015) point out that often energy advisors are only consulted by end users because their involvement is mandatory to receive certain state subsidies. In addition, end users have a low willingness to pay for the advice since it is not clear what it entails (technical training background of energy advisors varies, in addition there is a lack of transparency on the quality standards for the advisory process of energy advisors). Expectations regarding consultancy vary from 'the necessary evil' to 'an important source of information' (Fokken, Noll and Rogalla, 2017).

Energy efficient buildings should become more attractive through a clearer communication of the monetary and non-monetary advantages for all consumer groups. For this new information channels could be used, such as social media and apps. Besides, advice centers geared towards energy consultancy can inform consumers about questions about the EPC. Thereby, they can contribute to a targeted and cost-effective building renovation. In addition, a higher sensitization of consumers could be reached through a targeted consultation. This would strengthen the importance of the EPC to contribute to the achievement of the climate protection goals, especially on the way to a climate-neutral building sector by the year 2050 (Steininger *et al*., 2017). Fokken, Noll & Rogalla (2017) explain that end users wish for support and instructions during the whole process because renovation is not a single event. In order to be effective, energy conservation interventions need to consider the heterogeneity of households and building characteristics. Hence, they need to be sensitive to context-specific factors (Trotta, 2018).

Looking at who end consumers consult in their decision making process, it appears that they mostly search for information on the internet and consult family, friends or other customers, instead of looking for assistance from professionals in stores. Hence, they show a so-called "social-search behaviour" (Munkacsi & Mahapatra, p.2). Some studies emphasise the diminishing importance of the installer because of the increasing importance of the internet as a source of information (Munkacsi & Mahapatra, 2019). Also Tigchelaar, Backhaus and Best-Waldhober (n.d.) point out the importance of **social networks** during the decision process about EEMs. **Friends and families were found to be** even m**ore important than expected**. The question is how policy makers can make use of these networks (Tigchelaar, Backhaus, de Best-Waldhober, n.d).

2.3 Suggestions to improve the EPC for end users

The question is how the EPC could be improved such that it becomes more understandable and useful for the end user. This subchapter contains suggestions to improve the EPC that concern the content and the visualization of information in the EPC. Also, the aspect of providing feedback about real energy consumption is described which could represent added value to the EPC. Finally, the subchapter presents the idea to make the EPC more target-group oriented.

2.3.1 Improving the content of information tools

- **In order to involve the end user more an idea is to empower the end user to make the first estimations regarding the energetic condition of the building** (Fokken, Noll & Rogalla, 2017). This increases the self-effectiveness of the end user.

- **Taranu and Verbeeck (2018) emphasize that it is important to translate technical information to users.** Thereby, the clue is to make technical information tangible to laypersons without losing its credibility and trust (e.g. providing comparisons). **The wording of the information plays a crucial role: less technical terms should be used and the length of the content should not be too long.** End users should be able to read the certificate, independent from the assistance of energy experts (Taranu & Verbeeck, 2018). Also Fokken, Noll and Rogalla (2017) explain that information should be goal-oriented and therefore should be limited to the significant information.
- **Owners consider it as a handicap that they do not know about the financial implications of owning a building with a certain energy efficiency class** (EEC; Kastner & Stern, 2015). According to Kastner & Stern (2015) end users should receive information about the costs for energy and the potential savings that could be obtained after the implementation of EEMs. Therefore, the introduction of a heating cost parameter would be desirable. This parameter could inform the consumer about cost savings and would contribute to a better understandability of the information for consumers (Steininger *et al*., 2017). The *Report on the Use of Innovative Certification Schemes and its Implementation* (DOI: 10.5281/Zenodo.4525223) already suggested using an indicator which is based on cost-ratio (e.g. costs per day, month or year). Taranu and Verbeeck (2018) propose that end users are able to choose the unit in which they are informed about the energy performance of the building.
- **The inclusion of practical recommendations and tailored advice increases people's trust and perceived usefulness of the EPC** (Tigchelaar, Backhaus, de Best-Waldhober, n.d.). In order to implement EEMs it is important for end users to know the reasons behind measures and different options, as well as to receive information about materials and techniques that are used for the implementation of EEMs (Fokken, Noll & Rogalla, 2017). According to Delmas, Fischlein and Asension (2013) simple energy saving tips such as "turn off the lights when leaving the room" can be abstained from because they do not have a big impact on the energy saving behavior.
- At the moment, the EPC does not provide an overall concept for restructuring measures. But, it is a central driving force to initiate EEMs. **Individual renovation roadmaps need to be developed such that the impulses can unfold their effects** (Deutsche Umwelthilfe e.V., 2016). **Like the renovation roadmap the EPC should be dynamic and open, such that individual information can be incorporated, an individual renovation roadmap prevents the information from getting too complex for the reader**. An individual roadmap for renovations should include real-time, real-performance data in order to track savings (Fokken, Noll & Rogalla, 2017). Moreover, one could consider an online based tool next to a hard copy. According to Fokken, Noll and Rogalla (2017) end users would appreciate this because this would allow showing changed plans, energy prices, funding options and regulations. More features could be linked to the EPC such as smart finance models with a link to bonus programs; a tool to find craftsmen, instructions for self-implementation of smaller measures; early warning systems (in case they heating fails), technical updates, or a "Scheckheft" which documents implemented measures and can be handed over to the next owner (Ibid.).

2.3.2 Role of visualization of information in the EPC

According to Taranu & Verbeeck (2018) the layout of information, next to the content and wording, is important to make the EPC more relevant for decision making. Likewise, Fokken, Noll and Rogalla (2018) state that visualization of the information is decisive for the perception by end users. In general, there is a desire for more illustrations among end users (Fokken, Noll & Rogalla, 2018). The purpose is to increase awareness/comprehensibility of information regarding EE/consumption with visualization. According to Aboagye-nimo *et al*. (2016) thermal images could help to increase awareness about heat losses of a building envelope. Regarding the label for rating the EE of a building we should note that the visual scale might need to be adjusted because of the satisfice bias (Taranu & Verbeeck, 2018*)*. However, issuers of EPC often like to use favourable labels to signal overall quality in order to avoid gaining a bad reputation (Brohmann, Cames & Gores, n.d.).

2.3.3 Individual real-time feedback

According to Delmas, Fischlein and Asension (2013) individual real-time feedback of energy consumption, in combination with other measures, can foster energy saving behavior. The aim of metering and feedback is that consumers receive detailed, comparable and comprehensible information about their energy use (Brohmann, Cames & Gores, n.d.). There are four different categories of feedback measures:

1. Informative billing (most often on electricity, sometimes on gas or district heating, too).
2. Feedback by energy audits or advice programs
3. Single measurement (for instance of electric consumption)
4. **Smart measurement (home automation)** (Ibid.)

If the provided information is linked with a device to control the consumption the empowerment of the customers increases (Brohmann, Cames and Gores, n.d.). **Then, it should be considered that perceived ease of use and perceived usefulness are the two most important factors explaining system use (Legris, Ingham & Collerette, 2001**). **Moreover, the time scale of displayed values influences how useful the information is for end users (Taranu & Verbeeck, 2018).**

From the *Report on the Use of Innovative Certification Schemes and its Implementation* (DOI: 10.5281/zenodo.4525223) we can use the information that energy rating systems could become dynamic, based on actual consumption data of the building sector, according to an appropriate classification per building typology and use. With the availability of an appropriate actual consumption database of the current building stock, actual benchmarking would be possible. Benchmarking would allow the end user to put the energy consumption of a building into context. Knowing about the (comparative) level of consumption and the associated costs motivates a change to use energy more efficiently; an improved feedback may reduce the energy consumption by up to 20% (Tigchelaar, Backhaus & de Best-Waldhober, n.d.).

2.3.4 Splitting the EPC

From the *Report on the Use of Innovative Certification Schemes and its implementation* (DOI: 10.5281/Zenodo.4525223) we can learn that indicators should be tailored to the target audience, e.g. primary energy indicator for the government agency; energy cost indicator for end users, economic feasibility of the EEMs for energy auditor. Moreover, the main indicators oriented to end users should be based on actual consumption data which can be easily translated into costs. This indicates that it may be necessary to split the EPC into two versions/parts (one oriented to authorities and one oriented to end users).

2.4 Conclusion of the theoretical background

Based on the insights from this chapter we may suppose that the EPC might not be accepted and used by the majority of end users. We may question what end users know of the EPC, how they use it and what information is most interesting to them. We can conclude that a lot of factors influence energy behavior and the EPC may have only little to no effect. Opposed to this, the communication by intermediaries about EE and the EPC is important to foster the uptake of EEMs. This suggests to consider other stakeholders next to end users in the interviews and user-needs workshops in order to learn about by whom and how end users are influenced during decision making regarding EEMs. Also, we can derive themes for the interview guide based on the insights (e.g. knowledge, perception and use of the EPC as well as most interesting information to end users and other stakeholders, as well as the influence of other stakeholders on end users' decision making). Besides, this chapter suggests needs by end users regarding the EPC (understandable content, information about costs, individual recommendations) and needs that may be expressed by other stakeholders like policy makers (e.g. improving the quality monitoring). Moreover, this chapter proposes features that may improve the EPC schemes. This provides input for the concept of the user-needs workshops (real-time feedback, cost indications, road maps etc.).

3 METHODOLOGY

This chapter provides the methodology implemented within this research in ePANACEA. First, the overall research approach is presented. Then, the approach for literature review and the conduction of the stakeholder interviews and the online-user-needs workshops is described. Finally, lessons learned from the interviews and user-needs workshops are listed.

3.1 Research approach

Prior to this study, stakeholder maps were developed during the Stakeholder Analysis in order to identify *who* gets in contact with the EPC and end users. The *Stakeholder Analysis Report: General and country specific stakeholder maps* (DOI: 10.5281/zenodo.4501327) suggests that stakeholders of the EPC can in general be divided into (different types of) end users and other stakeholders (policy maker, EPC certifier, EPC informant, EPC multiplier, energy advisor, installers) and that the latter have an influence on the energy behavior of the first. In order to complement the stakeholder analysis interviews were conducted in the five pilot countries + Germany with the purpose to understand *who* gets in contact with end users and the EPC and what end users' and stakeholders' knowledge, perception and use of the EPC are, as well as finding out what information of the EPC they are most interested. Finally, the interviews served to learn about who and what influences end users' energy behavior (especially the uptake of EEMS). In addition, the stakeholder interviews delivered first insights on the critique and needs by end users and other stakeholders regarding the EPC. For the user-needs analysis user-needs workshops were conducted in the pilot countries + Germany, in order to be able to analyse user needs more precisely. On the basis of the insights from literary research, themes for the interviews and workshops could be determined.

3.2 Literature Review

Literature study was performed to write the chapter "theoretical background". Therefore, it was also conducted to set up the interview guide for the interviews (knowledge, perception and use of the EPC, as well as information deemed important by end users and other stakeholders and the influence of intermediaries on the energy behavior of end users). Likewise, literature was analyzed to provide a concept for the user-needs workshops (needs of stakeholders and possible features to improve the EPC).

3.3 Interviews

For the conduction of the interviews in pilot countries + Germany IZES provided guidance to project partners on the following points: objectives of the interviews, guidance for the recruiting of participants and the interview guide. Bilateral meetings took place between each involved project partner and IZES in order to discuss the suggested approach. After the feedback by project partners was incorporated, project partners and IZES started to conduct the interviews in the pilot countries and in Germany.

3.3.1 Objectives of the interviews

Primarily, the interviews were held to gain insights for the stakeholder map and secondly to gain insights for the conceptualization of the workshop on user needs.

Precisely, the themes of the interviews with end users were:

- Individual state of knowledge about EPC
- Importance of the EPC and connection of EPC and the energy transition
- Purpose of contact with EPC

- Most central information of EPC to end users, insights on needs
- Connection to other EPC user group: influence of other stakeholders on energy behavior

Themes of interviews with other stakeholders:

- Description of their job and contact therein with the EPC
- Individual state of knowledge about the EPC
- Importance of the EPC and connection of EPC and energy transition
- Most central information of the EPC to end users, insights on needs
- Insights on end users from other stakeholders' perspectives
- Influence on energy behavior of end users

3.3.2 Recruiting interviewees

This subsection describes the guidelines on the selection of interviewees (including target group, target number, criteria for selection) and the informed consent and pre-interview questionnaire which were handed to interviewees before the interview.

3.3.2.1 Target group and Selection of Interviewees

The target group of the stakeholder interviews were end users of the EPC and other stakeholders who get in contact with end users and the EPC and therefore are expected to influence end users' perception of the EPC, their acceptance and use of the EPC and therefore also their energy behavior (e.g. initiating renovation or not). Therefore, we do not study end users of the EPC as an isolated group, but as a group which is embedded into a social context. We expect that the inclusion of other stakeholders in the analysis will help to understand end users' decision making and behaviour regarding the use of EPCs and the uptake of EEMs. Moreover, we expected that the interviews with other stakeholders, who are often experts/professionals regarding the EPC (e.g. policy makers, certifiers of the EPC, informants about the EPC) will help to increase our understanding of different EPC schemes in the pilot countries + Germany.

The target range for the number of interviews in each country was 8-15 interviews. Thereof, the target range of interviews with end users was 5-10 and for interviews with other stakeholders was 3-6. The aim was to collect possibly diverse answers from different end user types and other stakeholders, while also being able to find recurring themes in the answers. Knowing the relevance of socio-demographic factors and building characteristics in determining the energy behavior of citizens we wanted to interview possibly diverse end users. Therefore, project partners had to consider to achieve a good gender balance, but also a balance regarding other variables such as occupant age, educational background and location of the building as well as the relation to the building in reference (owning, renting, social renting, occupying as e.g. employee, citizen or student, managing building), type of building (flat in multi-family house/flat/terraced house/ detached house) and usage of the building (residential/educational/commercial). This would allow us to understand the perception (and needs) of possibly diverse EPC end users. Also regarding other stakeholders, a group of interviewees should be selected which is possibly diverse regarding their interviewees' professions. After all, the interviewees were selected by the project partners according to interviewees' availability and accessibility.

3.3.2.2 Informed Consent and pre interview questionnaire

In order to ensure the fulfilment of GDPR requirements potential interviewees were informed about the research within the ePANACEA project and the conditions of their participation in an informed consent sheet. The informed consent templates are available in the protection of personal data (POPD) plan. The informed consent sheets have been prepared together with CENER and SYMPRAXIS. Prior to the interviews informed consent was collected from end users and from other stakeholders.

Before each interview, demographic data of the interviewee was gathered in order to track the variability of interviewed end users and to be able to attribute end user characteristics to the provided answers in the interview. Demographic data was enquired in the form of short a pre interview questionnaire. Aspects that were covered in the short pre-interview questions comprise: country, location of the building, type of building, function of building, ownership status of building. In addition, data regarding gender, age, educational background were collected.

3.3.3 Interview guide and conduction of interviews

Two interview guides were prepared by IZES: one for end users (cf. Table B,5) and another one for all other identified stakeholders (certifiers, advisors, policy maker, EPC multipliers, financiers and craftsmen; cf. Table B,6). The interview guide was meant as a guideline, not as a standardized questionnaire, i.e. that the use of the interview guide was flexible and could be adopted to the specific situation. For instance, the order of the question may be adopted according to the interviewee's responses. Bold questions in the interview guide were marked as "most important". The interviews were expected to take approx. 30 minutes each. Table B,5 and Table B,6 show the interview guides, give an overview of the reason for asking the question, the question itself and sub questions. Sub questions can be used as follow up questions. The project partners were allowed to adjust the questions in the interview guide if it appeared to be reasonable. We chose to conduct semi structured interviews because it allows us to capture individual understandings and experiences of interviewees.

Due to the pandemic most interviews took place on the phone or online. Also, the interviews were conducted in the respective national language to include non-English speaking citizens, too. Stakeholder interviews have been conducted by CENER (in Spain), VITO (in Belgium – Flemish region), VTT (in Finland), EASt and TUW (in Austria), CRES (in Greece) and IZES (in Germany). In total 63 interviews have been conducted in 6 different countries. Thereof 38 interviews were conducted with end users and 25 with other stakeholders (cf. Table B,7).

3.3.4 Data collection and analysis

Project partners provided a summary of each interview (1-2 pages) in English to IZES. The summaries were based on the record of the interview and e.g. the researcher's notes. The summaries were supposed to cover answers to the questions from the interview guide and additional aspects that were addressed and seem to be connected to the topic. The analysis of interviews was conducted by IZES. Thematic analysis involves coding and categorization of the texts to find recurring patterns and themes (Heinonen & Medberg, 2018). In general, the interview questions constituted a good basis for the finding of key themes. In this report, results are either generalized or the interviewees are referred to by numbers for anonymization purposes. Data from the stakeholder interviews is presented under headings, reflecting the main themes (Rowley, 2012) in chapter 4. Both repeated answers and opposing answers are reported.

3.4 User-Needs Workshops

The objective of the user-needs workshops was to explore participants' needs and interests regarding the EPC. Knowing that there are different stakeholders who have different understanding and knowledge of the EPC, we could expect different critiques and needs. Therefore, the objective was to find out how the perceptions and needs can be differentiated among stakeholders. The conduction of the user-needs analysis supports a participative EPC development because the aim is to consider stakeholders' feedback in the *Methodology Development* for the next generation of EPC which will be carried out during the ePANACEA project.

3.4.1 Guidance for the user-needs workshops

IZES provided the concept and the guidance for the conduction of the user-needs workshops for project partners. The guidance included indications on several aspects: recruiting or participants, communication with participants before the workshop, the distribution of roles and tasks within the moderation team and methods for an interactive workshop. Furthermore, IZES provided a script for the conduction of the workshop. Coaching sessions took place in order to discuss the provided concept with project partners. Project partners were made aware to adapt the structure and content of the concept for the workshop in order to fit it to the respective national context.

3.4.1.1 Recruiting of participants

IZES recommended finding approx. 15 participants for the workshop in each pilot country and in Germany, where approx. half should be end users and the other half other stakeholders (e.g. 7 end users, 8 other stakeholders). The selection criteria for participants were similar as for the stakeholder interviews: the aim was to attain a possibly high variability among participants. Regarding end users this meant to achieve variability among relationships to the building (e.g. owning/renting etc.); location, type and use of the building, participant age, educational background and income. These variables were surveyed in a short pre-workshop questionnaire (available in the POPD plan). Regarding other stakeholders we aimed at achieving variability among their profession and contact therein with the EPC and end users (e.g. architects, policy makers, EPC certifier, installer, consumer association, energy agency etc.). Both, stakeholders who already had taken part in an interview, and stakeholder who had not were invited to the user-needs workshop.

3.4.1.2 Informed consent an pre workshop questionnaire

Similar as for the interviews project partners had to collect informed consent from stakeholders prior to the participation in the workshop. The two used models are available from the POPD plan. Before the informed consent templates could be sent to potential participants they were translated into the respective native language by project partners.

Project partners were asked to send the pre-workshop questionnaires to the potential participants in order to collect the socio-demographic data. This sheet also had to be translated by project partners into the respective native language.

3.4.2 Script for the conduction of the workshop

A script with information about the respective content, method, time specification and responsible roles was prepared by IZES and shared with project partners. The script was planned for a duration of the workshop of approx. 2 hours. IZES prepared a PPP belonging to the script, which was available to be used during the user-needs workshops. The suggested script for the user-needs workshop (streamlined for this report) is provided in Table C,8.

3.4.2.1 Introduction and collection of critiques and needs

The introduction of the workshop served to introduce participants to the project ePANACEA, to the workshop, to the moderators and allow participants to introduce themselves by telling their name, for which organization they work and to what stakeholder(s) they can attribute themselves to**.** In order to collect the critiques and needs regarding the EPC by different stakeholders, participants' feedback regarding the EPC was collected in a mind map after the country-specific EPC had been presented and explained. The short presentation of the country-specific EPC should ensure that all participants had seen the EPC and understood the main information.

3.4.2.2 Presentation and evaluation of suggested features to improve the EPC

After the unstructured collection of feedback from participants, the moderation team was supposed to present suggestions of features to improve the EPC to participants. The input for this part was based on insights from The *Report on the Use of Innovative Certification Schemes and its implementation* (DOI: 10.5281/Zenodo.4525223), literature review and stakeholder interviews (interviewees' critiques and needs) as visualized.

Figure 1: Sources for the suggestions on how to improve the EPC

The consideration of the aforementioned sources of input resulted in the following selection of potential features to improve the EPC:

- Inclusion of real energy consumption data (insight from stakeholder interviews)
- Benchmarking of the energy consumption (suggestion from *The Report on the Use of Innovative Certification Schemes and its implementation* (DOI: 10.5281/Zenodo.4525223)
- Inclusion of environmental and life cycle indicators (insight from stakeholder interviews)
- Use of different units to express the energy efficiency of a building (insight from stakeholder interviews)
- More comprehensive recommendations (insight from stakeholder interviews), the list of aspects to receive recommendations about was taken from the EPBD project
- Guidelines for the ever-day energy behavior (insight from stakeholder interviews)
- Visualizations: thermal images and 3D model of the building envelope (literature review)
- Features of a smart and dynamic EPC (literature review)
- Format/versions of the EPC (split and oriented towards a respective target group; insights from stakeholder interviews and The *Report on the Use of Innovative Certification Schemes and its implementation* (DOI: 10.5281/Zenodo.4525223))
- Strengthening the communication about the EPC and EEMs (insights from stakeholder interviews)

The presented suggestions were either discussed in the plenary or evaluated in Google Forms by participants. The questions in the poll in Google Forms asked about participants' **understanding and perceived usefulness** of the suggested features. They are listed in Annex E *Conduction of the user-needs workshops* for each suggested aspect. Not all suggestions were discussed in each workshop, depending on whether the suggestions had already been discussed during the workshop and depending on the remaining time. We decided to make a poll during the workshop in order to receive feedback from possibly all participants.

Regarding the collection of feedback it is important to differentiate between different stakeholders. For this, the audio/video record helped to attribute statements of participants to stakeholder roles. The answers to the poll in Google Forms can be allocated to stakeholders as well, because participants were asked to indicate their stakeholder role in the first question. Knowing the differences of the EPC schemes is a basis for understanding the critiques and needs by stakeholders from the different pilot countries and Germany. The most relevant aspects of EPC schemes of ePANACEA pilot countries and Germany which are expected to be relevant for the stakeholder analysis and user-needs analysis are listed in Appendix A.

In the end, the concept for the online-workshop scheduled time for additional points that participants might want to discuss and for a preliminary conclusion of the workshop. The PPT and the poll in Google Forms had to be translated by project partners (CENER, CRES, VITO and IZES) into the respective native language.

3.4.3 Conduction of the user-needs workshops in pilot countries of ePANACEA + Germany

For the user-needs analysis six user-needs workshops have been conducted in the five pilot countries + Germany. The workshops were conducted online due to the COVID-19 pandemic. Also, in order to reduce language barriers most workshops were conducted in the respective native language by the project partners (except for the workshop in Finland which was held in English). For the documentation of the workshop, IZES asked project partners to record the workshops (if consent was given by all participants) to save the mind map about participants' needs and to take minutes.The basic concept of the user-needs workshops was modified by CENER and VITO. The adjusted structures and information about the conduction in each participating country are indicated in Appendix C. In total 60 participants (26 end users and 34 other stakeholders) took part in user-needs workshops in 6 countries. The overview of the number of participants per country and stakeholder type is provided in Appendix C, Table C,9.

3.4.4 Data collection and analysis of the user-needs workshops

IZES provided a template to project partners for writing the minutes, which should include the collected critiques and needs (e.g. from the mind map) summary of the discussion regarding the suggested features to improve the EPC and results from the poll (e.g. in Google Forms). Based on the collected data the user-needs workshops were analysed by IZES, considering different types of stakeholders, weaknesses and strengths of the respective EPC scheme. Results from the user-needs workshops for each country are presented under headings, reflecting the main themes in chapter 5. Also, chapter 5 indicates how many and what kind of stakeholder expressed a certain critique/need. Also, divergence between opinions is reported.

Finally, considering results from stakeholder interviews and user-needs workshops from all pilot countries + Germany IZES looked for recurring themes to reflect on whether/what perceptions, understandings, critique and needs were country-specific, common or dependent on the type of stakeholder. The results of this analysis are discussed in chapter 6. Based on the findings, IZES derived a criteria-set for an adequate EPC and recommendations for EPC authorities for the next generation of EPC.

4 STAKEHOLDER INTERVIEWS

This chapter gives an overview of the outcomes of the stakeholder interviews in each pilot country. Each subchapter for a specific country contains a description of the interviews that were interviewed. Moreover, they contain on the one hand, information from interviews with end users and on the other hand content from interviews with other stakeholders. In general, the results regarding end users for each country are further categorized into perception, knowledge and use of the EPC, critique and needs regarding the content of the EPC by end users. The results regarding other stakeholders for each country are categorized into perception of the EPC, critique and needs regarding the content of the EPC (which may be further categorized), insights on end users from the perspective of other stakeholders and recommendations by interviewed other stakeholders on how to improve the EPC for end users. The final categorization of themes for each country varies a bit among pilot countries + Germany, depending on which topics seemed important to end users and other stakeholders. For each country, a conclusion is drawn at the end of a subchapter.

4.1 Stakeholder interviews in Spain

In Spain there have been 9 interviews conducted in total, whereof 6 interviews have been conducted with end users and three with other stakeholders, including two interviewees who work in the field of policy making - one interviewee works at the Directorate-Genral for Urban Agenda and Architecture (Ministry of Transport, Mobility and Urban Agenda of Spain) and the other one has supported the implementation of the EPBD in Spain - and one architect.

4.1.1 End users

The following sections describe and analyse the perception, knowledge and use of the EPC by end users, as well as end users' expressed needs regarding the content of the EPC.

4.1.1.1 Perception, knowledge and use of the EPC

Based on the interviews, end users from Spain have limited interest in the EPC and regard it as a 'mandatory document' that must be available or presented during the purchase process. One end user stated that "when the EPC was issued**, it gave me the impression that it was a mere bureaucratic procedure."** It is apparent that end users, aside from the understandable graphics, often have little or no understanding of the EPC values and cannot interpret them in terms of their own household. Only end users who already had to apply for the EPC show a broader knowledge. Nobody has mentioned the EPC as a (priority) decision support for renovation projects or when purchasing/renting a building. **Other factors are more decisive**, **especially in Spain, where costs for energy consumption are relatively low compared to other costs**.

4.1.1.2 Needs regarding the EPC

In terms of content, **end users would like to see a more customized EPC with usage advice for everyday life and individual recommendations for investment opportunities**. Moreover, end users are interested in learning about the costs of implementing EEMs. **The EPC also lacks information on actual household energy consumption. Moreover, one end user was interested in knowing the estimated annual heating cost of his/her dwelling.** Two other end users expressed their interest in knowing the 'correct use of the building. Accordingly, one end users suggested **including a list with good practices regarding the use of the building,** e.g. a lighting schedule, thermostat setting and measures for water-saving. He/she would also appreciate it if the share of renewable energies was presented in a clear way.

4.1.2 Other stakeholders

The following sections describe and analyse the perception of the EPC by interviewed other stakeholders. It also contains a section of the multiple objectives of the EPC as explained by an interviewed policy maker. Next, suggestions on how to improve the EPC according to interviewed other stakeholders are presented. Moreover, other stakeholders' perspectives on end users of the EPC in Spain and suggestions on how to improve the EPC for end users are presented.

4.1.2.1 Perception of the EPC

For interviewed other stakeholders the EPC has a higher potential, which is not yet sufficiently taken into account. For instance, the interviewed policy maker (2) **perceives the EPC as a very important instrument to promote transparency regarding EE in the buildings sector.** To him, it is **a global instrument** that allows to provide information to end users regarding their buildings' EE. He had always considered that the EPC is a key instrument to the buildings sector with potential for improvement. **It is a key instrument which allows to adjust grant programmes for building renovations**. However, he admits that although the EPBD announced the instrument as a key to mobilize EE investments in the energy sector, it is not the case at the moment.

4.1.2.2 Multiple Objectives of the EPC

One interviewed policy maker explained that the **EPC was originally implemented with the objective to improve the knowledge of the building stock** for the Spanish Administration. This requires the use of indicators, e.g. primary energy [kWh/m^2 year] and emissions [kg (CO_2)/m^2 year]) which end users probably do not understand. Overall the policy maker thinks that "the EPC is a relevant instrument for meeting the objectives for the energy transition", considering that it contains recommendations for EEMs. Moreover, he points out that the **EPC has multiple functionalities/objectives**:

- **For the central Administration**, the main objective is to improve the knowledge regarding the current buildings sector. In this case, the whole information included within the EPC at the moment is necessary (e.g. global indicators of primary energy and emissions, sizes, categorization...).
- **For energy auditors, manufactures or companies** that are trying to introduce some products into the market, it is important to know the total energy use and to take into account the partial values (e.g. energy use and energy need according to each service) as well as the recommendations of technologies.
- **For end users,** the most relevant information is the class (the label) in order to see how much their buildings can improve and recommendations. The rest of information is not understandable **for them without the correct interpretation by an EPC assessor.**

4.1.2.3 Suggestions to improve the EPC

An interviewed technical architect explains that he would appreciate it if **databases with information about "measures, investment costs and energy costs" were available**, **which were continually updated.** Regarding the calculation of the EPC the **continuous update of primary energy conversion factors and rating system (scales)** should be possible in order to check European targets (e.g. RES, emissions etc.). This could be realized if **information was digitized and available online**. Policy maker (2) adds that there is a **clear target for 2050 and** the issue is "how we are managing to meet the objective". Besides, significant changes will occur until 2050 like the change of fuels, electricity mix, and demand for electrification. He/she continues that "**everything is going to be very dynamic and this is another handicap of the current EPC scheme at least in Spain, it is too static"**. Therefore, the whole EPC methodology should become dynamic in order to support the energy transition. On the one hand, the EPC should stay a legal instrument, which is linked to grant programmes. On the other hand, the EPC should be also able to provide more **dynamic information, e.g. on how the energy use changes if the building occupant changes his/her behavioural patterns or what the updated value of indicators is if conversion factors have changed due to a more recent electricity mix**. Therefore, one would have to discuss what databases would be most appropriate to use in order to generate up-to-date EPCs. The other interviewed policy maker agrees that EPC schemes

should include the **building end user dimension**, because this would **show how behavior patterns affect the energy use** inside the building.

Also, from a stakeholder perspective, the **EPC could be divided into a section with technical information for experts and a user-related section**. In order to improve the EPC for administration the policy maker thinks that **links to data bases of funding and building passports** should be provided. Also, more information regarding t**echnical characteristics of the building should be included such as location, HVAC and the global building efficiency**.

4.1.2.4 Looking at end users from the perspective of other stakeholders

According to the interviewed technical architect, end users think that the EPC is **an useless expense**. However, this perception has gradually changed; now end users can compare the EPC with other certification schemes (e.g. for electric appliances) and they like to obtain a good EEC for their own buildings. **End users would also be aware that they do not have access to grants for refurbishment works, if the building does not have an EPC**. Policy maker (1) agrees that funding for investment in EE linked to EPCs has been useful to improve the perception regarding the importance of EPCs. The same can be observed regarding end users in Greece. Policy maker (2) adds, that nowadays there is a higher environmental awareness which also contributes to an improved perception of the EPC. However, policy maker (2) experienced that although the concept (EEC associated with labels A-G) is regularly used for appliances and end users are familiarized with it**, the concept has not had the same impact in the buildings sector yet**. **Policy maker (1) supposes that the EPC is no decisive criterion during the decision making to rent or buy a building, because the energy costs would be low compared to the other costs associated with a building/dwelling/house**.

4.1.2.5 Suggested improvements of the EPC for end users

The technical architect recommended that **graphic representations about EEMs e.g. highlighting the impact on the energy use or the EEC,** could be helpful for end users to understand very technical data. The policy maker (1) also stated that the EPC, and the information as it is provided at the moment is **too complex** from an end user perspective. The current indicator (net primary energy) works for the administration but in order to engage end users and make the EPC understandable for them, **EPC schemes should include the *building end user dimension***, **indicating how user behaviour patterns affect the energy use inside the building.** Moreover, the interviewed policy maker (1) thinks that recommendations should be more **reliable** and **personalised** to each case. Policy maker (2) emphasized that the EPC has to provide **clear and short messages**, which are easy to understand.

4.1.2.6 Communication about the EPC

Other stakeholders anticipate that the **lack of explanations of the content in the EPC prevented the user from taking active action.** The interviewed policy maker (1) explains that EPC certifiers/EPC assessors are important to improve the understanding and knowledge regarding EPCs and EE for end users. But, they usually do not get in contact with final users in order to provide orientation regarding the most suitable measures. This should be changed; however, **this would be difficult due to the current EPC tariffs, which are very low in Spain.** The costs would rise with a more advanced EPC. Referring to new buildings, the **building company** is also important to inform customers regarding the importance of the content in the EPC. They should explain what type of building (or dwelling) they are selling from the 'energy use point of view'. The policy maker continued that a**lso selling agencies** (real estate companies) would have an important role: when they show an apartment for selling or renting, they should inform about the EPC as another relevant aspect for decision making. However, it is not the case at the moment. Accordingly, the potential importance of **property managers and town councils** was mentioned by a policy maker. These stakeholders could be "the link between technical information and end users" by e.g. giving information about the access to grants for refurbishment and their conditions. So, it is a shared task of involved stakeholders to make end users more aware of the EPC and EEMs. **Other intermediate links next to stakeholders could be websites and one-stop-shops** which

would enable end users to receive information and to carry out multiple steps with one stakeholder. The interviewed policy maker (2) explained that end users should make the final decisions regarding their **buildings, always supported by experts in order to make the most proper decisions**. So, to improve the understanding and use of the EPC for end users it is not only important to improve the EPC itself, but to also make stakeholders aware of their responsibility to explain information.

4.1.3 Conclusion of the stakeholder interviews in Spain

Interviewed end users from Spain perceive the EPC as a mere bureaucratic procedure and do not pay much attention to the EPC since energy costs are not high. They are missing advice for everyday life (e.g. a list with good practices regarding the use of the building) and individual recommendations for investment opportunities. According to them the EPC also lacks information on actual household energy consumption. Moreover, one end user expressed interest in knowing the estimated annual heating cost of his/her dwelling. Interviewed other stakeholders perceive the EPC as a very important instrument to promote transparency regarding EE in the buildings sector and to adjust grant programmes for building renovations. The EPC has multiple functions for policy makers, energy auditors, manufactures or companies and end users. Interviewed other stakeholders suggested dividing the EPC into a section with technical information for experts and a user-related section for the end user. Other stakeholders expressed their need for databases with continually update information about "measures, investment costs and energy costs". Moreover, they demand other forms of dynamization of the EPC, e.g. real energy consumption data in order for end users to see how they can influence their energy consumption with different behavioural patterns, or updated values of indicators if conversion factors have changed due to a more recent electricity mix. The EPC is too complex for end users and could be simplified by graphic representations, clear and short messages. Besides, recommendations to end users should become reliable and personalised. Moreover, the role of intermediaries (e.g. EPC certifiers, building companies, selling agencies, town councils and property managers) should include the translation of technical information from the EPC to end users. Other intermediate links next to stakeholders could be websites and one-stop-shops. End users' decisions regarding EEMs should always be supported by experts in order to make the most proper decisions.

4.2 Stakeholder interviews in Belgium (Flemish Region)

In the Flemish Region of Belgium 9 interviews were conducted, 5 of them with end users and 4 with other stakeholders (architects, researchers in the field of energy, an employee from the Flemish energy agency - VEA - and an employee from the social housing association Zonnige Kempen).

4.2.1 End users

The sections on interviewed end users in Flanders present the perception and use of the EP, the critique and needs regarding the EPC and end users' behavior regarding the initiation of EEMs.

4.2.1.1 Perception and Use of the EPC

In Flanders, similar problems as in the other ePANACEA pilot countries and Germany were observed. **End users likewise reported that the EPC is a mandatory document in the handover process of houses and apartments and is specified in real estate tenders**. Accordingly, one end user described the EPC as "necessary evil". However, some interviewed end users mentioned that the EPC was used to calculate possible renovation costs, for example when buying a house. For instance, one end user knows that "the less energy efficient house, you will have to renovate sooner" and thinks that the EPC informs about the required renovation measures and costs. This statement indicates that the user understood what the original purpose of the EPC is, beyond being a mandatory document. **One user has also attributed the EPC as a marketing tool that can drive the housing market forward.** This is in opposition to the perception by interviewees in Germany, where often study participants

stated that it is very unlikely that the EEC of a building could influence the market value of a property because consumers would not be willing to pay more for it.

4.2.1.2 Critique and Needs regarding the EPC

End users criticized the inadequate energy consumption data, **which is not sufficiently individualized, i.e. not related to their own building**. One end user also expressed his/her interest in information, such as **average consumption of the last 5 years** (both electricity and fuel), expressed in [kWh] and in cost. On the other hand, most end users **did not seem to miss any additional information**: "I don't think that more information should be included. Suppliers can say more about user behavior, so there are other ways to get this information (…) otherwise the EPC would become too extensive". Similarly, another end user would not add information about individual energy consumption to the EPC. In his/her view, **the EPC is about the residence whereas the energy consumption "is the responsibility of the user".** Tailoring the EPC to the individual energy consumption of tenants is not seen as practical by the end user because "a new certificate every time there is a new tenant is not feasible".

One end user suggested including (the high) **energy consumption by swimming pools** in the EPC. Flemish end users also supported the **inclusion of energy saving tips**, **more comprehensive renovation information** (realistic investment costs, annual energy savings), information on **available subsidies and contact lists for EPC certifiers** in the EPC. One end user reported that the renovation process was complicated by the fact that they had to find competent contact persons (installers, etc.) on their own responsibility. With regard to contact persons for the implementation of EEMs, end users **highlighted the importance of finding contact persons, who are *trustable*.** As one end user described: "our decision is influenced by advisors or banks if we know that they are 'in a neutral position' and not trying to convince for personal gain". **Likewise, a different end user rather relies on the recommendations from friends** than contact persons like contractors as "the contractor does not always recommend the best for its customer but what he makes the biggest profit on".

4.2.1.3 End users' behavior regarding EEMs

In the view of several end users the EPC affects their decision in terms of technical or structural solutions, but not in terms of indoor temperature settings. If their house had a bad EPC, they would rather pay for EEMs or pay for more fuels than reducing their thermal comfort. In addition to the EPC, end users also indicate other factors that influence a possible renovation, such as the age and condition of the building ("does an investment still make sense?"), time and effort of the renovation and the lack of knowledge about the qualification of the renovation workers.

4.2.2 Other stakeholders

This section presents the perception and use of the EPC by interviewed other stakeholders from the Flemish region of Belgium, as well as their expressed critiques and needs regarding the EPC. Next, this section contains information on end users from the perspective of other stakeholders and suggestions by other stakeholders on what would improve the EPC for end users.

4.2.2.1 Perception of the EPC

Interviewed other stakeholders mentioned as well that the EPC influences the market value of a property. Furthermore, they pointed out that the EPC is **irrelevant during the occupancy of the property** and older houses usually do not have an EPC. In Flanders, one expects the EPC to be a useful policy tool to attain the long-term goals for 2050. For the employee from Zonnige Kempen the EPC has a big importance because the company is striving for sustainability in general.

4.2.2.2 Critique and Needs regarding the EPC

Due to changing methods, as well as a lack of knowledge on the part of experts, EPC certifiers and **experts should, according to stakeholders, receive regular training.** For Zonnige Kempen one aspect which is missing to connect the EPC even more with the energy transition would be the consideration of **circularity in the building sector.** An interviewed architect suggested including **information about solar gains** that cause overheating problems. In this context the architect mentioned: "I have come across houses with a low EPC score that are unlivable in summer". **Moreover, he/she stated that the EPC is "rather complete for users" but too simplified for professionals. Accordingly, he/she proposed to divide the EPC into a simplified part for the user and a more technical part for experts that focuses on the construction sector and includes details, such as the amount and type of materials to use.** This could make it easier to understand the values of the EPC and could improve the use of the EPC. From the interviewed stakeholders' point of view**, the EPC should also be illustrated by exemplary user profiles**.

One interviewed researcher in the field of energy and technology development explained that a lot of instruments for measurement and digitalization technologies are becoming available and that it is possible to integrate them in the built environment. These technologies would allow an automatic operation of energy services in a building. **He criticizes that innovative technologies exist but that they are not yet considered in the EPC methodology (e.g. energy storage, electric vehicle (EV)).**

4.2.2.3 Looking at end users from the perspective of other stakeholders

The social housing provider Zonnige Kempen experienced that tenants do not show a big interest in the EPC. The EPC is considered as an obligatory document, also in social housing. Zonnige Kempen tries to implement renewable energies and to advise tenants about energy savings and sustainability and to motivate them to act accordingly. Therefore, Zonnige Kempen takes an exemplary role of an intermediate link. An employee from the Flemish energy agency VEA expected that increase of comfort is the main motive for end users to invest in EEMs.

4.2.2.4 Suggestions to improve the EPC for end users

As costs are a strong motivator for change, stakeholders see their role as to raise a greater awareness of investment and incentives by **identifying possible funding opportunities**. In this way, the problem of very late investments (preventing costs for as long as possible, only when necessary) could be solved by end users and replaced by investments (maintenance) that were tackled early on. Also, based on the experience from an architect end user's behaviour depends on energy costs. Thus, he/she suggested to **illustrate the role of the user in relation to energy costs**. Therefore, the architect proposed **incorporating user profiles** (e.g. "a family of four that want to heat their home up to 18 degrees").

A more general suggestion for improvement from a stakeholder is an **automatic and digital data storage of the energy consumption of the end users**.

A challenge of the Belgian EPC is to **inform end users but not to overload them**, as an employee of the Flemish Energy Agency (VEA) explained. The suggestion by an architect to divide the EPC into a non-technical part for end users and a technical part for other stakeholders reflects the goal not to overwhelm the end user while still providing sufficient information for both parties.

4.2.3 Conclusion of the stakeholder interviews in Belgium (Flemish region)

Interviewed Flemish end users reported that the EPC is a mandatory document in the handover process of houses and apartments; but, also consider the EPC as a marketing tool. End users criticized the inadequate energy consumption data, which is not sufficiently individualized, i.e. not related to their own building. On the one hand, end users stated that the average

consumption of the last 5 years (both electricity and fuel) would be interesting. On the other hand, most end users do not seem to miss any additional information and think that energy suppliers can inform the user about their behavior. An interviewed end user suggested including (the high) energy consumption by swimming pools in the EPC. Belgian users also support the inclusion of energy saving tips, more comprehensive renovation information (realistic investment costs, annual energy savings), information on available subsidies and contact lists for EPC certifiers in the EPC. With regard to contact persons for the implementation of EEMs, end users highlighted the importance of finding contact persons, who are trustable and objective, often these are friends who are experts.

Interviewed other stakeholders perceive the EPC as a useful policy tool to attain the long-term goals for 2050. Another interviewee emphasized that the EPC currently is irrelevant during the occupancy of the property. Interviewed other stakeholder suggested illustrating the EPC by exemplary user profiles. Thereby, the role of the user in relation to energy costs should become apparent. In order to strengthen the link between the EPC and the energy transition the circularity in the building sector should be considered. Moreover, other stakeholders suggested including information about solar gains and innovative technologies which are not yet considered in the EPC methodology. Besides, the EPC was considered as "rather complete for users" but too simplified for professionals. Because of this, another stakeholder proposed dividing the EPC into a simplified part for the user and a more technical part for experts. Finally, interviewed experts recommended that EPC certifiers should receive regular training.

4.3 Stakeholder interviews in Finland

Seven interviews were conducted in Finland - 5 with end users and two with other stakeholders, who are property managers in commercial and public buildings.

4.3.1 End users

This section presents the knowledge and perception of the EPC by Finnish end users, as well as their critiques regarding the EPC.

4.3.1.1 Knowledge and perception of the EPC

All of the interviewed Finnish end users have heard of the EPC; however, only two seemed to know the EPC quite well, whereas others showed more uncertainties. **The perceived importance of the EPC varies from "undervalued" to "not important".** Finnish interviewees described the EPC as "an expensive, required document" or "a rather unimportant factor for decision making when buying/renting a building". These two perceptions can be found among end users statements from all other considered countries. Furthermore, their answers show that the EPC might be important for the energy transition, in the sense that it is valuable for energy and city planners, but the importance for end users would be rather low. **It was also mentioned that the EPC could offer an impulse to "improve the functionality of a building". Finally, an end user expressed that he/she would pay more attention to the EPC (the EEC) "if the house was a newly built one, because then I would regard it as negative if it was not energy efficient".**

4.3.1.2 Critiques and needs regarding the EPC

Indications about CO_2 emissions as well as indoor air quality were proposed as a possible addition to the EPC. End users who participated consider the recommendations and the indicated EEC as essential. They also suggested features which would improve the usefulness of the EPC: **hints on how to change daily energy related practices, information about innovative technologies and how one's environmental impact would change between the EECs**.

4.3.1.3 Implementing EEMs

End users expressed that it is hard to find the right contacts when one wants to initiate EEMs which limits the possibilities for initiating renovations. This is similar to what was reported by interviewed Flemish end users. Other factors that would influence end users' decisions are economic aspects, thermal comfort, recommendations from both, experts and friends, legal regulations and a possible positive effect on the environment.

4.3.2 Other stakeholders

Other stakeholders who were interviewed are property managers of commercial and public buildings. During their job they use the EPC regularly. They consider the EPC as a tool to compare buildings. **The EPC is calculated. Therefore, the values might be hard to grasp for end users. In order to improve the EPC there were two suggestions: one was to make the EPC more dynamic and the other one was to base the EPC on facts that the end user can understand to make the EPC more relevant to them**. For non-residential buildings the EPC is often of no interest for end users. Green energy is more interesting to e.g. larger organizations. The two property managers conduct pilot projects regarding waste, water, electricity and heating to raise awareness. They have also been involved in incentives to support energy saving actions in public buildings.

4.3.3 Conclusion of the stakeholder interviews in Finland

Interviewed Finnish end users' perception of the EPC varies from undervalued to not important. One end user explained that to him/her the EPC of new houses would be more relevant than for old houses. Indications about CO_2 emissions as well as indoor air quality were proposed as a possible addition to the EPC. Interviewed other stakeholders merely consider the EPC as a tool to compare buildings. The EPC is calculated. Therefore, the values might be hard to grasp for end users. In order to improve the EPC it is considered as helpful to make the EPC more dynamic and to base the EPC on facts that the end user can understand to make the EPC more relevant to them.

4.4 Stakeholder interviews in Austria

In Austria there have been 11 interviews conducted, whereof 6 interviews took place with end users and 5 with different other stakeholders (a freelancer architect, a colleague from AEE *Energiedienstleistungen* GmbH which is a building energy consultation, an energy-sustainability auditor, a policy maker: employee at the Federal government of Styria and an employee of a building management company/facility management for buildings).

4.4.1 End users

This section presents the knowledge and perception of the EPC by interviewed end user from Austria, as well as their critique and needs regarding the EPC.

4.4.1.1 Knowledge and Perception of the EPC

Interviewed end users in Austria seemed to be unaware of the EPC and could not relate to it. Also, like in Germany, those end users who did not know the EPC, anticipated that the EPC contained information about the costs associated with using a building of a certain EEC.

4.4.1.2 Critique and Needs regarding the EPC

All interviewed end users stated that indications about the energy/heating costs would be the most important information to them (this would be more important than energy figures because monetary indications are more tangible for end users). An interviewed owner of a single-family house also misses benchmarking of the energy rating, he/she would like to

see: "how good is my building compared to others and which range of energy demand is OK for my building". Also, interest in usable recommendations was expressed. Recommendations could become usable if they were realistic (feasible for the building) and detailed (e.g. indication about insulation material).

4.4.2 Other stakeholders

This section presents other stakeholders' perceptions as well as their needs regarding the EPC. It contains information on how interviewed other stakeholders see end users, aspects that would improve the EPC for end users in the view of other stakeholders and the importance of communication between experts and end users.

4.4.2.1 Perceptions of the EPC

An interviewed Austrian policy maker (chairing the group 6 of OIB) thinks that the EPC plays a big role for possibly buyers of buildings because it is relevant for the building permission or funding possibilities. But, in general the EPC plays a role because it is required by law for some cases (buying, renting, building permission, etc.). According to him/her the EPC already has the right role in the perception of the public; it is used in the right manner. One employee of a property management company thinks that the **EPC is important because it is a control instrument for building regulations and funding requirements.**

4.4.2.2 Needs regarding the content of the EPC

The interviewed freelancer architect emphasized that **regulation for building construction should be tightened** and pointed out the problem **that the EPC for new buildings is only issued before the construction and does not have to be updated when plans for construction change** (this was also criticized by other stakeholders from Germany). Also, the range of application of EPC should be extended to all existing buildings.

Furthermore, the policy maker states that **the Austrian EPC is not designed to include consumption data because this complicates the comparability of two buildings**. **The EPC is an assessment of building quality with standardized user behavior.**

One interviewee, working in the field of sustainable building certification, **pointed out that the EPCs are internationally not comparable, but also often not comparable in the national context, since sometimes the results are too imprecise, but in other cases overly accurate. Hence, the results are manipulable due to a large amount of calculation parameters**, as it was also criticized by an interviewed architect from Germany. Therefore, the main improvement for the Austrian EPC methodology is seen in sharpening the default values/factors. **An interviewed policy maker suggested that "if all EPC produce *inaccurate* results, the comparability of the results is still given"**. This view is in line with the opinion of the interviewed architect from Germany.

Besides, the interviewed freelancer architect claimed that **environmental and building life cycle indicators are missing in the EPC**. For the assessment of the building's material, **its recyclability and environmental impact such as grey energy should be taken into account**. This interest was also mentioned by two end users in Germany and an employee of Zonnige Kempen in Flanders. An **employee from the energy consultancy AEE Energieleistungen explains that the focus of the EPC today is on achieving EE targets, more than on achieving CO_2 emission targets**. Energy efficient insulation materials are not necessarily environmentally friendly and do not necessarily require less energy for the material production. Hence, increased **EE does not necessarily imply a reduction of the total energy consumption.**

Moreover, the interviewed architect suggested taking 3D visualisation of construction components into account.

The managing director of AEE Energiedienstleistungen concluded that **it would be helpful if the EPC was split into two different parts. On the one hand, user-friendly and relevant information could be provided for the end user, while on the other hand, the detailed technical results could be presented clearly separated.**

4.4.2.3 Looking at end users from the perspectives of other stakeholders

According to the employee of the property managing company, tenants are usually not that interested in EPCs and do not use it as a decision tool. But, for sellers/buyers it is more relevant because it is something like a "quality seal". The EPC is also used when a renovation is planned because it gives a first overview on possible measures and the general condition of the building. The interviewed sustainability auditor explains that the age of the owner also plays a major role, as thermal efficiency measures often have relatively long payback periods.

The employee from the Federal Government of Styria doubts that the EPC leads to more energy savings and EE: recent years showed that less energy is consumed per square meter but the population is growing and has higher demands related to comfort or living area. Therefore, **efficiency gains are overruled by changing behavior of the population**. This statement is in line with the point brought forward by an end user in Germany who would appreciate it if the energy consumption was indicated in [kWh/*person* year] instead of [kWh/m^2 year].

4.4.2.4 Aspects which would make the EPC better for end users according to other stakeholders

The interviewed architect expressed that from the end user point of view, he thinks that building energy consumption, heating, cooling, and domestic hot water, as well as, heating and electricity costs and environmental impact are most relevant. Besides, he thinks that "**for the end user, information concerning the building becomes more important as soon as the person starts to live in the building". Therefore, he argues that more building use information should be provided in the EPC.** The interviewee from AEE Energieleistungen also suggested that information from the energy certificate should be prepared in a way that is understandable for laypersons **(for example including hints for energy saving, such as stating that a reduction of the room temperature saves energy and thus also costs; tips for avoiding overheating in summer such as window ventilation at night and sun protection during the day)**.

Another stakeholder, working in a building management company, mentioned that **the EPC in Austria already covers a lot of information and is "very blown up". He thinks that content of the EPC could be reduced for end users.** For instance, it is sufficient to only give the first 4 pages of the EPC plus a summary of the most important remarks of the EPC such as recommendations to end users. What is missing according to him is a short, compact description of the building (building history, etc.) for a rough first overview

Furthermore, **simple benchmarks of the EEC would help end users' to put the information about the EEC into context.** Likewise, interviewed experts think that costs and cost savings might be the most relevant information for the end user. However, a good estimation relies on good (reliable) calculation of other parameters – like the energy needs and also energy price assumptions. The employee from the property management company adds that the estimations of heating costs may be especially difficult for multi-family houses. I**nterviewed experts worry that the indication of estimated costs based on inaccurate parameters might not solve the actual problem of scepticism and untrustworthiness perceived by end users**.

The interviewed sustainability auditor stated that **information on renovation steps (sequence of measures) is missing in the EPC.** This could lead to wrong decisions during renovation (e.g. oversized heat generators, because the building envelope was not renovated already in the first step).

4.4.2.5 Communication with end users about the EPC and EEMS

In principle, interviewed other stakeholder pointed out that building projects should always be accompanied by comprehensive consultancy, so that long-term goals are targeted and not only the legal requirements. For end users, the EPC seems to be relevant only if its technical contents are made understandable for laymen. Corresponding consulting services would be necessary for this. The interviewed policy maker explained that costs and CO_2 emissions should be used as

argumentation aid, instead of energy consumption because the average person cannot relate to it. **Additionally, he thinks that product neutral energy consulting services are very important to influence end users.** Concluding, a possible solution to increase interest in EPC information would be to increase energy auditors' engagement and communication with end users, and to translate actual indicators in a more end user-friendly way.

4.4.3 Conclusion of the stakeholder interviews in Austria

Interviewed end users from Austria are unaware of the EPC and cannot not relate to it. All interviewed end users stated that indications about the energy/heating costs would be the most important information to them.

Interviewed other stakeholders explained that the EPC is important because it is a control instrument for building regulations and funding requirements. Regulation for building construction should be tightened and the EPC for new buildings should have to be updated when plans for the construction change. Besides, experts explained that the Austrian EPC is not designed to include consumption data because this would complicate the comparability of two buildings.

The EPCs are not comparable in the international context, but also often not comparable in the national context, because results can be either too imprecise or overly accurate. The results are manipulable due to a large amount of calculation parameters. If all EPC produced inaccurate results, they would at least be comparable. Besides, one expert mentioned that environmental and building life cycle indicators (e.g. recyclability, environmental impact and grey energy) are missing in the EPC in order to pursue the CO_2 emission targets. One expert suggested including more building use information in the EPC for end users (e.g. hints for energy saving in every-day life). Besides, simple benchmarks of the EEC would help end users' to put the information about the EEC into context. Regarding the indication of estimated costs, experts worried that these would be inaccurate due to changing energy prices and if user behavior was not considered. Moreover, information about renovation steps should be provided to end users so that they could take the right decision.

Finally, it would be helpful if the EPC was split into two different parts. On the one hand, user-friendly and relevant information could be provided for the end user, while on the other hand, the detailed technical results could be presented clearly separated. The EPC in Austria already covers a lot of information which is why content of the EPC could be reduced for end users. Interviewed experts also emphasized that building projects should always be accompanied by comprehensive, neutral consultancy.

4.5 Stakeholder interviews in Greece

In Greece there have been 15 interviews conducted in total, whereof 9 interviews were conducted with end users and 6 interviews with other stakeholders (including a civil engineer who is an accredited energy auditor, an energy auditor (certifier of EPC) and energy inspector of large scale buildings, one stakeholder who has been working with the built environment and real estate companies and is currently works on energy policy focusing on Green Deal and Renovation Wave, housing construction employees and a physicist who also is an energy consultant and works with an energy developers' team.

4.5.1 End users

This section presents the knowledge and perception of the EPC by interviewed Greek end users. It also presents the information that end users consider most important to be included in the EPC.

4.5.1.1 Knowledge and perception of the EPC

Greek end users who have been interviewed, **reported that they had not seen the EPC before, not even in the public sector.** The statement "I have never had any contact with the EPC before, today (during the interview) for the first time" reflects this. Only end users who had applied for subsidies for renovations have seen the EPC before. The insignificance of the EPC for

end users becomes clear again in the following statement: **"I know that EPC is an obligatory document for real estate, but not what it means to me as a user."** Regarding trust in the EPC **a**n interviewed owner of a flat in a multi-family house remarked that the public authority which is responsible for the information on the EPC was interesting; "if the logo of the competent ministry is displayed, I feel more confident".

4.5.1.2 Needs regarding the EPC

Greek interviewed end users often lack knowledge about the listed EECs and the objects of comparison. That they often cannot relate the information to real life: "I lack the reference from the data of the EPC (theory) to practical implementation/application." According to users, the Greek EPC should also contain **more precise and comprehensive explanations of the values stated in the EPC.** In addition, end users want the EPC to **include the actual (annual) energy consumption of the building and the recommendations associated with it** to reduce the energy consumption. The recommendations should include a **list of more energy-efficient technologies and further links to find appropriate installers (websites)**. Another interviewed occupant of an office building mentioned that a dynamic list (maybe a website) **with energy efficient technologies that can be applied on a building** (such as micro CHP) would be interesting. Two interviewees would like to receive **information and tips on user behavior and practices for a better understanding and reduction of building energy consumption.** These tips should help to save energy with 'no-cost measures'. Hence, interviewed end users would like to receive information about renovation measures and no-cost behavioural changes to reduce energy consumption. Apart from that, an interviewed occupant of an office building mentioned that the EPC was already a complete document and nothing would be missing.

4.5.2 Other stakeholders

This section presents the perception Greek interviewed other stakeholders have of the EPC as well as their critiques and needs regarding the EPC. Also, it contains information about the view of interviewed other stakeholders on end users.

4.5.2.1 Perception of the EPC

An interviewed policy maker uses the EPC indirectly as a basis for the building energy management and as a tool for the mitigation of energy poverty. Another interviewed other stakeholder stated that the **EPC is not considered as an option, but as mandatory by law.** One interviewed mechanical engineer regards the EPC as an **important tool which helps to obtain knowledge about the 'as-built situation'.** Likewise, an interviewed energy auditor and policy maker emphasized the function of the EPC as "the only document showing the building 'as built'". According to an interviewed policy maker **the EPC is the identity of the building** and an important tool to forward the energy transition in the building sector. Furthermore, he/she describes it as a static document **which should be dynamic** (cf. the same message as in the interviews with experts from Spain).

4.5.2.2 Critique and needs regarding the EPC

The interviewed energy auditor and policy maker **does not trust in the information because the quality of the information is low since the market prices for issuing an EPC are very low, too** (cf. Spain, Germany). Other than that, he/she explains that there is **no adequate quality control from the competent ministry**. The interviewed EPC certifier mentions as well that the regulatory framework exists but there is no monitoring/quality check control. The interviewed energy auditor and policy maker also demand that the EPC should be **issued before selling/renting a building so that the building value is linked with the EEC.** He/she summarizes that quality improvement will be achieved through three aspects:

1) **Quality control mechanism from independent body which will make extensive on-site checks**

2) **Consumer consciousness**

3) **Certification procedures for the energy auditors** so as to ensure the quality of the provided services.

For the interviewed policy maker, the smart readiness indicator (SRI) is an important feature to be added in the EPC. In addition, the share of RES production should be included in the EPC for statistical purposes and for the national energy policy. Other stakeholders also complained about the **lack of information on energy consumption and its costs** (cf. Spain). One engineer recommends **including the air quality of buildings in the EPC** (could become particularly important after the pandemic).

4.5.2.3 Insights on end users from other stakeholders' perspectives

One interviewed EPC certifier reported that "the EPC is considered as a problem by building occupants because it's an extra cost for them". He/she explains that in Greece, due to the economic crisis and building taxes, **EPC is considered as another type of tax.** However, this **perception has changed through the national funding programme**. According to an interviewed policy maker there is public awareness especially due to the funding programmes for the residential sector ("EXOIKONOMO") where the EPC is mandatory.

An energy consultant reported that end users **would not really trust in the information from the EPC**: **"They believe that past individual renovation actions are more effective and the EEC should be higher."** They would be suspicious regarding the data and the energy auditor **because they think that the latter would not be objective**. Besides, there is a general belief that the local installers/providers have better knowledge than the energy auditor. Maybe because citizens believe that "the energy auditors/engineers work only on the desk and they are not involved with the market" as a mechanical engineer explains. Based on this, one can conclude that end users in Greece perceive energy auditors as rather subjective, incompetent and far from reality.

To apply for subsidies consumers would contact experts such as energy auditors or engineers for calculations. In order to find ideas for renovation, opinions and recommendations from acquaintances or experience reports from people who have already implemented them are sought. This statement corresponds with the statement of a stakeholder that due to the consumers' problem of trust, energy consultants usually do not give recommendations and it is much more the social norm that influences the end users' behavior and decisions. One interviewed energy consultant described this as follows: **"the role of the energy auditors is less important; people care about the neighbours' renovations rather than what the recommendations on the EPC are** (...) if a building owner replaces the windows, all the others will do the same, independently on the energy auditor's proposal based on the EPC". The last phenomenon is a description of peoples' behavior of the small community 'Island Syros'. **End users would only use the EPC for contractual actions such as deep renovation, selling or renting**. In this context, a mechanical engineer experienced that **"prospective buyers of a building ask for the EEC without evaluating the actual meaning".** Finally, interviewed other stakeholders reported that consumers focus more on the investment costs (financing) than on benefits from increased EE, so more should be communicated about the energy saving possibilities by experts.

4.5.3 Conclusion of the stakeholder interviews in Greece

Several interviewed end users from Greece reported that they had not seen the EPC before, while others stated that they know the EPC as an obligatory document but that it was not clear what its actual meaning was. End users want the EPC to include the actual (annual) energy consumption of the building and the recommendations associated with it. Recommendations should e.g. include a list of more energy-efficient technologies, further links to find appropriate installers and information on the user behavior. Interviewed experts from Greece emphasized that the EPC is mandatory by law but also stated that it was an important tool to learn about the as-built situation. They recommended that the EPC should become dynamic. Next, they reported about low trust in the EPC scheme, from the view of experts and end users. The quality of the EPC is low, because market prices for EPCs are low, too. In order to improve the enforcement of the EPC, it should be **issued before selling/renting a building.** Besides, a quality control mechanism which conducts extensive site visits and the certification of energy auditors would improve the quality of EPCs. Regarding the content of the EPC, it would be important to add the SRI, the

fraction of RES production and the air quality. Interviewed Greek experts also complained about the **lack of information on energy consumption and its costs**. According to interviewed experts most end users became aware of the EPC because it is related to funding schemes. Prospective buyers of buildings would ask for the EPC because it was mandatory, without evaluating its actual meaning. Other than that, end users would perceive the EPC as extra costs or another building tax. Besides that, end users would not really trust in the information from the EPC and would be suspicious regarding the energy auditor. Instead, end users would trust the local installers and would rely on the reference from other citizens or simply copy EEMs that were introduced in the neighbourhood.

4.6 Stakeholder interviews in Germany

In Germany 12 interviews took place in total, whereof 7 interviews were conducted with end users and 5 with other stakeholders. The following other stakeholders were interviewed: one colleague from the energy agency in Rhineland-Pfalz, one colleague from the consumer association in Rhineland-Pfalz, an installer, who also works as an energy consultant and is certified to issue EPCs, an employee from CO_2 online, who also works for a company that issues EPCs, and an architect who is also working for the Chamber of Architects Saarland.

4.6.1 End users

This section presents the knowledge and perception of the EPC by interviewed German end users, as well as their critiques and needs regarding the EPC.

4.6.1.1 Knowledge and perception of the EPC

In Germany two of seven interviewed end users knew the EPC at the time of the interview. **The others had never seen the EPC and did not know if there existed one for the building they are living in**. However, most of these end users were interested in the topic and thought that the EPC was important, considering that households consume a lot of energy. Especially, during the pandemic, when people spend more time at home and therefore also consume more energy the need to become aware of energy consumption at home becomes more important since thermal comfort is very important as one end user explained. He also considered that end users have the power to change their energy consumption, which is something that should be communicated with them. We must take into account that most of the interviewed end users are young tenants, what might explain their unawareness of the EPC.

End users who did not know the EPC, **expected mistakenly that it would include an indication about annual heating costs and data about electricity consumption.** This assumption could be interpreted as their need to be informed about the costs which are associated with living in a certain building and the need to be informed about their electricity consumption. However, end user 7 realized that **electricity consumption should not be included in the EE assessment of a building, since it is independent from the building envelope and building facilities.**

So far, the interviewed end users did not consider the EPC during decision making when they rented a new flat**, simply because of the fact that the housing market is so scarce in the cities they live in that they are satisfied when they can find a suitable flat at all.** The most relevant factors to select a new flat are the location and the costs for the rent. This was also confirmed by three interviewed other stakeholders.

4.6.1.2 Critique and Needs regarding the EPC

Regarding the methodology for the EPC certification end users mentioned that they would appreciate it if the type of energy (renewable or conventional) was considered in the calculation. This is already the case for the primary energy

demand/consumption since the primary energy factor is based on the "environmental impact" of the used fuel. End user 2 seemed to be disappointed by the EPC, since she perceived it as **"totally standardized and not individual".**

Interviewed end users miss an **estimation of costs that can be expected from living in a flat.** Required energy for a building should, as expressed by most, be indicated in [**€/month] or** [**€/year],** in addition to/instead of the unit [kWh/m²a]. However, the interviewed architect sees the problem that costs are changing. Instead he suggests **to refer to the fuel that is used for heating** in the respective building: for instance if a building is heated with oil and has an end energy demand of 156 [KWh/m² year] he recommends **to explain that this means that 15,6l oil are required per square meter in a year.** Moreover, end user 7 expressed that he would appreciate it if the consumed energy was expressed in [kWh/**person]**, instead of [kWh/m²]. His argument is, that the total energy consumption should be decreased instead of 'only' increasing the EE of a building. **He considers it unfair that a big building, which is only occupied by one person, could attain a better energy rating than a small house with seven people**. His reasoning is that the latter would consume less energy per person than the single person household.

4.6.2 Other stakeholders

This section shows the perception other interviewed German stakeholders have of the EPC. Next, it presents other stakeholders' thoughts about the design of effective policy tools for the energy transition in the building sector. After that, their critique and needs regarding the quality control of the EPC and the generation and content of the EPC is presented. Finally, their view on the role of communication between experts and end users is presented.

4.6.2.1 Perception of the EPC

The representative of the consumer association views the EPC as 'important factor in the consumer information' in order to obtain a certain purchase behavior. The interviewed architect described that the EPC is perceived as a 'foreign body' by end users. He emphasized that **the EPC is too complex for end users** and therefore not readable. However, not only for end users but **also for professionals. The problem is that everybody who graduated as an architect and joined a chamber, is formally allowed to issue EPCs.** "I reckon that some colleagues are not capable of explaining the difference between primary energy and end energy". This statement points out the problem that more professionals are allowed to issue the EPC than there are professionals who are competent to do so.

4.6.2.2 Energy Policy

The representative of the consumer association referred to the EU label for electric appliances and that in parallel the eco-design-regulation exists which requires maximum values for the standby consumption of entertainment electronics. If the industry is regulated towards more EE and this is technically possible then this usually has a large effect. The reduction of energy consumption of electric appliances could have never been reached by the EU labelling alone. Hence, a set or combination of measures in the key to achieve a change of energy use. He explained: **"Looking at the building sector this would mean one would have to gradually introduce consumption standards for existing buildings in order to get movement in the modernization rate, which the EPC alone will not achieve".**

4.6.2.3 Missing quality control of EPCs

Furthermore, two experts (employee from an energy agency and the architect) criticized the lack of control of the calculated EE of a new construction: the architect experienced that often a better EE was calculated than which was reached after the building was built. According to him there are strict regulations from the state (e.g. the EnEV) which however are not implemented. **His suggestion thereupon is to make the requirements less strict, but to implement a quality check.** As long as the

implementation of requirements is not controlled it does not make sense to him to strengthen the requirements. Quality control would however require more qualified (!) personnel.

4.6.2.4 Critique regarding the generation and content of the EPC

Other issues that have been pointed out by several interviewed stakeholders are the following: **it is confusing and unnecessary that there exist two versions of EPC in Germany** (either based on the calculated theoretical demand or based on the measured actual consumption of building occupants). The representative of the consumer association made clear that **the two versions should not exist in parallel because they are not comparable.** The interviewed architect pointed out the discrepancy between the two versions of EPC: "I had fun for a while, calculating a demand-based and a consumption-based EPC for the same building and the discrepancy was enormous". The stakeholders indicated that their preferred version is the EPC issued based on the calculated demand (although this version is not accurate because of several reasons according to an interviewed architect). **The EPC based on consumption cannot be a profound basis for the evaluation of the EE of a building, because energy consumption varies significantly, depending on how many occupants are living in the building and depending on their lifestyle/every-day energy behavior**. Hence, the EPC based on the measured energy consumption rather is a "user certificate" than a "building certificate" (installer). However, in many interviews with stakeholders from pilot countries (ES, GR, BE) end users expressed the wish to be informed about their actual energy consumption. **This could be an addition to the existing EPC and should better not replace the current EPC in these countries, if one considers the feedback from stakeholders in Germany**. **Concluding, the demand-based EPC does not deliver realistic results and the consumption-based EPC does not allow to compare buildings.**

Moreover, the interviewed architect points out that the norm to calculate the EPC foresees very complex calculations (many variables are considered) with the aim to map reality. However**, such complex calculation software usually cannot be filled in with accurate values by professionals.** For some parameters they are using default values. That is why the calculated EPC provides inaccurate values. The architect explains that he does not know many terms that are mentioned but which have nothing to do with the daily works of an architect. He concludes: "the work is much coarser than the norm actually dictates". Therefore, **he suggests using less complex calculations from the beginning and to accept that the result is not very precise, but at least the values would be comparable.**

Moreover, the colleagues from CO_2 online and from the consumer association regret that the **EEC is calculated with regard to the climate conditions in Potsdam, no matter where in Germany the building is located.** According to the colleague from CO_2 online it is obvious and logical that a building in Bavaria close to the Alps is better insulated than a building in Karlsruhe, where it is by comparison very warm. Besides, he thinks that it is very easy to adjust the software for the calculation such that the climatic conditions at the location are considered.

Other than that, several interviewed other stakeholders claimed that the **area used for the calculation and as indicated in the certificate is not understandable for end users and other stakeholders**. It is confusing that another unit area is used than the one which is stated e.g. in the rental contract. This should be unified. Besides, the used unit area in the EPC is bigger than the perceived used area of a building. This biases the energy demand of the building since the bigger the divider (area) the smaller the energy demand. He anticipates that this reduced the motivation of an individual to become active (to initiate EEMs).

Besides, all other stakeholders stated that the **indicator "primary energy demand" is not understandable or useful for end users.** To end users only the indicated end energy demand would be interesting, since that can be associated with "the amount of fuel they need to buy" (architect).

Hints for everyday energy behavior such as for heating and window opening was considered as helpful from both, end users and other stakeholders. However, the interviewed architect remarked that hints will only be accepted by those who are willing to receive advice. The end users need to be open for advice on daily energy behavior, otherwise it would have no effect. This points out that information about the daily behavior should only be provided to interested readers. Moreover, the architect claimed that the energy rating of a building should be shown on the first page as this would be the most important information for end users.

4.6.2.5 Communication about EEMs

The energy agency primarily advises municipalities and companies on energy related topics instead of private individuals. According to the interviewee from the energy agency there is no reason to make the EPC mandatory for all buildings, if they are not sold or rented, and every end user shall decide him/herself whether he/she wants to implement EEMs. Furthermore, she stated that only through organized campaigns and activities in cooperation with municipalities the energy agency would inform end users and raise awareness about energy. The consumer association – as explained by the colleague and the architect who also consults in energy related topics for the consumer association – only provides an introduction into the topic of improving the EE of a building. **Their consultation is consumer-oriented, not profit-orientated.** In this sense, they want to perform education works rather than engaging in sales and marketing. **The installer explained that he has a big influence on end users' decisions since they trust his recommendation**. Often, end users would have no idea if they should improve the heating system of the house or e.g. dam the walls. Then, they would rely on his recommendation. Something which was apparent from all interviews with other stakeholders is, that **the EPC alone should not be used to implement EEMs, because the recommendations are based on calculations which are too inaccurate and the recommendations are not detailed enough. The colleague from the consumer association doubted that an improved EPC alone could replace the energy consultancy by experts.**

4.6.3 Conclusion of the stakeholder interviews in Germany

Most interviewed end users had never seen the EPC and did not know if there existed one for the building they are living in. Often, they expected mistakenly that the EPC would include an indication about annual heating costs and data about electricity consumption. They did not consider the EPC yet when searching for a building for rent because the housing market is so scarce in the cities that they are satisfied when they can find a suitable flat at all. One interviewed end user regretted that the EPC was totally standardized and not individual. The interviewed architect assumed that the EPC was too complex for the end user, and for professionals. The interviewed architect criticized that requirements to issue an EPC are rather low and broad, so that experts with different backgrounds are allowed to issue EPCs. Moreover, he criticized that energy standards should be lowered but that quality checks should be implemented. The existing complex calculation software usually cannot be filled in with accurate values by professionals (also professionals would fill in the software differently due to the broad range of backgrounds). Therefore, the suggestion is to use less complex calculations from the beginning and to accept that the result is not very precise, but at least the values would be comparable. Besides, experts stated that it is confusing and unnecessary that there exist two versions of EPC in Germany (demand-based and consumption-based EPC). The two versions should not exist in parallel because they are not comparable. The EPC based on consumption cannot be a profound basis for the evaluation of the EE of a building, because energy consumption varies significantly, depending on how many occupants are living in the building and depending on their lifestyle/every-day energy behavior. Other points of criticism were that the EEC is calculated with regard to the climate conditions in Potsdam, no matter where in Germany the building is located, that the area used for the calculation and as indicated in the certificate is not understandable for end users and other stakeholders and that the indicator "primary energy demand" is not understandable or useful for end users. Additional hints for everyday energy behavior such as for heating and window opening were considered as helpful from both, end users and other stakeholders. Finally, experts

recommended that the EPC alone should not be used to implement EEMs, because recommendations would not be detailed enough. One interviewed expert doubted that an improved EPC could replace the energy consultancy by experts.

4.7 Conclusion of stakeholder interviews

Based on the stakeholder interviews we can conclude that there is room for improvement regarding the EPC in all pilot countries and Germany, although the EPCs differ among MS, regarding the calculation methodology, completeness of information and visualization.

In most countries awareness about the EPC is low (ES, FI, DE, AT and GR). 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 ever-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 behavior. 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.

Finally, end users stated that they rely on the advice and references of befriended experts if and how they invest in EEMs for their building. In addition, based on statements from other stakeholders we may conclude that it would be worthwhile to strengthen the role of involved stakeholders (certifiers, multipliers, advisors and installers) in raising awareness of the EPC and EE and in explaining technical information in an understandable way. This is also connected to the recommendation that other stakeholders should be frequently trained with respect to the EPC and EEMs. The following chapter about the user-needs workshops will provide more in-depth insights into end users' and other stakeholders' critique and needs regarding the EPC.

5 ONLINE USER-NEEDS WORKSHOPS

This chapter presents the results, discussion and conclusion of the user-needs workshops in the 5 pilot countries (Spain, Belgium – Flemish Region, Finland, and Greece) + Germany. The results are described and analysed separately for each participating country. For each country the stakeholder roles of participants are listed. Then, the critiques, needs and interests regarding the EPC are presented in different categories, which differ among pilot countries and Germany due to adjusted structure and contents of the workshops, different EPC schemes and different stakeholders which resulted in different discussions. After that, the main insights from the polls (in Google Forms, Chat) are shown. For each country the critiques and needs regarding the EPC are differentiated by stakeholder type (end user/other stakeholder) and are considered in relation to the country-specific EPC schemes and conditions. Each subchapter finishes with a conclusion of the user-needs workshop.

5.1 User-needs workshop in Spain

This subchapter first describes the participants of the user-needs workshop in Spain. After that, it presents participants' critiques and needs regarding the Spanish EPC, participants' feedback on suggested features to improve the EPC, additional discussed points and a conclusion of the insights. The subchapter provides a conclusion of the insights at the end.

5.1.1 Participants

The workshop in Spain took place on the 13th January 2021. Sixteen participants were present (approx. 50% end users and 50% other stakeholders). The following stakeholder groups were present:

- End users (building occupants, building owners and building managers)
- Certifiers of EPC and advisors for EEMs (i.e. architects and engineers)
- Informants about EPC and EEM (National Energy Agency and experts from public institutions)

We need to notice that all participants have tried to answer the questions in Google Forms from an end user point of view.

5.1.2 Critique and needs regarding the Spanish EPC

The following sections provide further insights into critique and needs regarding the summary sheet of the EPC, the annex of the EPC (description of the building energy characteristics, building energy rating and recommendations as well as suggestions from participants to improve the EPC.

5.1.2.1 Energy performance certificate for buildings - EPC: summary sheet

Regarding the summary sheet of the Spanish EPC it was mentioned that **benchmarking of the EE indicator would be helpful to put the EEC of a building into context.** One professional remarked that regarding the energy rating of renewable primary energy, **it can happen that very inefficient buildings can achieve an A rating because they use 100% renewable energy**. This also became apparent in a stakeholder interview in Germany, when somebody criticized that energy from the district heating system is calculated with the primary energy factor "0". However, physically this does not make much sense if the primary energy demand of a building is "zero". The calculation should be reconsidered and the primary energy factor "zero" should be abolished.

5.1.2.2 Annex I: Description of the building energy characteristics

An end user criticized that the annex "description of the building energy characteristics" contains too much data for people who are not familiar with the technical aspects of certification. **Hence, this part of the annex could be included in the EPC for**

authorities but could be neglected in the version for end users. Another end users recommends that **the addition of graphic elements could make it more understandable to what construction components the information refers** (cf. recommendation from the workshop in Austria).

5.1.2.3 Annex II: Building Energy Rating

Regarding the annex which provides information about the building energy rating one participant suggested including graphical comparisons of buildings with similar characteristics. Another participant criticized that the reference of the scales is not clear. According to him/her it would be important to understand the information (e.g. if a "C" is good in a single-family house? How well does my building perform compared to buildings in my city/neighbourhood/of the same construction year?) **Here, the need for benchmarking and the demand for a context in which end users can relate the information about their building becomes evident again.** One professional assessed the information as useful but remarked that the lighting consumption is not taken into account for residential buildings. He thinks that it would be valuable to include this information, as it is already done for non-residential buildings.

5.1.2.4 Annex III "Recommendations for energy-efficiency improvement"

One participant mentioned that the recommendations are very useful at a technical level, but an average end user would have trouble understanding it; it lacks user-friendliness for a non-technical user. **Other end users agree that the recommendations are too technical and were only understood after explanation.** Another remark is, that it would be more interesting for end users to see how much costs can be saved with a certain measure**. Similar as it is realized already in the Belgian EPC, one end user expressed that he/she would like to know exactly what measure (and how much it would cost) to upgrade the EEC for example from G to F, or to E. Moreover, the return of investment of a specific measure would be of interest.** This is in line with the needs expressed by Flemish end users. **However, one expert stated that a very precise and complex annex of recommendations could make the EPC more expensive**. This could prevent end users from having an EPC issued, if they are not interested in renovating their building.

5.1.3 Suggestions from participants to improve the EPC

Finally**, participants recommended to simplify or to separate the content according to the target group** (cf. suggestion in the Austrian workshop). **Currently, the data which is of interest to end users or experts is mixed in one document. End users would appreciate it if the real energy consumption of the building was included or if at least the relationship to real energy consumption was indicated.**

5.1.4 Next generation of EPC

This subsection gives an overview of the feedback to suggested features to improve the EPC. The suggest features concern the use of indicators and units, the layout of the EPC and recommendations.

5.1.4.1 Indicators

All participants agree that it is a good idea to include partial indicators about the EE characteristics of construction components of a building/dwelling (cf. this is already realized in the Belgian EPC). Participants would find it interesting to receive information on the actual final consumption of the building/dwelling, disaggregated by services. This is opposed to the statements by experts in Finland and Austria who absolutely want to separate the EPC from possible other tools, that e.g. give information about the real energy consumption. Moreover, participants suggested using more useful/understandable units for the measurement of energy consumption. **Many participants considered it as interesting to include additional indicators**

about the indoor air quality, thermal comfort and smart readiness of the building in the EPC. The two first additional indicators also were assessed as useful by participants in the Belgian workshop.

Participants explained why they perceived certain units to express the energy consumption useful: knowing the energy consumption per square meter allows comparisons with other buildings. The absolute values €/year and kWh/year would be beneficial to get an idea of the costs and energy used. The unit [€/year] was considered as useful for end users since they are most often interested in energy costs. For technicians the other units would be more important. One end user preferred the units [kWh/person year] and [kWh/person month] since with these units it would be easier to calculate the total energy consumption: e.g. [kWh/person year] could be multiplied with the number of persons that live in a building and one could estimate the total energy consumption in a year.

One participant mentioned that in relation to this it would be important that partial indicators were provided (e.g. for walls, floor, roof, doors and windows), then it would be more easy to understand where the weak points of the building are (cf. realized in the Belgian EPC already). **One expert commented that the unit which is currently used in EPC schemes [kWh/m² year] is comparable. However, regarding the alternative to express energy consumption per person, the difficulty is that persons have different use profiles regarding energy, which is not considered yet in the EPC (currently the use is standardized).** This objection was already mentioned by a policy maker in the German workshop. Moreover, the use of "€" (price of kWh) adds a variable which is very volatile (and dependent on the type of fuel). This problem was also addressed by participants of the workshop in Finland. Consequently, participants suggested that **the EPC should become dynamic. Then, the EPC could be automatically updated with the current energy prices through a connection to energy cost databases.**

5.1.4.2 Layout

All of the 16 participants considered that the layout of the EPC is an important aspect to consider during the development of the next generation of EPC. Most of the participants (13) found it useful to generating a double certificate (one standardized certificate aimed at the administration which would allow knowledge and objective comparison of the current building stock and a second certificate tailored end users, based on real energy consumption which would provide more easily interpretable information to end users). This is in line with the suggestion from the Austrian workshop to split the EPC into two documents. The answers about the comprehensibility and usefulness of thermal images were diverse; however, at least half of the participants indicated that they would understand the figure and consider it as useful. Regarding benchmarking the majority of participants (14) answered that they would find it useful to compare the respective building indicator on the presented graph. During the workshop in Spain a web display tool was proposed to participants which was suggested by participants of the Finnish workshop. Most of the participants of the Spanish workshop (12) considered it useful to compare different building indicators of the respective building to buildings of the surrounding (city/neighbourhood) on a 3D map. Most participants appreciated the suggestion to include information about other services next to those processes which are already included in the EPC (heating, cooling, domestic hot water, ventilation and lighting). **The additional inclusion of information about all other household appliances (12) and electric vehicles (8) was selected most often by participants.**

5.1.4.3 Energy Efficiency Recommendations

In general, participants perceived it as useful if the EPC included explanations/instructions about the EEMs that can be implemented (12)**. Also, most of the participants (15) evaluated the suggestion to include a roadmap which could help to encourage decision making about investment in EE of a building as useful.** The example from the Belgian EPC was presented to participants. Likewise, the suggestion to include updated information about funding programmes and/or grants which are available related to the improvement of EE in buildings was perceived as interesting by participants (15). The opinions regarding the suggestion to include guidelines for everyday energy behaviour to save energy diverged. But, the

majority was convinced by this suggestion (13). According to participants it would be most interesting to receive information on the replacement of lights with LED lights (14). One end user additionally proposed receiving information about the use of intelligent devices that can be controlled via the internet (such as thermostats, lights and others).These devices could be controlled from a mobile phone or from an app and they could help to increase the EE. **This system could be linked to the energy consumption monitoring system which informs end users about the real energy consumption. Hence, this feature would have to be an additional tool next to the EPC provided to authorities**. Furthermore, a participant mentioned that measurements and recommendations regarding the air quality would be interesting, as well as **information about the grey energy of materials**. However, another participant doubted if the EPC would be the right document to include this information (cf. statement by professionals from the workshop in Austria).

5.1.5 Additional discussed points

Although the user dimension (i.e. EPC based on actual energy consumption) is relevant for EEM implementation, it is not useful for the sale and rental of a building. This is because a previous user of the building could have different behavioural patterns and could not be comparable with the behavior of the new user (e.g. different thermostat set point preferences, different schedules of occupancy etc.). So, the provided information would be not accurate. **The suggestion from participants was that the EPC could be customizable according to the building user when a building is sold/rented. This means that the EPC would become (now regarding the building use/behavioural pattern of the user) dynamic**. **This would allow end users to know the forecast of their energy consumption in the respective building prior to the purchase/rental of the building.**

5.1.6 Conclusion of the user-needs workshop in Spain

Currently, end users' perception about the EPC is that it is just a legal requirement when they sell/buy or rent a building or dwelling. In order to engage the end users beyond the legal requirement the content and format of the current EPC report needs to be reviewed. End users showed that they are interested in indicators which are more understandable to them and related to actual energy costs (e.g. €/m^2 year or €). The user dimension (i.e. actual use) should be taken into account in order to engage end users. **Standardised operational conditions are not understandable for them.** Since the use is very relevant for energy consumption, this is very useful when an owner wants to invest in EE or refurbish his/her building/dwelling. Also, during sale or rent of a building this information could be useful**. A customizable EPC prior to the sale or rent could be interesting in order to estimate running costs of the building. This suggestion could be addressed through the development of different user libraries that would allow the automatic adaptation of operational schedules of energy assessment models in order to represent the new use** (interpret information of the building on the EPC based on user information). However, since the current content is also important for the administration, a double EPC report could be interesting.

5.2 User-needs workshop in Belgium (Flemish Region)

This subchapter first describes the participants of the user-needs workshop in the Flemish region of Belgium. After that, it presents participants' feedback (positive and negative) as well as their needs regarding the EPC. After that, it presents participants' feedback on suggested features to improve the EPC and a conclusion of the insights. At the end, the main insights are summarized in a conclusion.

5.2.1 Participants

In Flanders two user-needs workshops took place - one with experts and one with end users. Three end users participated and two other stakeholders (employee from the VEA (Flemish Energy Agency) and an employee at the energy department of an

'intercommunale' (organization that helps citizens with energy related aspects, e.g. answers questions citizens might have regarding the EPC, helps vulnerable citizens to apply for renovation loans etc.).

5.2.2 Positive feedback, critique and needs regarding the Flemish EPC

During the user-needs workshop in Flanders positive feedback, critique and needs regarding the Flemish EPC have been collected in a mind map. The collected feedback is presented in Table 1.

Table 1: Collected feedback about the EPC from participants of the user-needs workshop in Belgium Flanders

Positive feedback	Critique	Need
• Necessary improvements and their costs are given • Useful recommendations for the individual building • Technical aspects are explained in language that is understandable	• No direct link with actual energy costs (just a range of costs is indicated) • Heating section: does not contain information about how the building is heated (gas/fuel/…) • **Proof of a good EPC is difficul**t for existing buildings that were built before introduction of requirements (e.g. it is hard to proof that the walls are well isolated everywhere).	• Clearly understanding the global score • Clarification on what has the biggest impact on the score ⇨ **highlighting main influencing factors** • Information about targets for residential buildings • **Buildings Target values** • EPC should contain actual savings (in euro; cf. interviews in Flanders) • including subsidies and reduction of investment costs

5.2.3 Discussion of suggested features to improve the EPC

In Flanders the following aspects to improve the EPC have been presented and discussed during the user-needs workshop:

- Suggested features for the next generation of EPC
- Benchmarking
- Real energy consumption data
- Different units
- Detailed recommendations
- Visualization: thermal images and 3D model of the building envelope
- A smart and dynamic EPC

The feedback from end users and other stakeholders is presented separately in the following sections.

5.2.3.1 Suggested features for the next generation of the EPC

End users most often selected the features “automatic data collection of existing sources (housing pass, Fluvius)”; “information about comfort **(indoor air quality**)” and an “online platform to consult about the EPC”. Each of the features was selected three times. **Professionals discouraged the idea to include monitoring data of individual devices or a score that indicates how smart the building is (automatization, interaction between different devices).** Instead they assessed “automatic data collection of existing sources”, “information about self-consumption and feed-in of locally produced renewable energy (PV), “roadmap for renovation” and “comparison of real consumption with similar buildings” as more useful (each feature was selected twice by professionals). Hence, in total the feature “automatic data collection of existing sources” was assessed as

useful by five participants. “Information about comfort (indoor air quality), “roadmap for renovation” and “comparison of real consumption with similar buildings” were selected four times each.

5.2.3.2 Benchmarking of the energy performance indicator

End users expressed that it would be more useful to include more information on what a realistic target is for the specific building, rather than benchmarking. This hint is a very valuable point. Also, it was mentioned that it would be useful to know what costs would occur to realize the target EEC of a respective building. Besides, when buying a new building benchmarking could help people to see “where the building is positioned within the market”. To estimate the value/worth of the building, this would be an important aspect. Hence, the figure of benchmarking the EE of buildings is perceived as positive, however improvements were suggested, such as to put the whole figure into context by indicating a target value in general and for the respective building. Professionals thought that this figure can have an opposite/negative effect as well. When people see that their house has a better score than the benchmark, the motivation of the homeowners to invest in renovations might be lower than without having the benchmark graph. The colours also play an important role in this aspect. When the EEC of the building is marked in green there will be less motivation to do additional investments (cf. satisfice bias).

5.2.3.3 Real energy consumption data

Questions: “Should real consumption data for electricity, gas and fuel be provided separately?”

All end users who answered this question (3) assessed that real consumption data should be provided separately for electricity, gas and fuel consumption. One professional stated that by providing separated information about fuel consumption would give end users a better idea regarding the average consumption values for fuels.

Questions: “If EPC was an online file, would you like to have real-time insight in your energy consumption?”

End users expressed that it could be useful to provide consumption data separately. Another end user stated that he would only use this option if the platform was safe regarding privacy. This concern was also mentioned by an expert in the Austrian workshop. Another end user expressed that this could be useful but that his energy supplier would also offer this service (cf. remark from experts from the workshops in FI and AT that this should not be covered by the EPC). The interviewee explained: **“The system my energy supplier offers is as follows: I have to add some details manually since I don’t have a digital meter. I can add details concerning my energy behavior, energy prices etc. online and based on that my energy contract can be adjusted online based on my needs”**.

Professionals mentioned that information about the real-time energy consumption could give insight to end users about the impact their behavior can have on energy consumption. Compared to obtaining energy consumption data from energy bills the difference is that end users obtain the feedback about their energy consumption immediately which could allow them to analyse what action consumes how much energy. Moreover, they would have the chance to react to the feedback, if it was provided e.g. on a daily basis or in real-time. If end users see at the end of the month or year how much energy they consumed they might not know what actions/behaviours consumed how much energy and they might be less motivated to change behavior.

Another professional doubted if real energy consumption data should be part of the EPC because this would be dynamic. Also, real-time energy consumption would not be tightly related to the building anymore, but rather to the users (cf. same comments in the workshop in Finland and Austria).

5.2.3.4 Different units

Question: “In what unit do you prefer the EPC to express the energy demand?”

The options which were provided:

a) [kWh/m² year]
b) [kWh/year]
c) [kWh/person year]
d) [€/month]
e) [€/year]

Surprisingly, two end users opted for the option b), which was found to be not understandable to many end users during the interviews and in other workshops. This selection could indicate that end users cannot grasp what energy consumption per m^2 means. One professional opted for a) and one for e).

5.2.3.5 Recommendations

Question: "What recommendations would be most interesting for you?"

The option which was most often selected in total was: "provide wall insulation or cavity wall" (three times selected). One end user remarked that the importance of the recommendation depends on the needs of one's building and on which renovations are possible.

5.2.3.6 Thermal Images

One end user stated that he regards thermal images as useful. It would be important to obtain the image of every façade to receive a complete picture of the building. This could also be solved by giving access to a digital 3D model to end users. **Another end user assessed thermal images to be useful to learn about "where the heat losses are" in the building.** This was exactly the purpose of providing thermal images to end users. Professionals also assessed that this could definitely be useful, even more if a reference colour per item (e.g. reference colour for roof/window/…) was provided. This would solve the problem which was pointed out by participants of the German workshop, that the scale for the colours would be manipulable.

5.2.3.7 Individual model of the building envelope

One end user expressed that he/she would prefer to see what his/her house should ideally look like: "how much space do I have to add, how many additional isolation layers?". This is opposed to the statement by professionals from Austria, stating that recommendations could not be derived from such a schematic model. One user informed that the Belgian EPC already contains some information about this in the recommendations. **According to one professional the individual model would not add much value if one did not have a reference. Again the remark is that end users should be informed about a target, "what it should ideally look like".** Another professional found that it could be useful if it was used to explain certain techniques for wall- and roof isolation (as it is done already in the Flemish EPC).

5.2.3.8 A smart and digital EPC

Question: "Which of the following aspect(s) should a smart and dynamic EPC contain?"

The options which were most often selected are: "**Financial information: investment costs; subsidies and bonuses; fuel prices** (4 times selected)", "instructions to reduce energy consumption yourself" (3 times selected) and "alarm that provides early warning of possible failure/indicates when maintenance is required)" (2 times selected). The most often selected aspect mirrors the outcome of interviews in Flanders that end users want to receive more economical information about fuels and EEMs.

5.2.4 Conclusion of the user-needs workshop in Belgium (Flemish Region)

End user who participated in the Belgian user-needs workshop would appreciate it if the main influencing factors on the EEC of a building were indicated. Moreover, they would like to see building target values in the EPC. Also, the EPC should contain

actual subsidies and an indication of the reduction of investment costs and savings in €, obtained through respective EEMs. End users expressed that it would be more useful to include more information on what a realistic target is for the specific building, rather than benchmarking. Regarding the display of individual real time feedback about energy consumption, one end user pointed out that he/she would only use this option if the platform was safe regarding privacy. Professionals mentioned that information about the real-time energy consumption could give insight to end users about the impact their behavior can have on energy consumption. Another professional doubted if real energy consumption data should be part of the EPC because these would be dynamic aspects and real-time energy consumption would not be tightly related to the building anymore, but rather to the users. The inclusion of thermal images was perceived as rather useful since they could help to learn about heat losses. Regarding the 3D model we received the suggestion to show how the building should ideally look like (related to the need for information about targets). Also, an expert recommended that a reference should be provided together with the 3D model of a building envelope.

5.3 User-needs workshop in Finland

This subchapter lists the participants that took part in the Finnish workshop, presents participants' critiques and needs regarding the EPC and their feedback to the presented suggestions to improve the EPC. The subchapter finishes with a conclusion.

5.3.1 Participants

In total six persons participated in the online workshop in Finland. Participants of the online user-needs workshop in Finland:

1. End user, advisor to consumers, multiplier, (owner of single family house)
2. Expert, Informant / advisor to policy makers
3. End user, former consultant, advisor to cities
4. End user, advisor to friends
5. End user, advisor to friends
6. Multiplier of EPC, property manager (the company owns and manages mainly non-residential buildings).

One participant noted that "compliance and control -role" could be added to the stakeholder map. In Finland the Housing Finance and Development Centre of Finland ARA, has this role. They are responsible for quality control and manage the database of EPCs and certified experts.

5.3.2 Collection of critique and needs regarding the Finnish EPC

The presented critiques and needs regarding the Finnish EPC are categorized in to needs regarding the implementation of the EPC, generation of the EPC and ideas to improve the EPC.

5.3.2.1 Implementation of the EPC

During the online workshop participants mentioned that EPCs are meant to compare buildings. Therefore, the user impact on energy consumption is standardized through standard user profiles. This view was also communicated by experts in the workshop in Austria. Participants 3 and 4 mentioned that the EPC does not give much information for the tenant, because the EPC is for a building, not a single flat; **and consumed energy costs are embedded somehow in the rent. In Finland the central heating costs are included in the rent and there is no tenant metering or heat cost allocators – usually the allocation is based on floor area. That means that a tenant could not profit financially from reduced energy consumption.** Participants 3 and 4 inform that in principle the electricity consumption per flat can be viewed online, however not many are interested.

It was appreciated by a participant that the energy indicators are public (except for single family houses) and available from the registry. Also, the fact that the two first pages of the Finnish EPC are public and available in the EPC registry indicates a better enforcement of the EPC in Finland than in Germany, where registration is not mandatory.

5.3.2.2 Generation of the EPC

Regarding the calculation of the EPC in Finland participant 3 mentioned that she **appreciates that on-site visits are mandatory because buildings and installations are not always built and operated as planned.** This aspect was criticized by experts from Germany, because site-visits are not mandatory there and they are often omitted by EPC certifiers. Participants 2 and 6 mention that the Finnish EPC considers measured consumption, if data is available. However, it is not visualized well. Deviations between the theoretical and measured energy consumption could be indicative to some problems in the operation of the building. However, deviations are considered as normal in other countries. Participant 6 described the extent of the user impact: "you can have an A-class building and run it on B-level." Accordingly, it would be especially interesting regarding new, very energy efficient buildings if they really performed according to the theoretical value indicated in the EPC. Hence, to operate a building in the EEC as indicated in the EPC, energy efficient and conscious behavior is required by the end user.
Participant 1 stated that the primary energy indicator is unclear for many end users. **However, the concept and conversion factors would be difficult even for experts.** This was also reported by an expert form Germany.

5.3.2.3 Ideas for improvement of the EPC

Participant 5 mentioned that the monitoring of energy consumption, normalized for weather conditions, is important for benchmarking the values which are indicated in the EPC**. In general participants demanded that the values of the EPC are put into a context (benchmarking and comparison to target values). Participant 2 suggested that the real energy consumption values could be shared online, visualized on map to enable (real) benchmarking or business for EPC companies.** Benchmarking could be interesting regarding different aspects (benchmarking of the EE of selected construction components). Participant 3 informed that benchmark numbers for non-residential buildings are available from the Motiva (energy expert company) website.
Participant 6 mentions that the calculated energy consumption in the EPC could be also converted and presented as costs for the end user, for instance in "€/year", also as compared to equivalent costs of other activities (example: "your energy costs as much as X hours of sauna or Y hours of watching TV"). According to him this would improve understanding for end users and they could assess the running costs of the building. He also considers that fuel prices are changing but he thinks that end users could calculate the running costs themselves if they know the current costs of fuels. **Participant 1 remarked that EPC values are not meant to be used to derive energy costs from because the consumption profiles are normalized and do not correspond to reality.** Therefore, end users could not derive running costs from the EPC. **He suggests that this could be overcome by a dedicated online tool which allows for individualization of the consumption profile of end users. Then the EPC could be recalculated based on the individual profile data (**similar suggestion was made during the Spanish workshop). Participant 5, who is an end user remarked that to him other factors are more important than the EPC when it comes to selecting a flat/house. **He suggested visualizing the share of energy costs in relation to the whole rent bill**. This could be interesting in the view of a tenant. However, a tenant could not do much with such information because the rent will not be adjusted according to lowered energy consumption.

5.3.3 Evaluation of suggestions to improve the EPC

This section gives an overview of participants' evaluation and remarks concerning the following suggestions: benchmarking of the energy consumption, the use of different units, recommendations (regarding renovation and every-day behavior) and features of a dynamic EPC.

Seven participants of the user-needs workshop in Finland answered the poll in Google Forms. The distribution of stakeholders that answered the poll is the following: all of the respondents considered themselves as end users (7). In addition, respondents attributed themselves to multipliers of EPC (2), informant about EPC (2), energy advisor (2), researcher (1) and implementer of EEMs (1).

5.3.3.1 Benchmarking of energy consumption

Only one end user indicated that he/she cannot understand the figure "benchmarking of energy consumption". There are different opinions about how useful the information from this figure is, but looking at all responses it is perceived as rather useful which is in line with the discussion during the workshop.

5.3.3.2 Different units

[€/month] or [€/year]: These units are understandable to everyone except for one informant about energy EPC. There are very different answers to the statement "I trust the indications in this unit". Also, there is a broad range of answers to the question how understandable the unit [kwh/person year] is. This unit is rather perceived as useless. Two third of the participants think that the unit [kWh/m^2 year] is more useful.

5.3.3.3 Recommendations

The aspects most participants want to receive recommendations about are the following:

- Ventilation system with heat recovery (5),
- Installation of renewable energies (4)
- Installation of a new boiler/heating supply (4),
- Fit double glazing or energy efficient glazing (4)

Regarding the source of information all of the participants (7) would like to talk to an energy professional in the first place to receive information about EEMs, the sources "energy supplier" and "friends/families who are experts" were chosen by five participants.

5.3.3.4 Providing information for every-day behavior to save energy

Participants assessed that hints for every-day behaviour to reduce energy consumption should only be an addition to the EPC, available to those who are interested in it. This information would appeal to behave more sustainable or environmentally friendly. Participants understand that energy is hard to grasp for end users. In general it is important that information is presented such that end users can relate to it and such that their awareness for energy is increased.

5.3.3.5 Visualization of the building envelope

The visualization of the building envelope is perceived as rather user-friendly and there is a divergent range of answers to the question if the visualization is perceived as useful.

5.3.3.6 Dynamic EPC

Five participants would appreciate instructions for self-implementation of smaller measures. The features "updated regulations and technical updates", "inclusion of indicators about building services and appliances + e-mobility", and "early warning systems" were chosen four times respectively.

5.3.4 Conclusion of the user-needs workshop in Finland

The Finnish EPC is quite comprehensive already, participants did not mention that something in particular would be missing. Nevertheless, participants proposed to add indicators which are easy to understand for ordinary consumers, for instance to not

express energy consumption only in [kWh] but in relation to a monetary value, also as compared to equivalent costs of other activities. The provision of comparisons and putting the values into a context to real life would be helpful to increase the understanding and relevance of values from the EPC for end users. Experts suggested using an additional tool to "interpret" the numbers in the EPC according to one's consumption behavior and household composition to set the values provided in the EPC into context and to make them more tangible to the end user. Finally, not more information/functions should be added to the EPC. This should be covered by another tool.

5.4 User-needs workshop in Austria

This subchapter informs about the participants that took part in the Austrian workshop, their critiques and needs regarding the EPC, their feedback on the suggestions to improve the EPC and a conclusion of the insights.

5.4.1 Participants

Fourteen participants took part in the online user-needs workshop in Austria which took place on the 14th January, 2021. Twelve participants introduced themselves as follows:

1. **Energy advisor** of the network energy consulting Steiermark and operates an energy agency; **certifier** of the EPC, in the context of energy consultancy he knows about the problem of different qualities between the EPC for sales of buildings and the EPC needed to apply for support measures.
2. **Issues EPCs** and works on **funding submissions** and categorizes herself in the group of advisors for EEMs.
3. Employee of EASt, has first worked as an **architect** and then started to work as an **energy consultant** in the country's energy association. Certifier for EPCs, makes restructuring consulting, where ecological construction is of great concern. He also considers himself as an **informant about the EPC.**
4. Owns an installing company, he is **technician** for the installation of heating systems and **issues EPCs.**
5. Works at EASt, issues EPCs, thereby gets into contact with end users (private individuals and housing associations and housing developers). At work she consults on refurbishments of buildings and thereby works with the different EPCs (high and low requirements in regard of the EPC).
6. Works at EASt in the field of **energy consultancy** and collaborates with the Province of Styria regarding the implementation of the EPBD in the field of heater inspection.
7. Attributes himself with the work of a **regional authority (policy maker)**. He works in the department "housing subsidy", promotion of sustainable and innovative energies. He is also working as an **energy consultant.** He has been working in the **department "renewable energies" of the ministry of economics** and has been **EU representative for the topic "energy" in Brussels.**
8. Works in the energy agency in the department "buildings". She considers herself mostly as an end user. She worked in a project about a dynamic EPC, she mainly wants to learn more about the EPC because in the project the focus is on end users as well.
9. Is working in the chamber of commerce (department: ecological business consultancy) and has managed many energy consultancy projects. He is also working in the Legal Service of the Austrian Chambers of Commerce and provides information about this field. He is mainly interested in the combination of the EPC with grants (e.g. thermal building refurbishment). According to him there is much potential for a better combination of the two.
10. Works for BMH consulting engineers (individual entrepreneur in an engineering office), he is energy advisor, energy auditor, has planned and built the first energy passive house in the province Steiermark and also lives in it.
11. Policy maker: has chaired the working group which developed the EPC (for Austria). He has been the common representative of all provinces of Austria in Brussels and has worked for the Commission for writing legal guidelines.

He considers himself as responsible for everything "around the EPC in Austria". Now he is a superannuated end user of the EPC and is interested in its further development.

12. He has his own office and another employment as master builders and works on ecological planning and consultation. He also issues EPCs for residential buildings (less often for non-residential buildings).

The other two participants could not introduce themselves due to technical problems.

5.4.2 Critiques, needs and interests regarding the EPC in Austria

This section reflects participants' critiques and needs, addressing the original goal of the EPC and its implementation, the uneven quality of EPCs and the content and format of the EPC.

5.4.2.1 Original goal of the EPC and future implementation of the EPC

Participant 11 refers to the discrepancy between calculated and real energy consumption and links this to the purpose of the EPC: the EPC was exclusively designed to compare buildings. Therefore, the user behavior is not considered in the generation of the EPC. He continues that it has been clear from the beginning that there will be 28 methods to calculate the EPC in 28 MS. Until now it could not be attained to converge the EPC among MS (cf. different quality of EPCs in MS). **But, the ePANACEA project could have the power to create a "Europe-wide, split, parallel document" that mediates "what the building can do" to end users.** The EPC oriented towards end users could become a European framework. Participant 10 would appreciate it if this document was set up in the same way among MS, or at least among pilot countries in ePANACEA: "this document could fulfil minimum requirements but at least it should be a uniform document".

5.4.2.2 Uneven quality of EPCs

Participants 10 and 11 pointed out that the quality of the EPC is decisively determined by previous knowledge of the certifiers. According to participant 10, the problem is that **certifiers come from different sectors and therefore have different competencies. This constitutes a problem for the comparability of the EPCs and the recommendations**. **Moreover, "nothing can/should build up on the demand-based EPC, because in most cases only standard values are considered for the generation of the EPC".** According to him the purpose of the EPC also influences its quality. For the sale and leasing of buildings the EPC is only a pro-forma document; a document with few requirements, it cannot be used to initiate EEMs. Participant 1 adds that **end users often do not understand why their EPC cannot be used for subsidy applications** (EPC issuers sometimes refuse to share EPCs for subsidy applications). Participant 11 explains the existence of a simplified calculation method by the fact that "good calculations" are complex and expensive. There is a discrepancy between the quality requirements by the authority and the end users. He refers back to the basic problem that many professions may issue an EPC, but are not competent enough. Next to the quality discrepancy among EPCs within a country there are quality discrepancies regarding the EPC among MS: Participant 11 states that in some MS "not even 5% of the data which are required for a good calculation are demanded, results based on this incomplete data can only be nonsense" (cf. freedom regarding the implementation of EPC in MS).

Participant 2 criticizes the "spurious accuracy" that is calculated during the EPC generation and thereby refers to the use of conversion factors that are often unrealistic. Therefore, there is a big discrepancy between what the EPC states and what end users really consume (cf. participant 11). Also, participant 10 remarks that specific indicators pretend an apparent EE because the buildings surface of new constructions has increased more significantly per person than the EE requirements have become stricter. Therefore, there is a higher energy consumption in total.

5.4.2.3 Content of the EPC

Participant 12 expressed the wish to outline the ecology of a building in the EPC, since ecology is the most important topic in his private and work life. **According to him, buildings should not only be rated depending on the EE but also depending on the ecology of the building. Thereupon, participant 11 explains that information about ecological aspects should be available in an additional document, but should not be added to the EPC because he considers the EPC as already complex.** According to him the EPC in Austria should rather be simplified (cf. interviews in Flanders).

Participant 8 addressed the fGEE (total EE factor), and the difficulty to explain this indicator to end users. She questioned if it was not possible to present the information in a more understandable way. In line with this, participant 1 reported that end users do not understand the unit [kWh]. **For his customers it is more important to know how many "tons of pellets" and how much costs for heating can be saved through a specific measure.** But, participant 3 justifies the use of the unit [kWh] by explaining that costs are variable but the physical unit [kWh] is stable. However, he understands that [kWh] are not tangible for end users. When using fuel costs as indicators the calculation would have to become dynamic. Participant 3 describes that he always compliments the EPC with an additional report in which he explains the EPC to end users to increase their understanding.

5.4.2.4 (A new) format of the EPC

Participant 3 expressed t**he idea to split the EPC into one version for the end user, with very visual and simple presentations (e.g. cost savings). The other version should be directed to authorities who can use it during decision making regarding the granting of funds. Participant 11 agrees with splitting the EPC into a document for end users, that explains the building and gives recommendations for actions, and an EPC as instrument for authorities that are working with permits and grants.** He formulates this as his request to the project ePANACEA. Another participant suggested leaving out the information of the EPC generation and to include a generalized cost comparison for the refurbishment recommendations in the version for end users. Participant 10 adds that the fGEE indicator, which is often not understood by end users could be left out in the version for end users.

5.4.3 Suggestions to improve the EPC

This section summarizes participants' feedback on the suggested features: real energy consumption data, benchmarking of the energy consumption, use of different units, recommendations, visualization of the building envelope and features of a dynamic EPC. Eight participants of the user-needs workshop in Austria answered the poll in Google Forms. The distribution of stakeholders that answered the poll is the following (the number of participants for each stakeholder type is indicated in brackets):

- End user (3)
- Policy maker: regional authority (1)
- EPC certifier (5)
- Informant about the EPC (5)
- Energy advisors for EEMs (6)
- Research (1)
- Event manager for the organization of lectures, actions etc. (1)

5.4.3.1 Data about energy consumption in the EPC

Participant 11 pointed out again that he absolutely wants to separate information about the building and real energy consumption data: the EPC serves to compare buildings and information about the energy consumption should be available in parallel. Energy consumption (for heating) as well for electricity can be obtained from bills. **Participant 10 agrees**

with this opinion, also because the default values that are considered for the calculation are areal (in relation to a surface). This has a big influence because currently apartments become bigger per person. This could mean that e.g. the hot water consumption is reduced because less people actually live in the building. **Therefore, the indication about the energy consumption (per square meter) cannot be correct anymore. By conclusion, the energy demand of a building can be indicated per square meter, but the hot water consumption cannot, because it is very dependent on the number of persons living in the building and on their behavior. The comparison to driving a car makes this clear: everyone knows that the fuel consumption depends on the driving style; the standard fuel consumption can never be measured based on this.** Participant 9 agrees that it is crucial to have a theoretical indicator which allows to compare buildings; however, he adds that it is problematic if one wants to initiate EEMs and one has certain expectations about the reduction of energy use and these are not met because the initial value is not realistic. Hence, it is difficult to evaluate the energy savings. **Participant 8 suggested combining the EPC with another tool, as it is now possible to process data digitally. The energy consumption data could e.g. be saved and after a few heating seasons a benchmark could be developed for the building.** Then, the EE (the current energy consumption) could be compared to that. The EPC could stay available to authorities, for subsidies, permits etc.

5.4.3.2 Benchmarking of energy consumption

All participants indicated that they understand the figure and that they perceive the information as rather useful. This is an overall positive reaction to this suggestion.

5.4.3.3 Different units for energy consumption

- **[€/m² year]:** All participants indicated that they understand the unit €/month, four participants (50%) indicated that this unit is very useful, while three indicated the opposite. Hence, the opinions about this suggested unit diverge. Three participants (one policy maker, two informants about EPC and energy advisors respectively) do not trust the indication with the unit €/month, three of them trust it, while two participants indicate that they are not sure whether they can trust in the validity of an indication in this unit.
- **[KWh/person year]:** There is a broad range of answers to the question how understandable the unit [kWh/person year] is. Four participants (policy maker, end user, EPC certifier and energy advisor) find this unit useless. The same participants do not consider this unit to be more useful as the unit [kWh/m² year]. However, two participants, who attributed themselves to the categories “EPC certifier, informant about EPC and end user” indicated the opposite.

5.4.3.4 Recommendations

The aspects which were chosen the most often in order to receive recommendation about are the following:

- Installation of a new boiler/heating supply
- Apply attic insulation
- Insulate the water/heating pipes
- Improve the air tightness of the building

All of these aspects were selected seven times. Regarding the source of information the most often selected sources to receive information from about recommendations are the following:

- Talking to an energy professional (all; 8)
- Next generation of EPC (4)
- Information from suppliers of energy saving products (4)

5.4.3.5 Visualization of the building envelope

Participants discussed the visualization of a building envelope in the plenary: **There is software available that allows to export schematic representations already; but, it would be desirable if these were standardized and would have a common design. Participants 11 and 10 agree that the schematic representation should be simplistic and should help end users to understand how the ceiling or wall construction of their building looks like.** However, no evaluations or recommendations could be derived from this. One participant suggested using schematic icons and to consider single components of a building. **This could help the end user to link the information from the EPC with the respective construction component (cf. EPC in Flanders).** The poll in GF indicated that the visualization was perceived as rather useful (3 participants chose the option "strongly agree").

5.4.3.6 An intelligent and dynamic EPC

Participant 11 remarked that he expects a lot of the listed features (dynamic simulation, energy use forecast) of smart meters and not of the EPC. Also participant 10 stated that these are good suggestions in principle, which however do not belong in the EPC: "the body weight is also not indicated in the identity card". He suggests to focus on what could be left out, instead of adding information. Regarding the bookkeeping of energy data he is waiting for the roll out of smart meters, too, which however seems to take long. **Moreover, data protection could become an issue since energy consumption data in relation with address, name etc. can be used to draw conclusions on the end user's behavior and could be used by companies.**

The most often selected option (7) was **"a roadmap, similar to the building passport"**. The options following options were selected by 4 participants respectively:

- Updated regulations and technical updates
- Dynamic simulation of consumption data (individual real-time feedback)
- Inclusion of indicators about building services and appliances + e-mobility and energy use-forecasting

5.4.4 Conclusion of the user-needs workshop in Austria

One expert referred to the discrepancy between calculated and real energy consumption and linked this to the purpose of the EPC which was to have a tool to compare buildings. Another participant criticized the "spurious accuracy" of the EPC and made the use of (often unrealistic) conversion factors responsible for that. Therefore, nothing should build up/should be derived on the demand-based EPC. Moreover, certifiers come from different sectors and therefore have different competencies. This constitutes a problem for the comparability of the EPCs and the recommendations. Hence, EPCs do not display real energy consumption values and are often not comparable. Furthermore, an expert expressed the wish that the EPC would include information about the ecology of the building (life cycle assessment indicators). However, a policy maker strongly demanded to include these information in an additional document because the EPC would be already complex. During the workshop the idea was raised to split the EPC into one version for the end user, with very visual and simple presentations (e.g. cost savings) and another version directed to authorities who can use it during decision making regarding the granting of funds. The version for end users could be a "Europe-wide, split, parallel document". Another participant suggested leaving out the information of the EPC generation and to include a generalized cost comparison for the refurbishment recommendations in the version for end users. Participant 10 adds that the fGEE indicator, which is often not understood by end users could be left out in the version for end users. Regarding the suggestion to include real energy consumption data in the EPC a policy maker remarked again, information about the building should absolutely be separated from real energy consumption data. The EPC could be combined with another digital tool. Regarding the presentation of 3D-models of building envelopes in the EPC, experts emphasized that the generation of the schematic representations should be standardized and should have a common design. A simplistic schematic representation could help end users to link information from the EPC with the respective construction component.

Referring to the suggestion to make the EPC dynamic and digital two experts stated that the suggested features were good in principle, but that a lot of the listed features (dynamic simulation, energy use forecast) could rather be expected from smart meters. These features would not necessarily belong into the EPC (cf. using an additional tool). Instead, one should focus on streamlining the EPC for end users. Moreover, data protection could become an issue since energy consumption data in relation with address, name etc. can be used to draw conclusions on the end user's behavior and could be used by companies. A roadmap, similar to the building passport, was the most often selected feature to be included in the EPC.

5.5 User-needs workshop in Greece

This subchapter informs about the participants that took part in the Greek user-needs workshops, their critiques and need regarding the EPC and their evaluation of the suggested features to improve the EPC. The subchapter finishes with a conclusion.

5.5.1 Participants

Thirteen persons participated in the online user-needs workshop in Greece which took place on the 13th January 2021. Eight end users participated, one certifier for EPCs, three advisors for EEMs and one implementer of EEMs.

5.5.2 Critique and needs regarding the Greek EPC

As we learned from the interviews end users consider the EPC as 'extra cost', but are interested in familiarizing with the EPC data. **End users expressed the need to gain detailed information about the energy saving measures. Also, one end user suggested that the EPC should be linked with the digital building ID.** The digital building ID (a database with all the necessary documents and plans for each property) will be mandatory in Greece from 1st of February 2021. **End users are interested in their real energy consumption because this is the amount they pay for. End users would prefer if this could be part of a digital EPC**. **Also, advisors for EEMs claimed that the EPC should become digital and that real consumption data should be displayed.** The real consumption data can be displayed on the EPC in Greece; however, it is not mandatory and it is difficult to collect the data.

5.5.3 Evaluation of suggestions to improve the EPC

This section displays participants' evaluation of benchmarking of the energy consumption, use of different units, recommendations, visualization and features of a dynamic EPC.

5.5.3.1 Benchmarking

The majority of the participants indicated to understand the figure about benchmarking energy consumption. Also, most of the participants considered benchmarking to be useful.

5.5.3.2 Use of different units

Regarding the use of different units to describe the EE of a building we can conclude that all participants understand the unit €/month. Likewise, everyone indicated that this unit would be useful. In general, participants would trust the indication with this unit, however five participants chose the middle response option, indicating that they are not sure whether they can trust the unit. The answers regarding the question how understandable the unit [kWh/ year] diverge. Also, this unit appears useful to some participants, while it does not to others. The same is true for the question whether the indication per person is more understandable than the indication per square meter.

5.5.3.3 Recommendations

The three most often selected recommendations which appear to be most interesting to participants are: installing a new boiler/heating supply, installing an external shading system and installing renewable energy technology (each of the three aspects was chosen 10 times). **Moreover, participants suggested including a list of certified building product installers/providers together with detailed recommendations. For instance, they want to learn about the thickness of the thermal insulation (how?), instead of just receiving the information that they should install thermal insulation**

(what?). The preferred source of information about recommendations would be talking to an energy professional (selected 12 times).

5.5.3.4 Visualization: thermal images and 3D models of the building envelope

Most participants find the use of thermal images user-friendly (12 participants strongly agree). All participants find thermal images useful in order to become aware of "less energy-efficient" construction components of a building. Likewise, participants considered an individual 3D model of the building as user-friendly. However, the answers to the question how useful this would be, were less positive: only 50% of the participants strongly agreed. In general, CRES concluded that visualizations could give more confidence to end users (to understand the information).

5.5.3.5 Dynamic EPC

The answers to what features the next generation of EPC should contain were various. Participants most often selected the option **"a roadmap, similar to the building pass".**

5.5.4 Conclusion of the workshop in Greece

During the online workshop end users expressed the need to gain detailed information about the energy saving measures. Also, one end user suggested that the EPC should be linked with the digital building ID. End users are interested in their real energy consumption because this is the amount they pay for. End users would prefer if this could be part of a digital EPC. Also, advisors for EEMs claimed that the EPC should become digital and that real consumption data should be displayed. Moreover, participants suggested including a list of certified building product installers/providers together with detailed recommendations. The preferred source of information about recommendations would be talking to an energy professional. Most participants appreciate the idea of including a road map, similar to the building pass in the EPC.

5.6 User-needs workshop in Germany

This subchapter describes the types of stakeholders that took part in the German user-needs workshop, participants' critiques and needs regarding the EPC, and insights into participants' evaluation and feedback about presented suggestions to improve the EPC.

5.6.1 Participants

The online user-needs workshop took place on the 17th December, 2021. Eight participants took part. The following participants were present in the user-needs workshop in Germany.

1. **Property manager,** administration of 80 objects and multiplier of EPC
2. **Policy maker:** *Umweltamt für Bauwesen und Raumforschung*, contributed to the EnEV, participated in research projects about the Renewable Energy Act (EEG) and certifier of the EPC and energy advisor.
3. **Policy maker:** deputy head of the environmental ministry Saarland – responsible for EMAS (Eco Management and Audit Scheme), informant about the EPC
4. **End user:** owner of a building
5. **Certifier of the EPC** and self-employed **energy advisor**
6. **End user:** owner of a building
7. **End user:** tenant
8. Delegate of Bavaria of the German Energy advisor network (DEN e.V.), participated in the field test of the 1st EPC, **EPC certifier** and **informant about EPC and EEMs.**

5.6.2 Critique and needs regarding the German EPC

The critique and needs regarding the EPC from participants of the German user-needs workshop are categorized into the purpose and development of the EPC, generation of the EPC and the (lack of) quality monitoring, content of the EPC, use of the EPC by end users and visualization of information.

5.6.2.1 Purpose and development of the EPC

According to participant 6 the EPC is only a political instrument. Participant 8 assumes that at the beginning one wanted to have a tool which allowed the energetic evaluation of a building. Participant 2 explained that "one started with big goals in the beginning". But, the problem was that a lot of interests had to be considered, so the end product was a compromise. The idea was to obtain a profile of a building, similar to the building pass. Participant 8 agrees and adds that she sees the development of the EPC as rather disappointing and assumes as well that this is because of the attempt to satisfy too many different interests.

Participant 3 criticized that the compulsory generation and presentation of the EPC in non-residential buildings would have no added value, because the energy consumption was dependent on other factors. He continues, that the EPC is only mandatory but that the EMAS was more profitable to the authority he is working for. Participant 2 explained that the obligation to present the EPC in non-residential buildings is a European requirement and was implemented accordingly in Germany. Public buildings should have a model character (showing the public that the public sector is working in energy efficient buildings).

Participant 8 pointed out another "loophole" regarding the embedding of the EPC as a policy tool in Germany: since 2014 there are penalties for real estate agents if information from the EPC is not included in the property advertisements. Sometimes the property advertisements only indicate "EPC is being processed". Then, once the building is sold or rented nobody is interested in it anymore.

5.6.2.2 Generation of the EPC and (deficient) quality monitoring

Participant 6 pointed out that often the EPC is calculated based on **estimated values** which are given by the EnEV. **However, these values would diverge from the real values**. For a profound calculation the reality needs to be taken into consideration which requires a lot of time and money. **Participant 8 agrees that the consumption-based EPCs often deliver very different results than the demand-based EPCs.** She emphasized the general problem that the **demand-based EPC is regarded in the same way as the consumption-based EPC**. The existence of the two versions in Germany often leads to confusion for end users. Her message is that the demand-based EPC cannot be compared with the consumption-based EPC. This issue has been mentioned by experts during the interviews as well. But, there is another problem: would there have been enough certifiers to issue so many demand-based EPCs?

Participant 8 regretted that **site visits are not mandatory for issuing an EPC.** The legal basis for this is missing, or rather equivocal. This leads to another structural problem: if consumption-based EPCs are generated she always visits the site; however, that makes the EPC more expensive (minimum price is 250 €). **But, one can obtain consumption-based EPCs from online platforms for 20 €. She demands that for the certification of an EPC site-visits must become mandatory** (as it is the case in other pilot countries). If this was the case one could control the information provided by customers (heating, area). Requiring site-visits is the minimum claim, to abolish the consumption-based EPC is her second demand.

Participant 2, who is a policy maker, mentioned that with the introduction of **quality controls** of the EPC, it may be possible that the auditor makes a site visit and that then the building is compared with the calculation and the recommendations. By then it should become apparent if there is a discrepancy. He dislikes the idea of prescribing site-visits because one cannot prescribe everything. Participant 8 agrees that it is valuable that the auditing of issued EPCs was introduced in 2014. Along with this the registration numbers for EPC were introduced. With an allocated **registration number** an audit can take place. **The other way**

round, the audit can be avoided by not indicating a registration number in the EPC. Furthermore, **she criticizes that there is no central institution who has an overview of the registration numbers.**

Participant 6 criticized that the CO_2 values in the GEG (German Energy Act for Buildings) are not corresponding to the current CO_2 tax. Again the GEG uses fictional CO_2 values which are not realistic. However, **if the CO_2 indications in the EPC were realistic one could estimate the costs related to the CO_2 emissions.**

As it was criticized in the German stakeholder interviews, participant 6 criticized that the energy demand does not **refer to the respective location but to Potsdam**. However, since the meteorological data is not the same everywhere in Germany, this would be an outdated system. **An end user realized that therefore the indicator must be relative and not really usable, unless one lives in Potsdam**.

5.6.2.3 Content of the EPC

Participant 5 mentioned that the GEG in Germany would have been an opportunity to include more information in the EPC, such as **thermal insulation in summer** (how many hours of overheating? is the building liveable then?). This is especially the problem for old buildings that have been renovated, but which in summer quickly overheat. In a next generation of the EPC the heating and cooling load should be indicated.

Participant 6 remarked that the EnEV does not require indications on the sustainability of the construction components. **If the GEG and the ENEV were linked to the life cycle assessment the end user could become aware of how much primary energy, end energy and CO_2 emissions for the construction of the building were used.** However, currently the political discourse only considers the energy consumption in the use phase of a building. According to him information about the construction material (e.g. wood/concrete; individual components/prefabricated) should be included. Participant 2 assumes that the problem would be to include the life cycle assessment in the calculation of the EPC.

Participant 6 criticizes that the annex with e.g. information about the data used for calculation of the EPC is missing. He concludes that the EPC is neither meaningful to end users nor to experts since it is too complicated for the first and not complete for experts (cf. similar critique from participants in the Belgian workshop). Hence, it would make sense to split the EPC.

5.6.2.4 Use of the EPC by end users

Person 1 who is a property manager, stated that the idea behind the EPC is good in general; however, no end user would understand the meaning of the energy label of a building. He reported that end users always opt for the least expensive EPC (consumption-based EPC). **However, this EPC has flaws regarding the calculation because vacancies and absence of people are not considered because they are unknown.** Nobody is interested in the EPC; only during sale and leasing of a building it must be present. He added that upon purchase or rental of a building a lot of other factors would play a more decisive role than the EPC. Another end user concluded that the EPC is unclear, complex and would not deliver any information on what he would need the EPC for. **Also, no individual instruction manual including cost implications are possible from the EPC. For instance, it is not clear how much costs could be saved by owning a building of a lower EEC.** Participant 6 suggests that the relevance for end users could become bigger if the global energy indicator would refer to the real usable space instead of the “AN-area”. This was also mentioned during stakeholder interviews in Germany. According to participant 2 the basic problem of the EPC is that it contains too much information which cannot be correctly interpreted by laypersons. Also, the fact that a lot of norms are cited is no valuable information to the end user.

5.6.2.5 Visualization of Information

Participant 6 suggested including a schematic presentation of the relevant construction components of the building in the EPC. This suggestion is similar to the one we prepared and showed in the second part of the online workshop. For this, also a site-visit would be important.

5.6.3 Evaluation of the suggested features to improve the EPC

This subsection presents participants' evaluation and remarks regarding benchmarking of energy consumption, the use of different units, recommendations, visualization (thermal images and 3D model of a building envelope) and a dynamic EPC. Finally, participants reflected on the need to improve the communication between end users and intermediate links.

Seven participants of the user-needs workshop in Germany answered the poll in Google Forms. The respondents attributed themselves to:

- End user (3)
- Policy maker (1)
- EPC certifier (1)
- Multiplier of EPC (1)
- Energy advisor for EEMs (1)

5.6.3.1 Benchmarking of energy consumption

Participant 6 commented that the indication [CO_2/person year] is missing in the diagram. He argues that society would become aware of the topic "CO_2 equivalent" in the next ten years. **Including a benchmark about CO_2 emissions would pursue the target to lower CO_2 emissions by 2050.** There is a broad range of answers to the question about the understanding of the figure in the poll in GF. The information from this figure is perceived **as rather useless.**

5.6.3.2 Different units

- **[€/month] or [€/year]:** These units are understandable to most of the participants except for one (energy advisor for EEMs). There is a split view about the usefulness of this unit: two participants believe this is not useful (energy advisor and multiplier of EPC) while end users, policy makers and EPC certifiers assess it as useful. Trust in information with this unit is different, too. The same participants - energy advisor and multiplier of EPC and one end user - would not trust the information indicated in this unit.
- **[KWh/person year]: Participant 2 remarked that for the unit [kWh/person year] the user profile should be considered since this is decisive for the consumption data. Participant 6 suggested including all units in the next generation of EPC, including a benchmark**. There is a broad range of answers to the question if the unit [kWh/person year] is understandable. This unit is only perceived as useful by 2 end users and an EPC certifier; the same participants find this unit more useful than [kWh/m^2 year]. The energy advisor and the multiplier of EPC do not perceive this unit as useful.

5.6.3.3 Recommendations

Participants chose the following aspects because they consider them as most interesting to receive information about:

- Installation of a new boiler/ heating supply (3)
- Applying double-glazing of energy-efficient glazing (3)
- Insulation of water and heating pipes (1)
- Improve the air tightness of the building (1)

One end user indicated that all listed points would be useful. In addition, **one EPC certifier mentioned that he would like to receive information about the necessity to renovate the building/party of the building**, e.g.: "in comparison - with reference buildings/sustainable new construction- all components of your building need to be modernized (in the long-term until 2050) / the respective components (depending on age of components/ life cycle costs) need to be modernized. This is a valuable hint. **Regarding the source of information the majority of the respondents (6) believe that talking to an energy professional would be the best option**, one participant (EPC certifier) chose the consumer association as preferred source of information.

5.6.3.4 Thermal Images

All response options regarding the comprehensibility of the figure were selected. Also, there is a split view on the usefulness of the figure. This may be connected to the discussion during the workshop where the energy advisor explained that thermography is only useful for experts and that thermal images are often only a sales tool. **The problem is that the temperature scale can be adjusted and that therefore it would not be an adequate tool to compare buildings.**

5.6.3.5 3D model of the building envelope

The figure is perceived as user-friendly and as rather useful (except for 1 end user who does not consider the figure useful).

5.6.3.6 A smart and dynamic EPC

The following features were selected because respondents think they should be included in a smart EPC.

- Energy use forecasting (2)
- Update regulations and techniques
- A roadmap, similar to building passport, to meet EE targets through staged deep renovations, conducted EEMS (making the EPC more dynamic)
- A tool to find craftsmen
- Instructions for self-implementation of smaller measures
- Early warning systems (in case they heating fails),
- Dynamic simulation of energy consumption

One end user perceives all aspects as useful. **One EPC certifier commented that he would appreciate information like: "the life cycle is exceeded for x components (…) we recommend modernization".** This is a valuable idea about how life cycle assessment indicators could be used in the EPC. In addition, the energy advisor commented that only information about the clear and uniform and comparable actual state should be given. This would serve the original purpose of the EPC to be an information tool for end users which can be used to compare the EE of buildings.

In addition, participant 6 expressed that the inclusion of electricity consumption data in the EPC would make sense, because in the long term a lot of countries will require the use of PV systems. Because of this it would be valuable to know the electricity demand.

5.6.3.7 Communication about the EPC and EEMs between "intermediate links" and end users

Participant 6 remarked that the companies which issue EPCs are sometimes very big. He pointed out that the ordinary energy advisor 'will die out' in the next ten years because he would not be competitive compared to the big organizations (cf. similar statement from a German expert from CO_2 online). Furthermore, participant 6 assumes that due to the increasing complexity and the missing legal situation the number of the working energy advisors would decline. The title "energy advisor" is not protected and the quality of an energy advice is dependent on the competence of the advisor. Furthermore, he explains that the consumer associations only give initial advice, if one wants to obtain subsidies one has to contact somebody from the free

market. The consumer association is paid for explaining the EPC to end users, whereas the self-employed energy advisors are not.

Regarding the question how the role of the experts can be improved **he claimed that the professional field of energy advice is the professional field which comparatively has to prove the most training** (this is opposed to the appeal in Flanders that experts should receive more training and to the fact that there are inequalities regarding the competencies of experts e.g. in Germany). Related to this, participant 6 criticized that the **energy consultancy depends on the professional background of the advisor. He assumes that some experts would only use the energy advice as an opportunity to pursue their economic intentions.** He criticizes that some energy advisors are not able to make a holistic evaluation of a building (only for the techniques/components they are specialized in). **According to him an energy advisor should also inform about the life cycle of the building components and should estimate if a refurbishment of the demolition of the building is more economical** (cf. this information is given in the Belgian EPC). **That means that an energy advisor should be able to give holistic recommendations.**

5.6.4 Conclusion of user-needs workshop in Germany

Several aspects which were criticized during the stakeholder interviews were mentioned again in the workshop: e.g. that the consumption-based EPCs often deliver very different results than the demand-based EPCs and are therefore not comparable and that the calculated energy demand always refers to the climatic data from Potsdam and that the areal unit used in the EPC is not known by end users.

Other than that, experts who participated criticized that site visits are not (like in the other pilot countries) mandatory. Moreover, the quality difference among EPCs was emphasized, where the low quality EPCs are already available for 20€ from online platforms. Next, it was criticized that the quality monitoring is not enforced for the EPC because an audit can be avoided by not indicating a registration number in the EPC. An expert has demanded that the EPC should include 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. In addition, he expressed that the inclusion of electricity consumption data in the EPC would make sense, because in the long term the application of electricity generating or consuming appliances and systems might become more relevant. Because of this, it would be valuable to know the electricity demand. He concluded that the EPC is neither meaningful to end users nor to experts since it is too complicated for the first and not complete for experts.

Regarding the suggestion to include a benchmark for energy consumption, an expert recommended to also include a benchmark for CO_2 emissions since this would pursue the target to lower CO_2 emissions by 2050**.** If the CO_2 indications in the EPC were realistic one could estimate the costs related to the CO_2 emissions. Regarding the presented units we received the hints that for the unit [kWh/person year] the user profile should be considered since this is decisive for the consumption data and that all suggested 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. The majority of the respondents believe that talking to an energy professional would be the best source of information, about recommendations. Regarding the use of thermal images there is the problem that the temperature scale can be adjusted and that therefore it would not be an adequate tool to compare buildings. Finally, an expert claimed that energy consultancy depends on the professional background of the advisor and that energy consultancy might often not be objective. In the best case energy advisors would be able to give holistic recommendations.

6 DISCUSSION

First, this chapter indicates what stakeholder types should be added to the stakeholder map based on insights from stakeholder interviews, user-needs workshops and regional exploitation board (REB) meetings. Then, this chapter provides an overview of the main findings (EPC perception, critiques and needs and communication about the EPC and EEMs) from interviews and user-needs workshops in the six countries, differentiated for end users and other stakeholders. From this, the chapter further analyses stakeholders' perceptions, critiques and needs regarding the EPC and suggests why these may (not) differ among plot countries + Germany and among stakeholder types. Then, this chapter points out the role of communication about the EPC and EEMs by other stakeholders. Based on the dicussed results this chapter delivers a criteria-set for an adequate EPC. From this, the chapter derives recommendations for EPC authorities for the next generation of EPC.

6.1 The role of other stakeholders

This subchapter presents the collected feedback from interviewees, participants of the user-needs workshops and REB meetings regarding the completeness of the stakeholder map.

In general, the existing stakeholder maps were assessed as correct by participants of the REB meetings and the user-needs workshops. 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 calculation 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 CO_2 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 2.

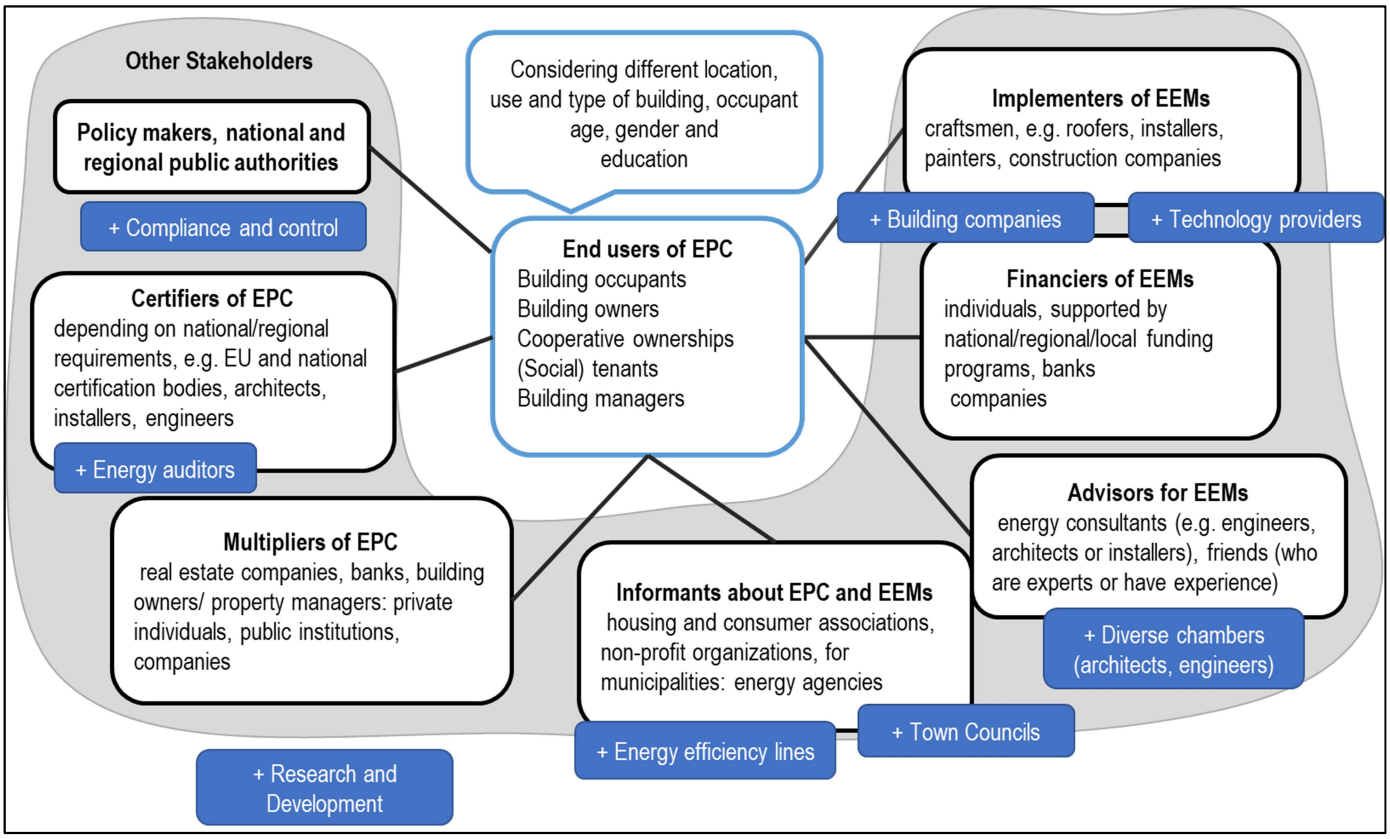

Figure 2: Adjusted Stakeholder Map

6.2 Highlights of interviews and user-needs workshops

This subchapter provides an overview of the main findings from the interviews and user-needs workshops. The highlights are presented per country and stakeholder type. Moreover, they are divided into perception of the EPC, critiques and needs regarding the EPC and communication about the EPC and EEMs. Table 2 presents the main findings from Spain, Belgium (Flemish region), Finland and Greece, whereas Table 3 provides an overview about the main findings from Germany and Austria.

Table 2: Highlights of interviews and user-needs workshops in Spain, Belgium (Flemish region), Finland and Greece

		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

Table 3: Highlight from interviews and user-needs workshops in Austria and Germany

		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.

6.3 Perceptions of the EPC by study participants

Figure 3 presents a word cloud of the collected perceptions of the EPC from stakeholder interviews and user-needs workshops. Therefore, it contains perceptions from all ePANACEA pilot countries + Germany and from all stakeholders. The green words present positive associations with the EPC, black presents neutral associations and blue presents rather negative associations with the EPC. From the empirical chapters we learned that end users – with a few exceptions - had rather negative perceptions of the EPC, whereas other stakeholders (especially policy makers) knew the original goal of the EPC, its use as a policy instrument in the energy transition and regarded the EPC as instrument to know the as-built situation of the building stock. However, often experts admitted that the EPC has not fulfilled its potential yet.

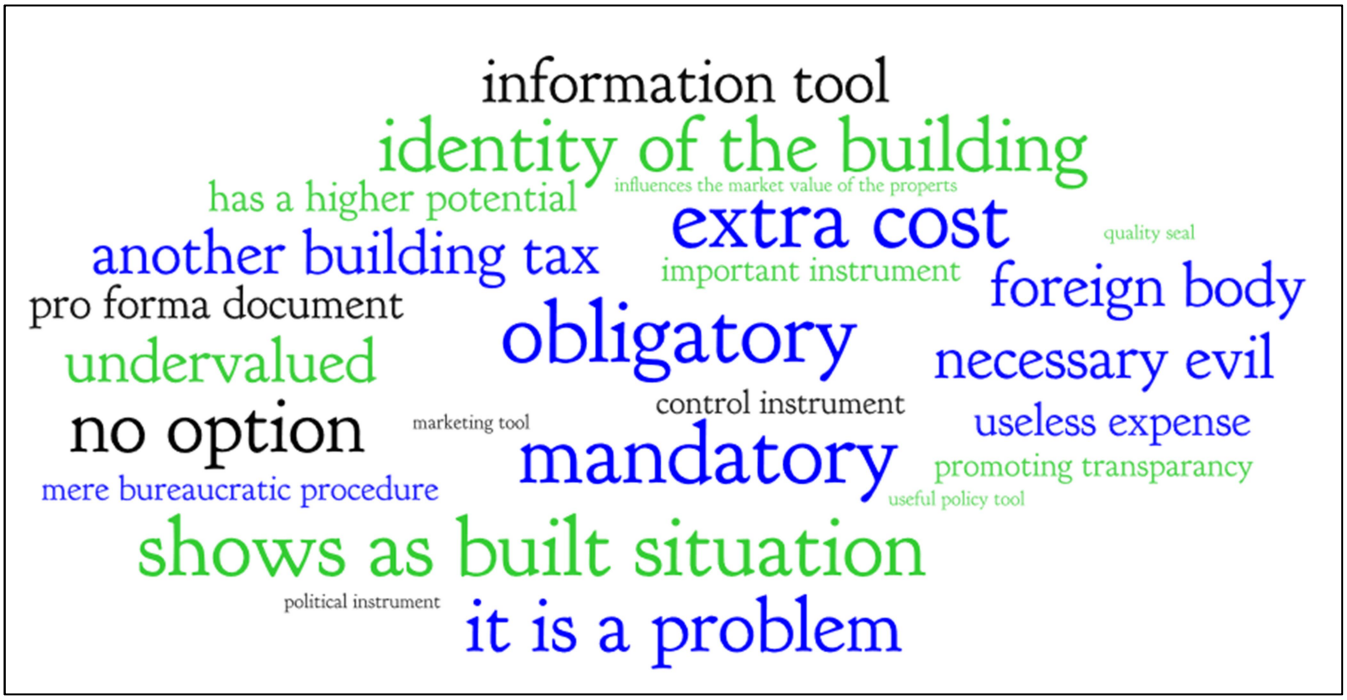

Figure 3: Collected perceptions of the EPC from stakeholder interviews and user-needs workshops

End users commonly perceive the EPC as mandatory document among all pilot countries + Germany. They use it **for contractual actions such as deep renovation, selling or renting. However, from various interviews we learned that they often do not use it as a decision-making aid but only as a mandatory document that is filed. This may be due to various reasons such as low awareness and interest in energy efficiency in general and little trust in the standardized indicators which say little about the real individual situation and are therefore not reliable (in terms of the calculated EPC).** Flanders may be an exception, where the EPC is also understood as a document that can increase the market value of a building. Increased public awareness could be observed in countries where the EPC is linked to funding programmes (EXOIKONOMO), for which EPCs are mandatory like in Greece. Here the phenomenon is that end users are aware of the EPC as a mandatory document but they do not consider the information it contains. One reason for this may be that they do not trust in the information because they feel that the indicated EEC is worse than in reality. In Germany, end users do not rely on the EPC because the document including the recommendations are justifiably perceived as standardized. Furthermore, the irrelevance of the EPC was often explained with the scarcity of the housing market by tenants in Germany. Besides, other factors (e.g. location and total costs for the rent) are considered as more important than the EEC of a building.

It is also interesting that thermal comfort seems to be important to end users. For instance, in Belgium the EPC affects their decision in terms of technical or structural solutions, but not in terms of indoor temperature settings. This indicates that these

end users are not prepared to reduce their demands on heating comfort in order to save energy. Likewise, an expected increase of energy comfort is considered as motive to initiate EEMs.

In general, house owners are more interested in EE of a building than tenants who often live temporarily in an apartment. Also, depending on the billing system energy costs are not directly attributed to the individual's energy consumption (e.g. shared flat, flat in a multi-family house or costs for energy are included in the rent), which is why the monetary incentive to save energy through EEMs is low to non-existent. Nevertheless, tenants expressed an interest in information about heating costs; one tenant stated that with the possibility to monitor energy consumption he could check the heating bill – however, this is not the original objective of the EPC. The EE of a building plays a more important role to prospective owners of a house, who are e.g. planning a construction because then they are confronted with energy standards. Tenants who imagined becoming owner of a building in a few years confirmed that they would probably pay more attention to energy related aspects in future than now. **Furthermore, the age of the building and of the owner seems to play a role.** One end user from Finland explained that to him/her the EPC for new houses is more relevant than for old houses. Regarding old houses he/she seems to be more likely to accept a bad EPC. Moreover, the age of end users plays a role regarding the question if one would invest in the EE of a building or not. If building owners are of advanced age it could be that they do not experience the payback period.

6.4 Critiques and needs by study participants

This chapter discusses the collected critiques and needs regarding the EPC. First, this subchapter suggests a categorization of the critiques and needs according to different levels of the EPC. Then, this subchapter seeks to explain why there are different needs among stakeholder types and countries. Furthermore, it outlines topics on which opinions diverge and zooms into one point of discussion: feedback about real energy consumption. It continues with highlighting other, often mentioned needs regarding the EPC (making the EPC customizable, dynamic and splitting the EPC).

6.4.1 Categorization of critique and needs

During the interviews and user-needs workshops 'different levels of the EPC' were discussed. Interviewees and participants discussed systemic aspects (e.g. quality monitoring of the EPC) as well as details of the generation of the EPC (e.g. complex calculation methods) and details of the content of the certificate itself (unit of the energy performance indicators). The idea that the discussed critiques and needs can be classified into three superordinate categories is visualized in Figure 4. A funnel was used for the visualization to show that the topics go from broad (implementation of the EPC as a policy tool) to detailed (use of the EPC as a certificate). Also, the funnel can be understood as an arrow, indicating that the implementation of the EPC with its regulations has an influence on the generation of EPC and finally on the use of the EPC. Topics belonging to the first level are country-specific, topics concerning the generation of the EPC are intended for experts (EPC certifiers) and the use of the EPC as a product concerning individuals where the focus is on end users.

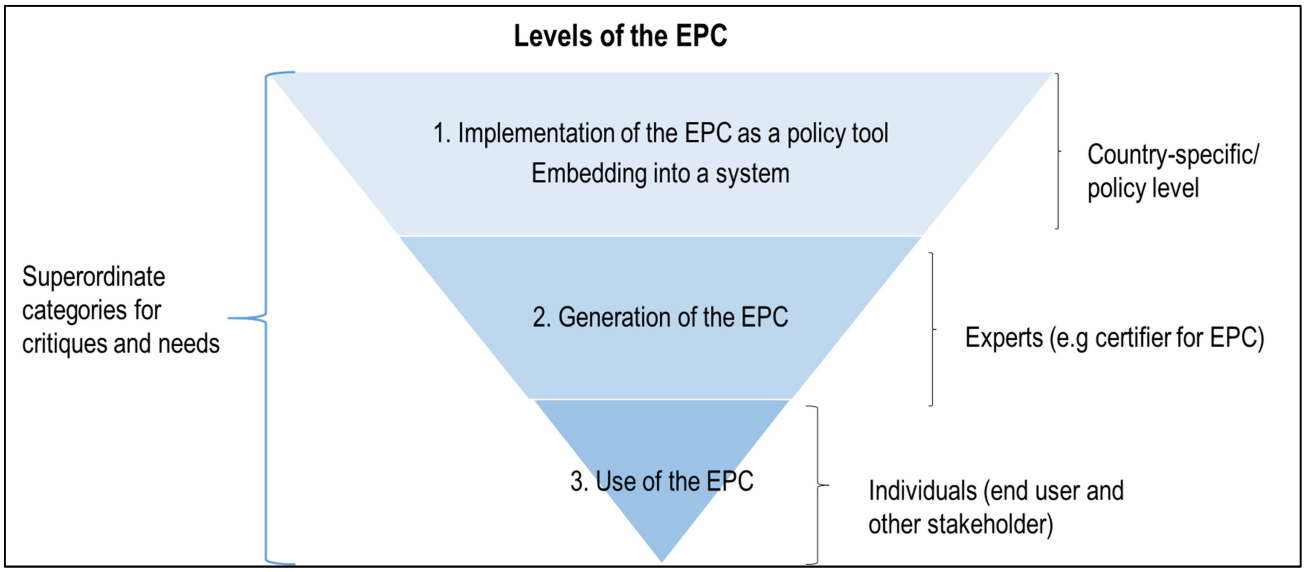

Figure 4: Critique and needs regarding the EPC address „three different levels“

6.4.1.1 Examples of topics for each level

The following list provides examples for each level of the EPC that have been mentioned during the data collection.

- ✓ **Level 1: Implementation of the EPC**
  - Envisaged goals
  - Scope of application
  - Requirements for certifiers of EPC
  - Quality monitoring
  - Enforcement

- ✓ **Level 2: Generation of the EPC**
  - Data basis
  - Method for calculation
  - Site-visits

- ✓ **Level 3: Use of the EPC**
  - Certificate: content, structure, visualization
  - Perception of the EPC: trust, understanding and usefulness influence it‘s acceptance and use

Sometimes topics cannot be clearly attributed to one or the other level because they seem to belong to multiple levels: for instance, site-visits can be demanded by a country (level 1), is part of the generation of the EPC (level 2) and might also influences the trust in the EPC by end users (level 3). The focus of the research questions for the stakeholder analysis and the user-needs analysis is on level 3 (How do end users perceive the content? Do they understand it? What information are they missing? How do they use the EPC? etc.). However, due to the presence of experts (e.g. policy maker and EPC certifier) that participated in interviews and workshops, also the other levels (1 and 2) were discussed.

6.4.2 Possible reasons for different needs by study participants

Needs regarding the EPC may be different among pilot countries, mainly due to different EPC schemes. For instance, in Germany stakeholders criticized the basic implementation more than in other countries (e.g. site visits are not mandatory, two

different versions of the EPC exist). Participants of the user-needs workshops from Belgium (Flemish region) gave positive feedback about the EPC which mirrors the quality of the Belgian EPC.

Also, needs may be different for **end users and experts** due to different knowledge and experiences regarding the EPC. Other stakeholders expressed critiques and needs regarding all three levels (implementation of the EPC, generation of the EPC and the use of the EPC), while end users rather criticized the content and expressed needs regarding the use of the EPC). End users' needs are oriented on improving the EPC such that their understanding and usability of the information would increase. Other stakeholders did not only express needs in order to improve the quality for themselves but to improve the EPC in general, considering that it should be understandable and useful for end users. Due to their knowledge and experience, other stakeholders can also assess the implementation feasibility of the suggestions and end users' needs regarding the next generation of EPC. For instance, the assessment of the suggestions for improvement (partially based on end users' needs) were realistic by experts who participated in the Austrian user-needs-workshop. They questioned several desires that had been expressed by end users in the preceding interviews (e.g. data about the real energy consumption and life cycle analysis indicators). It becomes clear that due to the lack of knowledge end users do not consider the original goal of the EPC when they express their needs. Moreover, they cannot assess the implementation feasibility of their suggestions. We can consider it as our task to merge the needs of end users with the objective of the EPC and the hints about the implementation feasibility we received from experts. This can mean e.g. to split the EPC into two versions and/or to offer an additional information tool for end users.

6.4.3 Topics on which opinions differ among study participants

The following lists summarizes the topics on which divergent opinions became apparent during data collection:

- **More information versus less information**: End users want to know more e.g. about their real energy consumption, cost indications and want to receive more detailed recommendations. But, experts think that the EPC is already too complex for end users and should therefore be streamlined. The compromise can be to remove content from the EPC which is not understandable for end users (annex with calculation details, primary energy demand indicator) and to provide more explanations in the EPC. Experts think that additional information (e.g. about the real energy consumption) should be provided in an additional document/information tool. Furthermore, not all end users are likely to be equally interested in additional information which is another argument to provide it as addition, not in the basic EPC document.
- **Stricter requirements versus looser provisions:** On the one hand, an expert from Germany suggested making the requirements (energy standards) for new constructions less strict, but to implement a quality check (expert, Germany) which would overall lead to more energy efficient buildings. On the other hand, experts from Austria and Germany argued that regulation for building construction should be tightened in order to make the building sector more energy efficient.
- **Training of experts:** Experts from Flanders stated that experts (energy advisors, EPC certifiers) should receive more training while one expert from German stated that the field of energy advice is the field where the most training is required. This could point to differences in training requirements for energy advisors in Flanders and Germany.
- **Real energy consumption and binding energy rating versus demand-based EPCs, standardized for user behavior.** On the one hand, end users demand binding energy rating (preferably based on real energy consumption) which allows to derive costs and recommendations**.** This is supported by experts from Spain and Flanders who recommend that it at least should be possible to interpret the EPC based on the user profile. Experts from Austria strongly recommend providing real energy consumption data in an additional tool, not in the EPC. Hence, according to them the EPC should stay demand-based, standardized for user behavior.

6.4.4 Point of contention: feedback about real energy consumption

We must understand that **the basic idea of the EPC was not to indicate values which say something about the real energy consumption of a consumer. The idea was rather to have a tool which allows to compare all buildings with each other, based on standardized user behavior.** Also, no cost associations or recommendations should or could be derived from the demand-based EPC because in most cases it only considers standard values.

However, standardized operational conditions are not understandable to end users as experts from Spain and Finland explained. Calculated values might in general be harder to grasp for end users. Also, we learned that **some end users have the need to know about their real energy consumption. The real energy consumption data is interesting to end users because it has something to do with the building, the behavior and the costs of the individual household. They are also interested in deriving individual recommendations based on their real energy consumption.**

As we learned from the interviews and user-needs workshops **the energy consumption should not be the basis for energy rating of a building because it depends on the user behavior and number of people living in a building**. This was also pointed out by German experts who explained that the consumption-based EPC is rather a user certificate than a building certificate. Also, the energy demand of a building can be indicated per square meter, but the hot water consumption cannot, because it is very dependent on the number of persons living in the building and on their behavior. **Therefore, feedback about real consumption should only be provided as an addition to the demand-based EPC. Feedback about real energy consumption should be only available to the respective consumer.**

Moreover, the fact that user behavior is not considered in the calculation of the EPC of a building, is not the only reason the results are inaccurate. Other reasons such as changing plans during construction (the building is built differently than planned), inaccuracies and uncertainties associated with modelling inputs were mentioned by participants of the interviews and workshops.

Participants from the South Eastern REB meetings mentioned that the energy behaviour of end users could be influenced by installing a simple building management system (BMS), which shows the energy consumption and therefore raises awareness. BMS can show the energy consumption on a regular basis compared to energy bills which report the energy consumption at the end of a period. Therefore, users could react to their consumption because they see *when* they consume how much energy. Receiving real-time feedback about energy consumption could have an impact on the everyday energy behavior next to the strategic energy behavior. This recommendation is in line with the assessment by many professionals who participated in the user-needs workshop and who stated that the feedback about real energy consumption should be realized with another additional tool but should not be included in the EPC.

If real time energy feedback was connected to the EPC one would extend the possibilities for material participation for the EPC; one would add another potential use phase for the EPC. Because the EPC would then not only be used during rent/purchase of a building and renovation, but also during the everyday habitation. If energy consumption was displayed in real time, it would make sense to also visualize water consumption and electricity generation/consumption, too. The latter would be appropriate regarding the increasing use of EVs, solar batteries, PV systems, electric household appliances and heat pumps.

The energy consumption could e.g. be monitored using in-home displays (IHDs). For the monitoring with IHDs one could consider individual goal setting and possible recommendations for every day energy behavior. Moreover, end users would be able to see immediately when their energy consumption is reduced after the implementation of EEMs.

6.4.5 Suggestion: a customizable EPC based on user profiles

If real energy consumption data cannot be added to the EPC and costs indications and recommendations cannot be available based on that, or if consumption data is simply not present (e.g. a young tenant who rents his/her first apartment) another suggestion would be to make the EPC customizable. Then, end users would still obtain an interpretation of the EPC values

according to their profiles (number of people, user behavior). **If the EPC became dynamic regarding the consideration of different user behavior, end users could know a forecast of their energy consumption in the respective building prior to the purchase/rental of the building.** A customizable EPC prior to the sale or rent could be interesting in order to estimate running costs of the building. This suggestion could be addressed through the development of different user libraries that would allow the automatic adaptation of operational schedules of energy assessment models in order to represent the new use (idea from the user-needs workshop in Spain). Also experts from Flanders suggested illustrating the EPC by exemplary user profiles in order to make the influence of the user on energy costs visible. Similarly, experts from Finland suggested using and an additional tool to "interpret" the numbers in the EPC according to one's consumption behavior and household composition to put the values provided in the EPC into context and to make them more tangible to the end user. **Making the EPC customizable according to user profiles would be one way to make the EPC dynamic.**

6.4.6 Common need: making the EPC dynamic

There are a couple of aspects that have been mentioned during the interviews and user-needs workshops that would make the EPC more dynamic:

- A customizable EPC (dynamic regarding the consideration of different user behavior). End users could know a forecast of their energy consumption in the respective building before the purchase/rent of a building.
- EPC connected to databases e.g. on fuel costs, policy targets and conversion factors based on the energy mix. The updated results could e.g. be visible in an app or on a digital EPC. **This could be a solution to the concern that fuel costs vary and therefore price indications for heating costs in the EPC should not be static.**
- The use of roadmaps for staged deep renovations would be a way to make the recommendations "dynamic". Road maps was the most often selected feature to be covered by a digital EPC by participants of user-needs workshops in Greece, Austria and Germany. Moreover, road maps for renovation were mentioned as beneficial by experts in Spain and Flanders.

Moreover, the desire for benchmarking and the provision of targets would mean that the energy rating would become dynamic. By conclusion, if the EPC became dynamic (e.g. would be connected to databases with costs) this would mean that (part of) the EPC would become digital in order to show the updated output.

6.4.7 Suggestion: a double certificate with an add-on

Due to stakeholders' different understanding, interests and needs there are reasons to split the EPC into two versions for two different target groups: one version oriented towards authorities, a second versions oriented towards end users. Hence, a double certificate would be generated. This was recommended by experts from three pilot countries: The current EPC in Flanders is "rather complete for users" but too simplified for professionals (expert, Flanders). Similarly, an expert from Germany explained that the EPC is neither meaningful to end users nor to experts since it is too complicated for the first and not complete for experts.

We learned that end users are interested in their real energy consumption. But, it is difficult to make the EPC comparable and mapping real life at the same time. The need that the EPC should be binding is in opposition to simpler standardized calculation methods. Also, we learned that not every information and function should be provided in one document (the EPC), this would go beyond the original purpose of the EPC. If the EPC was target group oriented one could focus on providing useful data to the authority and understandable and useful data to end users.

The EPC could be divided as follows: a simplified part for the user and a more technical part for experts (Flanders). Experts from Spain suggested the same and added that the part for users should be "user-related". Experts from Austria would

appreciate it if the EPC for end users contained visual and simple presentations (e.g. cost savings). The other version should be directed to authorities who can use it during decision making regarding the granting of funds.

Regarding the desires that the EPC should become more dynamic and should be split into two versions the following questions arise: how dynamic should each version be (what changing variables should influence the EE class)**? Should the EE class on the version for authorities and end users be continually updated e.g. based on updated conversion factors? We already concluded that the EE class on the EPC should not be updated based on the real energy consumption but that the EPC could become dynamic if the information could be interpret based on different user profiles (customizable EPC).** Another concern is that if end users can monitor their real energy consumption e.g. on an IHD they see the discrepancy between the indicated values for energy demand on the EPC and the real measured consumption data.

6.5 Communication about the EPC and EEMs

This subchapter points out the importance of other stakeholders considering their ability to communicate about the EPC (intermediate links) and to provide good energy advice (energy advisors).

6.5.1 Intermediate links

Apart from the energy advisor, other types of stakeholder can have an influence on end users, too; they could help end users to become aware of the EPC and to understand information from the EPC, by translating technical information to them. This role could be fulfilled by intermediate links as it was mentioned during the interviews in Spain: EPC certifiers, building companies, selling agencies town councils and property managers could be viewed as such. Selling agencies and property managers have another task as well: forwarding the EPC to end users. Thereby, they can influence if information about the EE of a building is (correctly) displayed in real estate ads. Other intermediate links could be websites and one-stop-shops. Here the following questions rises: should translating of technical information for end users still be necessary if an EPC oriented toward end users was developed?

6.5.2 Energy advisors

That the energy advisor has an important role to play regarding the uptake of EEMs became apparent in all participating countries. For instance, end users from Belgium (Flemish region) highlighted the importance of finding contact persons, **who are trustable and objective**, in order to initiate EEMs. The option “talking to an energy professional” as a source of information about EEMs was chosen as most preferred option in the polls in Finland, Greece, Austria and Germany. In Finland, the sources “energy supplier” and “friends/families who are experts” were chosen by five participants as the secondly preferred option.

In addition to explaining the content of the EPC, several experts from different countries pointed out that the recommendations about EEMS should always be accompanied by energy advice because recommendations would not be detailed enough. In particular, interviewed experts from Austria, Germany and Spain emphasized that building projects should always be accompanied by comprehensive, *neutral* consultancy.

The expert from Germany doubted that also an improved EPC could not replace the energy consultancy by experts. Another German expert demanded that energy advisors should be able to give holistic recommendations regarding a building. If many energy advisors with diverse backgrounds would advise on EEMs, they would focus on their field of expertise respectively. Also, another barrier for taking advice from energy experts might be higher costs.

Concluding, the approach to consider other stakeholders next to end users in this study can be justified. Other stakeholders are important to consider because they influence end users’ awareness and understanding of the EPC and EE as well as their decision making regarding EEMs. Therefore, we should continue to consider other stakeholders during the user acceptance

analysis. Also, due to the fact that they are **knowledgeable** regarding the EPC and considering that they want the EPC to become better for end users, we should continue to talk to other stakeholders during the ePANACEA project.

6.6 Criteria-set for an adequate EPC

This subchapter presents a criteria-set for an adequate EPC (cf. Table 4) which is based on needs that have been expressed by different stakeholder groups in different countries. The criteria are derived from the stakeholder interviews and user-needs workshops. A need/suggestion to improve the EPC that was expressed by a specific stakeholder in a specific country could be also beneficial for the EPC scheme in other countries. Therefore, the criteria-set addresses EPC in general. Also, indicators for the criteria and recommendations for the application of the criteria are provided in Table 4. Besides, the indicators address the three identified different levels of the EPC (implementation of the EPC as a policy tool, generation of the EPC and use of the EPC).

Table 4: 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

6.7 Recommendations for the next generation of EPC

This subchapter presents recommendations for EPC authorities for the next generation of EPC. The recommendations are linked to the criteria-set for an adequate EPC and are based on the critique and needs which were expressed by end users and other stakeholder in the stakeholder interviews and user-needs workshops. Critique and needs were stated by a particular stakeholder in a particular country but the recommendations based on these could be helpful/relevant for all. Therefore, the recommendations are considered as relevant for all pilot countries + Germany, if they are not already fulfilled by the current EPC scheme in the respective country. First, recommendations which refer to the EPC in general (both, the EPC oriented towards authorities and the EPC oriented towards end users), are presented. The recommendations are structured according to the three levels (implementation of the EPC as a policy tool, generation of the EPC and use of the EPC). Then, recommendations differentiated for the two different target groups are presented. For each EPC version recommendations are given which address the third level (use of the EPC, focusing on the content and visualization of information). Where relevant, concerns and raised questions regarding the implementation feasibility of recommendations are indicated. Finally, this subchapter provides recommendations regarding the communication about the EPC and EEMs between other stakeholders and end users.

6.7.1 Implementation of EPC

This section lists recommendations in order to improve the EPC regarding its implementation as a policy tool, including reminders on its original objective, recommendations regarding the enforcement and quality of the EPC and other general recommendations.

6.7.1.1 Objective of the EPC

- ✓ EPC should pursue the original goal and preliminarily allow to compare buildings' energy efficiency
- ➔ The EPC should be based on the standardized energy demand of a building in order to be comparable (expert from Austria)

6.7.1.2 Enforcement of the EPC

- ✓ EPC for new buildings should be issued after the construction of a new building or at least the EPC should have be updated when plans for construction change (experts from Austria & Germany)
- ✓ EPC should be issued before selling/renting a building so that the building value is linked with the EEC (expert, Greece)

6.7.1.3 Quality of the EPC

- ✓ Registration of EPCs should be mandatory and there should be central institutions where the EPCs are registered (critique about the German EPC)
- ✓ Site visits should be mandatory when issuing an EPC (expert from Germany) and checking the quality of an EPC (expert from Greece), the benefit of site visits was pointed out by an Finnish expert
- ✓ Energy auditors should be certified in order to improve the quality of the EPC (Greek experts)
- ✓ Requirements to issue an EPC should become more precise and demanding so that not a lot of experts with different background are allowed to issue an EPC, who often are not competent enough to do that (critique from experts from Austria & Germany)
- ✓ EPC certifiers should receive regular training (Belgian expert)

6.7.1.4 Concerns regarding Quality Improvement of the EPC

- ✓ Concern: market prices for issuing an EPC are very low, therefore the quality of the EPC is not high (expert, Greece). If the certification e.g. includes site visits the EPC becomes more expensive (250€). But, one can obtain EPCs from online platforms for 20 € (German expert) → regulate market?
- ➔ Who will pay for a higher quality and more complex EPCs? An increased price of the EPC could prevent end users from having an EPC issued, if they are not interested in renovating their building.

6.7.1.5 Additional recommendations

- ✓ Do not use two versions of EPC in parallel, e.g. a demand-based and a consumption-based EPC because they are not comparable (cf. Germany)
- ✓ Make it possible to connect the EPC with other policy tools (CO_2 tax, SG development goals, eco design directive) (experts from Germany & Greece)

6.7.2 Generation of the EPC

- ✓ The amount of calculation parameters should be reduced, this would make the EPC less manipulable (experts from Austria & Germany). The current calculation programmes are too complex for experts (expert from Germany). If a common, less complex programme was used for calculation, the results would be not very precise but at least comparable (experts from Austria & Germany). **One of the aims of ePANACEA is to make the EPC coherent among EU MS. However, the EPCs are not even comparable within the national context!**
- ✓ Ecological aspect and circularity in the building sector should be considered in the calculation for the energy rating of a building (experts from Austria & Flanders)
- ✓ Include electricity demand in the EPC since in the long term the use of electricity in households will become more important (e.g. looking at EVs, PV-systems and heat pumps; expert from Germany).
- ✓ Include information about solar gains and innovative technologies (Flanders, experts)
- ✓ Normalize energy demand for local weather (e.g. in Germany not everything should be normalized for Potsdam; experts from Germany)
- ✓ Use a common and known unit area (experts from Germany)
- ✓ The primary energy factor "zero" should ideally be abolished (experts, Spain and Germany)
- ✓ Include a comprehensive database for calculating and storing data
    - Database should provide updated information about e.g. measures, investment costs, energy costs, conversion factors → making the output of the EPC dynamic (expert from Spain)
    - Concern: for whom would these updated data be interesting? To end users and authorities? Considering changing conversion factors would also update the EE class on the EPC version for authorities.

6.7.3 Use (content and visualization) of the EPC

- ✓ **Include information about the necessity to renovate the building/part of the building, related to life cycle analysis indicators** (expert, Germany)
    - Concern: an expert from Austria explained that information about ecological aspects should be available in an additional document, but should not be added to the EPC because the EPC is already complex.
- ✓ **Provide partial indicators** e.g. for walls, floor, roof, doors and windows to make it comprehensible where the weak points of the building are (end user from Spain)
- ✓ **Include additional indicators:** indoor air quality (Finland, Spain, Germany), thermal comfort (Spain), smart readiness of the building (Spain, Greece), the fraction of RES production for statistical purpose and national energy policy (Greece) and CO_2 emissions (Finland), solar gains and thermal insulation (Flanders & Germany), energy consumption (e.g. by swimming pools (Flanders))
- ✓ **Use benchmarking for energy consumption (Austria, Finland, Flanders, Germany)**

- Include indication on how well the building performs compared to others and which range of energy demand is OK for the building (end user + other stakeholder from Austria)
- Include information on what a realistic target is for the specific building next to benchmarking (end users from Flanders).

➔ This could be connected to the suggestion to make the energy rating system dynamic, i.e. basing the energy rating on current energy consumption data about the building stock of comparable buildings.

- Include a benchmark about CO_2 emissions which would pursue the target to lower CO_2 emissions by 2050 (expert rom Germany).
- Indicate benchmarking for separate construction components (expert from Finland)

6.7.4 EPC oriented toward authorities

✓ An annex with e.g. information about the data used for calculation of the EPC should be included (expert, Germany)
✓ For technicians units like [kWh/m^2 year] would be more important (expert from Spain)
✓ Do not base any price indications/recommendations on the demand-based EPC because in most cases only standard values are considered for the generation of the EPC (expert, Austria)

➔ This is opposed to the need for individual indications about costs and recommendations

6.7.5 EPC oriented towards end users

✓ **Create a "Europe-wide, split, parallel document" that mediates "what the building can do" to end users (expert, Austria)**
✓ **Streamline the content of the EPC for end users**

- Do not make the EPC more complex, reduce the content for end users (experts, Austria, Finland & Flanders)
- Additional information should be covered in an additional document/tool (Finland, Austria)
- The EPC for end users could be simplified by graphic representations, clear and short messages (experts, Spain)
- Leave out the information of the EPC generation and to include a generalized cost comparison for the refurbishment recommendations in the version for end users (expert, Austria)
- The total energy efficiency factor fGEE (included in the Austrian EPC) and primary energy demand indicators, which are often not understood by end users could be left out in the version for end users (Experts from Austria, Spain and Germany)

✓ **Include real energy consumption data (Greece, Spain, Flanders, Germany)**

- End users are interested in their real energy consumption because this is the amount they pay for (Greece)
- EPC schemes should include the building end user dimension, because this would show how behavior patterns affect the energy use inside the building (experts from Spain & Flanders)
- End users criticized the inadequate energy consumption data, which is not sufficiently individualized, i.e. not related to their own building (Flanders)
- Use an automatic and digital data storage of the energy consumption of the end users (expert from Flanders)
- End users expressed that it could be useful to provide consumption data separately (Flanders)

✓ **Concerns about the inclusion of energy consumption data**

- Platform needs to be safe regarding privacy (end user from Flanders);
- Data protection could become an issue since energy consumption data in relation with address, name etc. can be used to draw conclusions on the end user's behavior and could be used by companies (expert, Austria)
- The EPC based on consumption cannot be a profound basis for the evaluation of the EE of a building, because energy consumption varies significantly, depending on how many occupants are living in the building

and depending on their lifestyle/every-day energy behavior. This would complicate the comparability of two buildings (experts in Austria and Germany)

- Suggestion to combine the EPC with another tool, as it is now possible to process data digitally. The energy consumption data could e.g. be saved and after a few heating seasons a benchmark could be developed for the building

✓ **Consider a customizable EPC/ the use of user profiles**

- The EPC should be illustrated by exemplary user profiles. Thereby, the role of the user in relation to energy costs should become apparent (Flanders, experts).
- A customizable EPC prior to the sale or rent could be interesting in order to estimate running costs of the building. This suggestion could be addressed through the development of different user libraries that would allow the automatic adaptation of operational schedules of energy assessment models in order to represent the new use (Spain).
- Experts suggested using an additional tool to "interpret" the numbers in the EPC according to one's consumption behavior and household composition to set the values provided in the EPC into context and to make them more tangible to the end user (Finland)

✓ **Include cost indications in the EPC**

- There is a need of end users to know the indications about the energy/heating costs associated with living in a building (Austria, Germany, Greece, Spain)
- End users want to know how much costs could be saved by owning a building of a better EEC (Germany)
- Add indicators which are easy to understand for ordinary consumers, for instance to not express energy consumption only in kWh but in relation to a monetary value, also as compared to equivalent costs of other activities (expert, Finland)
- End users in Spain showed that they are interested in indicators which are more understandable to them and related to actual energy costs (e.g. €/m2year or €).
- Concern: regarding, experts worried that the indication of estimated costs would be inaccurate due to changing energy prices and if user behavior was not considered (Austria, Spain, Finland, Germany)

✓ **Use different units than [kWh/m² year] to make information tangible to end users**

- Present information in various units, including a benchmark (expert from Germany)
- Regarding the unit [kWh/person year] the user profile should be considered since this is decisive for the consumption data (expert, Germany)

✓ **Provide more detailed and individual recommendations for renovations**

- Recommendations to end users should become reliable and personalised (Spain, experts)
- Greek end users want to know detailed recommendations related to real energy consumption.
- Recommendations should e.g. include a list of more energy-efficient technologies, further links to find appropriate installers (Greek end users)
- Information on what measure (and how much it would cost) to upgrade the EEC for example from G to F, or to E (Spain, end user)
- Indication about insulation material (end user from Austria)
- Need of information about realistic investment costs, annual energy savings, information on available subsidies and reduction of investment costs in €, and contact lists for EPC certifiers in the EPC (Flanders, end users)

- Information about the installation of a new boiler/heating supply was under the most often selected recommendations in Austria, Finland and Germany.
- Provide information on renovation steps (sequence of measures) → helps end users making the right decisions during renovation → road map (expert from Austria)
- Concern: a very precise and complex annex of recommendations could make the EPC more expensive (expert from Spain)

✓ **Include hints for every-day behavior to save energy (Greece, Germany, Spain, Flanders & Austria)**
- Need for information on the user behavior (Greek & German end users)
- Need for a list of good practices regarding the use of the building (end users, Spain)
- Belgian end users also support the inclusions of energy saving tips additional hints for everyday energy behavior such as for heating and window opening was considered as helpful from both, Belgian end users and other stakeholders
- More building use information should be provided in the EPC if the EPC is supposed to be used by end users (expert, Austria)
- Include hints for energy saving, such as stating that a reduction of the room temperature saves energy and thus also costs; tips for avoiding overheating in summer such as window ventilation at night and sun protection during the day (expert from Austria)

✓ **Make the EPC more dynamic**
- Need for a dynamic EPC expressed in Greece, Spain and Finland
- The most often selected feature to be included in a dynamic and digital EPC was a roadmap (Greece, Austria and Germany), moreover it was expressed as a need in Spain and Flanders, too.
- Including consumption data is considered as making the EPC more dynamic (experts, Spain)
- Concern: suggested features of a dynamic EPC are good in principle, but that a lot of the listed features (dynamic simulation, energy use forecast) could rather be expected from smart meters. These features would not necessarily belong into the EPC (Austrian experts)

✓ **Visualize Information**
- Visualize the fraction of renewable energies (end user from Spain, expert from Greece)
- Visualize fraction of energy costs compared to total costs (end user from Finland)
- Visualize the main influencing factors on the EEC (end users from Flanders)
- Indicate building target values (end users from Flanders)

✓ **Include schematic representations of the building envelope**
- Helps the reader to refer information from the EPC to a specific construction component (experts from Austria)
- There is software available that allows to export schematic representations already
- It would be desirable if schematic representations were standardized and would have a common design (expert, Austria)
- Indication of what the building should ideally look like. Reference should be provided (Flanders)
- No recommendations should be derived from such schematic model (experts from Austria)

✓ **Use thermal images**
- Thermal images was perceived as rather useful since they could help to learn about heat losses (end users from Flanders)

- Indicate a reference, otherwise the scale is manipulable and not useful to compare buildings (expert, Germany)

6.7.6 Communication about EPC and EEMs

In addition to improving the system where the EPC is embedded in (e.g. enforcement, quality monitoring), the generation of the EPC and the certificate itself, also the communication about the EPC should be improved by intermediaries (certifiers, assessors, building companies, selling agencies and town councils). This could improve the understanding of technical data from the EPC (if the next generation of EPC is still not understandable for all). Likewise, the energy consultation by energy advisors should be holistic and objective. This could foster the trust in energy advisers and the uptake of EEMs. The question is here as well: who will pay for a high quality consultation by an energy advisor? Will intermediaries improve their communication about the EPC if they need to spend time on it that they are not paid for?

6.8 Discussion of Research Methods

This subchapter discusses the generalizability of the research findings from stakeholder interviews and user-needs workshops. The target number for interviews (in total 8-15) was reached in ePANACEA pilot countries + Germany. However, the number of conducted interviews does not allow to draw conclusions which are representative for e.g. a certain type of stakeholder or a specific country. The target number for the user-needs workshops was not reached in Germany, Flanders and Finland. However, it was still possible to obtain rich data from the discussion because the composition of participants was diverse and participants who were knowledgeable regarding EPC took part. In Austria the majority of participants (11 of 12) were experts. This explains why the discussion regarding the suggestions to improve the EPC was very critical, compared to other user-needs workshops, but also helpful looking at the implementation feasibility. In general, more experts than end users took part in the user-needs workshops. This may be due to the fact that experts consider participation as part of their job while end users sacrifice leisure time. The fact that experts with diverse backgrounds regarding the EPC and EE took part in the interviews and workshops and that participants of the workshops were not necessarily the same as in the interviews, **allowed to gather a broad range of perceptions, critique and needs regarding the EPC, rather than representative answers for each stakeholder type. However, based on the results we can differentiate needs between end users and other stakeholders**.

We could derive that there are opposing needs, or at least different needs among participants of the studies. The question is if the differences are due to the fact that certain persons have been interviewed/took part or if the reason is that needs represent country specific needs (cf. Annex A for differences among EPC schemes). The combination of results of the interviews and workshops could help to find out: the results from the user-needs workshops strengthen the findings from stakeholder interviews for each country. Often, aspects which were criticized by stakeholders during interviews were repeated by other participants in the user-need workshop within one country**. Still, it could be that statements of individual participants do not represent the country's specific needs. It may be the case that participants overlooked something which however would be logical to criticize in his/her country as well.** Accordingly, a suggestion that was made e.g. in Finland could be beneficial for the EPC and its implementation in other countries as well, although the suggestion has not been mentioned by participants from other countries (due to different backgrounds, knowledge etc.).

Also, we must consider that the results of the user-needs workshop are not comparable among pilot countries + Germany regarding each aspect because the content and structure has been different among user-needs workshops, the EPC schemes are different among pilot countries + Germany and participants had different backgrounds. Therefore, different topics related to the EPC were discussed in the user-needs workshops.

Moreover, the results from interviews and user-needs workshops are not representative for all EU MS since EPC schemes vary and only six EU MS were considered in this research. Nevertheless, recommendations for EPC authorities which were derived in this report may be valuable for other EU MS as well.

7 CONCLUSION

This chapter summarizes the research findings and thereby provides answers to the research questions: what do stakeholders of the EPC (end users and other stakeholders) know and think about the EPC? How do they use it and what are their critiques and needs regarding the EPC? How do other stakeholder influence end users decision making regarding EEMs? What recommendations can we derive for the next generation of EPC based on stakeholders' common and opposing needs? Besides, this chapter provides an outlook containing questions that raised from this report and an indication on how the research findings should be considered during the further course of the ePANACEA project.

7.1 Summary of research outcomes

Based on the stakeholder interviews and user-needs workshops in pilot countries + Germany the following stakeholders can be added to the stakeholder map: **energy auditor**, **technology providers**, **research and development, energy efficiency lines** and **town councils.**

We can conclude that end users know little about the EPC, perceive it as a mandatory document which they use for **contractual actions** such as deep renovation, selling or renting among pilot countries. They perceive the EPC for what it is – a standardized document – which does not allow to make realistic assumptions about the costs for running the building or to obtain individual recommendations. However, although the EPC is standardized for the building operation, the EPCs are not comparable in the national context, due to inaccuracies and uncertainties associated with modelling inputs and due to the fact that EPCs are issued before construction of a building and not corrected if the building was not constructed as planned. Other stakeholders who were interviewed and/or took part in a user-needs workshop show a rather positive perception of the EPC being aware of its original goal as policy instrument to contribute forwarding the energy transition in the building sector. Besides, they appreciate the EPC as the only instrument which maps the 'as-built situation'. However, admittedly the EPC would not have fulfilled its potential yet (in view of the fact that end users are not really interested in it in their perception, too).

One of the most obvious common needs among end users from pilot countries + Germany (also partially supported by experts) is the interest in feedback about real energy consumption, connected to the need to receive reliable cost indications for running the building and individual recommendations. Regarding the latter, the list of mentioned examples is long: realistic investment costs, annual energy savings, information on available subsidies, and links to find appropriate installers, as well as more information about energy-efficient technologies. Likewise, end users from all countries except for Finland demanded hints for every-day behavior to save energy. However, experts (mainly from Austria) consistently point out the original purpose of the EPC – a tool to compare the EE of buildings - which excludes to derive information about the real energy consumption. End users' need to monitor real energy consumption could therefore only be fulfilled by an additional tool, but not by the conventional EPC. Besides, experts want to refrain from adding more information to the EPC which is already complex and difficult to understand for end users (Austria, Finland and Spain).

Due to this, experts from Austria, Spain and Flanders suggested splitting the EPC into two versions: one user-related version, oriented to end users, with very visual and simple presentations (e.g. cost savings) and another, more technical version directed to authorities who can use it during decision making regarding the granting of funds. Besides, it was commonly mentioned to make the EPC more dynamic – which could be realized in various ways, e.g. by connecting the EPC to databases e.g. on fuel costs, policy targets and conversion factors. This would e.g. allow to provide updated information about heating costs to end users. Moreover, the EPC could become more dynamic with the use of roadmaps for staged deep renovations (most desired feature to be included in a digital, dynamic EPC). Other than that, as recommended by experts from Finland, Flanders and Spain, the EPC could become dynamic by making the EPC customizable (dynamic regarding the consideration of different user behavior). This could be an alternative to providing feedback about real energy consumption. By implication, if the option(s) to

make the EPC dynamic were implemented, this would mean that (part of) the EPC would need to become digital in order to display current, updated information.

Looking at all expressed critiques and needs, we can categorize them into three levels of the EPC: implementation of the EPC as a policy tool, generation of the EPC and use of the EPC. Needs mainly differ among stakeholders due to different knowledge backgrounds and among countries due to differently advanced EPC schemes. Nevertheless, a criteria-set for an adequate EPC was developed based on the collected critiques and needs. According to this, an adequate EPC is reliable, ideally comparable in the national and international context, understandable (for end users), tangible (for end users because they can refer information to real life), comprehensive (considering regulative and technical developments), adequate and dynamic. Furthermore, recommendations for EPC authorities for the next generation of EPC were derived from this. The formulated recommendations address the three different levels of EPC and are separated into recommendations addressing EPC in general and those addressing the EPC version for authorities and end users, respectively. In addition, they draw attention to the potential of other stakeholders to improve communication about the EPC. Particularly, assessors, construction companies, selling agencies, property managers and town councils could become active as intermediate links by translating technical information from the EPC to end users. Energy advisors play a crucial role by providing service-neutral energy advice to end users. Hence, next to the EPC schemes the actors who get in contact with the EPC and end users play a crucial role in fostering the awareness and understanding of the EPC as well as the uptake of EEMs.

7.2 Outlook

The results from this report – especially the criteria-set for an adequate EPC and the recommendations for EPC authorities – should be considered (if feasible) in the Methodology development for the next generation of EPC which will be carried out during the ePANACEA project. For instance, the suggestion to split the EPC into two versions and to develop a common format for the EPC oriented towards end users among EU MS/pilot countries of ePANACEA might be interesting to follow up. In addition, the need for the EPC to become more dynamic must be given more consideration. Also, the questions that this report raised may be worthwhile to consider during the methodology development. For instance, how should each version of the EPC, if separated, look like? How dynamic should/could (parts of) the EPC be for different target groups? That means what parameters/features should be considered for the 'dynamization' of EPC? What databases should/could be considered to make the EPC dynamic? And how can the current/updated information be displayed to authorities and end users (e.g. in a digital EPC)?

Other raised questions like: "Is improved communication about the EPC by intermediate links is still necessary if the understanding of the EPC can be improved for end users?" and "Who should pay for an improved EPC/communication/energy advice?" could possibly be considered in the WP6 *Dissemination, exploitation and replication potential* of the EPC.

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9 ANNEX

Appendix A Different EPCs schemes in ePANACEA pilot countries + Germany

Knowing the differences of the EPC schemes is a basis for understanding the critiques and needs by stakeholders from the different pilot countries and Germany. This subsection briefly outlines the most relevant aspects of EPC schemes of pilot countries and Germany which are expected to be relevant for the stakeholder analysis and user-needs analysis:

Spain

- ✓ Calculated energy rating
- ✓ On-site visits mandatory for existing buildings
- ✓ Energy demand is normalized for different climatic zones within Spain
- ✓ Additional indicators which are provided: energy need for heating, cooling, non-renewable primary energy and CO2 emissions for heating, cooling, domestic hot water and for lighting (only in tertiary).

Belgium (Flemish Region)

The Flemish EPC is already advanced and several aspects are interesting for the development of the next generation of EPC within the ePANACEA project.

- ✓ Calculated energy rating
- ✓ On-site visits mandatory for new and existing buildings
- ✓ EEC class of the building in reference to long-term target to reduce GHG until 2050
- ✓ List of "ten good reasons to renovate" in order to raise awareness for energy issues.
- ✓ Indication of the potential improvement for the total EEC, reached through (aggregated) measures.
    - Presentation of what measures should be done first and what EEC could be reached after the respective measure
    - Use of icons and colours to represent measures and EE
    - Visualization of different methods to insulate walls

Finland

- ✓ Calculated energy rating
    - Site visits are mandatory for new and existing buildings
    - Presentation of input data for calculation (U-value, m^2 etc. for envelope, windows, ventilation, heating, hot water, internal loads; Finnish EPC)
    - Four climatic zones for energy calculation, but to keep EPCs comparable they are always calculated with the Southern Finland zone data
- ✓ 8-page document: first two pages: summary pages of key information (these pages are public and information is available in the EPC registry, pp. 3-4: present main starting values and results of the E-number calculation, pp. 5-6: findings and savings recommendations
- ✓ Separated measures for external walls, doors and windows and estimated impacts

Austria

- ✓ Calculated energy rating

- On-site visits for buildings are optional

✓ Indication of the total energy efficiency factor (fGEE): ration between the final energy demand of the present building and the final energy demand of a reference building

✓ Recommendations should be feasible from an economic perspective – however no specific economic calculation is required

Greece

✓ Calculated energy rating

✓ On-site visits are mandatory for new and existing buildings

✓ Global energy performance indicators, different climatic zones are considered

✓ The current and potential energy classifications are shown

✓ Additional indicators: comfort conditions (thermal, visual and acoustic), non-renewable primary energy for heating/cooling/lighting, renewable and CHP primary energy

✓ Detailed recommendations: investment costs, energy saving, payback period, CO_2 emissions reduction, upgrade of building class

Germany

✓ **Generation of the EPC**

- Different software for the generation of EPC are allowed, which can deliver different results for one building (Deutsche Umwelthilfe e.V.)
- The majority of all EU MS ensures the quality of the input data through site-visits which is not considered as absolutely necessary in Germany (Deutsche Umwelthilfe e.V.).
- Calculated and measured energy rating: The dual system of demand and consumption-based EPCs results in an insufficient comparability of the EE. Because of this, one should aim at standardizing the calculation method for the EPC in Germany (Steininger *et al*., 2017).

✓ **Enforcement**

- The consideration of the EPC in property promotion is not controlled to that extent as the EnEV is demanding in Germany (Ibid.). In general, the energy certification requirement for buildings is hardly tracked and controlled in Germany (Steininger *et al*., 2017).

Appendix B Conduction of stakeholder interviews

Table B,5: Interview guide for interviews with end users

	Reason for Question	Questions	Possible sub questions
1	Open question to find access to the topic, Individual state of knowledge about EPC,	**Do you know the EPC?**	**What do you know about the EPC?**
2	Individual state of knowledge about EPC, applied to individual situation	**Is there an EPC of your house/flat or the building you are managing/occupying?**	**What does it say?** **What figures does it show?** **In what units does it give information? What does this information mean referring to your house/flat?** **What energy efficiency class does it have?**
3	Individual state of knowledge, understanding of EPC	**Can you understand the provided information in the EPC? (Scales, recommendations)?**	**If not: What is unclear?** **What would help you to understand?**
4	Perceived importance of EPC	How important do you regard the EPC?	Why do you think that it is (un)important? What should change such that the EPC becomes more important according to you?
5	Perceived connection of ECP and energy transition, association of EPC, Relation of EPC to broader context → perceived importance	How is the EPC related to the energy transition?	What else do you associate with EPC?
6	Purpose of contact with EPC	**When did you get in contact with the EPC?**	Do you regularly get in contact with the EPC? If yes, in what way? Who is issuing the EPC?
7	Usefulness of the EPC to interviewee/ state of knowledge on EPC	**How do you use EPC?**	
8	**Input for user-need analysis**	**What information of the EPC is central to you and why?**	
9	Input for user-need analysis	What information (which is currently missing) do you want to obtain from the EPC? Why?	How would you use this information?

10	Understanding end user's decision making and behavior	If you wanted to renovate the building (e.g. dam the walls and roof, exchange windows), would you know who to contact?	Who else would play a role in the process? Who would you contact in case you wanted to install a PV system on your roof? Who else would play a role in the process?
11	Understanding end user's decision making and behavior	**Besides these contact persons who/what else would influence your decision regarding energy efficiency measures?**	In what way do these factors/stakeholder influence your behavior? What is your experience in dealing with landlords/ building owners and certifiers/advisors/financers/craftsmen in regard to EPC?

Table B,6: Interview guide for interviews with other stakeholders

	Reason for Question	Questions	Sub questions
1	Purpose of contact with EPC	**Please describe what you do in your job and why you get in contact with EPC therein?**	
2	Individual state of knowledge about EPC	What else you know about EPC?	
3	Perceived importance of EPC	**How important do you regard the EPC?**	Why do you think that it is (un)important? What should change such that the EPC becomes more important according to you?
4	Perceived connection of ECP and energy transition	How according to you is the EPC related to the energy transition?	
5	Usefulness of the EPC to interviewee	If not answered under 1): How do you use EPC (in your job)?	
6	Input for user-need analysis (UNA)	**What information of the EPC is central to you and why?**	
7	Input for user-need analysis	What information (which is currently missing) do you want to obtain from the EPC? Why?	How would you use this information? What information (which is currently missing) would be valuable for EPC end users?

8	Learning about building occupants from the perspective of other stakeholders	What is your experience in dealing with building occupants in regard to EPC?	
9	Learning about building occupants from the perspective of other stakeholders	**In your experience: What do building occupants use the EPC for?**	**What should/could they use an EPC for?**
10	Learning about building occupants from the perspective of other stakeholders	What do building occupants usually struggle with in regard to EPC and energy efficiency measures?	Why do you think they struggle with it?
11	Understanding the influence which other stakeholders have on end users of EPC	**Do you try to influence end users' energy behavior?**	**How do you try to influence end users' energy behavior?**
12	Understanding building occupants' decision-making and behavior	What and who else influences end users' energy behavior?	How could their decisions be more positively influenced?

Table B,7: Overview of number of interviews

Country	Number of Interviews		
	Total	End users	Other stakeholders
Spain	9	6	3
Belgium (Flemish Region)	9	5	4
Finland	7	5	2
Austria	11	6	5
Greece	15	9	6
Germany	12	7	5

Appendix C Conduction of the user-needs workshops

Basic script for the user-needs workshops

Table C,8: Script for the user-needs workshops

		Content	Method	Time (mins)	Responsible
1	1.1	Data protection, conditions for participation	PPT	4	Moderator 1
	1.2	Presentation of ePANACEA and introduction of hosts	PPT	10	Moderator 1
	1.3	Presentation of stakeholder map Short introduction of participants & attribution of participants to stakeholder types	PPT: stakeholder map	22	Moderator 1
	1.4	The workshop within the context of the project, its objective and a short agenda	PPT	24	Moderator 1
	1.5	Instruction for the participation in the workshop	PPT	27	Moderator 1
2	2.1	Presentation of EPC of pilot country	Digital template of country-specific EPC	37	Project partner from pilot country/expert
	2.2	Stakeholders' needs and interest regarding the EPC	Collecting needs in a mind map (e.g. PP)	52	Moderator 1+2, participants
Break				57	
3		Suggestions to improve the EPC	PPT with prepared suggestions and examples **+ discussion / evaluation in Google Forms**	97	Moderator 1+2, participants
4		Additional discussion points/ideas	Points raised by participants or content-related questions from the chat	102	Moderator 2 + participants
5		Summary of workshops and conclusion (of critiques and user-needs) and outlook (on 2nd	Conclusions can be formulated on a PPT	107	Moderator 1

		workshop).			
				+ 10 extra = approx. 2hrs	

Presented aspects to improve the EPC with the associated questions for discussion/Google Forms

- ✓ **Real energy consumption data (insight from stakeholder interviews)**
  - Discussion in the plenary
  - Questions:
    1. How important is it for you to obtain information about your real energy consumption
    2. And should also data about your electricity consumption be included?
    3. In what way would you like to receive information (e.g. via QR-code, mobile app, in-home displays)?
    4. On what time scale should feedback be provided?

- ✓ **Benchmarking of the energy consumption (suggestion from *The Report on the Use of Innovative Certification Schemes and its implementation* (DOI: 10.5281/Zenodo.4525223))**
  - Evaluation in Google Forms
  - Questions:
    Do you understand the figure "benchmarking of energy consumption"? (yes/no)
    Do you think the information from this figure is useful for you? (Scale: strongly disagree – strongly agree)

- ✓ **Environmental and life cycle indicators (insight from stakeholder interviews)**
  - Discussion in the plenary
  - Questions
    1. How important is it for you to obtain information about your real energy consumption
    2. And should also data about your electricity consumption be included?
    3. In what way would you like to receive information (e.g. via QR-code, mobile app, in-home displays)?
    4. On what time scale should feedback be provided?

- ✓ **Use of different units to express the EE of a building (insight from stakeholder interviews)**
  - Presentation of the following units: [€/month], [€/year]; [kWh/person year]
  - Evaluation in Google Forms
  - Questions regarding the units [€/month], [€/year]:
    This unit is understandable to me (Scale: strongly disagree – strongly agree)
    This unit is useful for me (Scale: strongly disagree – agree)
    I trust the indication in this unit (I believe that the indication are valid)
  - Questions regarding the unit [kWh/person year]
    This unit is understandable to me (Scale: strongly disagree – strongly agree)
    This unit is useful for me (Scale: strongly disagree – agree)
    I think this unit is more useful than [kWh/m2 year] (Scale: strongly disagree – agree)

- ✓ **More comprehensive recommendations (insight from stakeholder interviews),** the list of aspects to receive recommendations about was taken from the IDEAL project
  - Evaluation in Google Forms
  - Question
    1. Which of the following recommendation(s) should be included in the EPC because it/they would be useful for you? Tick the boxes and if you would need recommendations on additional aspects you can add them.

       - Install new boiler/heating supply
       - Fit double glazing or energy efficient glazing
       - Install loft insulation
       - Change the heating control
       - Insulate the water/heating pipes
       - Draught-proof windows and/or doors
       - Install wood burning stove or fireplace
       - Improve the air tightness of the building
       - Install cavity or solid wall insulation
       - Install floor insulation
       - Insulate the hot water tank
       - Install renewable energy technologies
       - Install ventilation system with heat recovery

    2. Which of the following sources would you prefer to get your recommendations from? Tick the box(es) and if you're having further recommendation, add them below.

       - Information from suppliers of energy saving products
       - Talking to an energy professional
       - Information in the national and local press
       - Information from my energy supplier
       - Information on the Internet
       - Information on the radio and television
       - (Next generation of) EPC
       - Friends/family members who are experts

- ✓ **Guidelines for the ever-day energy behavior (insight from stakeholder interviews)**
  - Discussion in the plenary
    1. In which areas do you believe you can still improve your energy saving behavior?
    2. What else should be taken into account with these references (building related, person related) or general references?
    3. Why would you (not) consider notes on the factors mentioned above?

- ✓ **Visualizations: Thermal Images (literature review)**
  In this case benchmarking allows one to relate one's energy consumption to the energy consumption of comparable buildings (similar building characteristics and use of building) e.g. inside the country.
  - Evaluation in Google Forms
  - Questions
    Do you think thermal images are user-friendly?
    (Scale: strongly disagree – strongly agree)
    Do you think thermal images are useful? (Scale: strongly disagree – strongly agree)

- ✓ **Visualization: 3D model of the building envelope (literature review)**
  A 3d-model of the individual building could illustrate the composition of the building envelope. In this way, this visualization could contribute to increasing understanding about the energetic condition of the building. In order to place the building of reference in context, there should be an example of a desirable structure of a building envelope provided.

  - Evaluation in Google Forms
  - Questions
    Do you think an individual model of the building envelope is user-friendly?
    (Scale: strongly disagree – strongly agree)
    Do you think an individual model of the building envelope is useful? (Scale: strongly disagree – strongly agree)

- ✓ **Features of a smart and dynamic EPC (literature review)**
  - Evaluation in Google Forms
  - Questions
    Which of the following aspect(s) should a smart and dynamic EPC contain? If you're having further recommendations, add them below!

    - Updated regulations and technical updates,
    - Dynamic simulation of consumption data (individual real-time feedback),
    - Inclusion of indicators about building services and appliances + e-mobility and
    - Energy use-forecasting
    - A roadmap, similar to building passport, to meet energy efficiency targets through staged deep renovations, conducted EEMS (making the EPC more dynamic)
    - A tool to find craftsmen
    - Instructions for self-implementation of smaller measures
    - Early warning systems (in case they heating fails),
    - Connecting points for add-ons such as smart finance models which intend a link to bonus programmes, prices of fuels and materials
    - 3D-model of the building envelope

- ✓ **Format/versions of the EPC (insights from stakeholder interviews and *The Report on the Use of Innovative Certification Schemes and its implementation* (DOI: 10.5281/Zenodo.4525223))**
  The idea is to split the EPC into two versions or to adapt the indicators in the EPC according to the target group
- Discussion in the plenary
- Questions

How do you like the idea of generating a double certificate or adapting the indicators according to the target audience?

- ✓ **Strengthening the communication about the EPC and EEMs (insights from stakeholder interviews)**
  - Discussion in the plenary
  - Questions

    Who could become more active as an intermediate link for end users?

    How could the role of other stakeholders be improved in order to increase the acceptance and use of the EPC?

Conduction of the online user-needs workshops in ePANACEA pilot countries and Germany

Spain

The online user-needs workshop in Spain took place on the 13th of January 2020 and was organized and conducted by CENER.
The agenda of the online workshop was as follows:

1. Overview ePANACEA project
2. Presentation about the Spanish EPC report (structure, content and visualization) → Google Form 1
3. Next generation of EPC
   - 3.1 Presentation of possible main indicators & additional information → Google Form 2
   - 3.2 Visualization → Google Form 3
   - 3.3 Recommendations about EEMs → Google Form 4

Critiques and needs were collected through the four Google forms according to the structure of the agenda. The first Google Forms was used to collect information about the understanding, critique and needs of the EPC by participants. It replaced the collection of this information in a mind map. CENER presented additional suggestions (to the proposed ones) to improve the EPC. They divided the suggestions into “possible main indicators and additional information”, “visualization” and “recommendations about EEMs”. The three other Google Forms aimed at receiving feedback about the presentation of suggestions for improvement belonging to the three categories. .

Belgium (Flemish Region)

VITO organized two user-needs workshops - one for other stakeholders and one for end users. The workshops took place on the 17th December 2020. VITO organized a reward for participants of the workshops. For the first (user-needs workshop) the reward was a kWh meter. For the following two workshops they organized prices as well: a shower LED for the 2nd workshop and a wall plug/meter for the 3rd workshop. VITO adapted the structure and content of the suggested concept as follows:

VITO used Mural for the first part of the workshop to collect participants' feedback on the current Flemish EPC. For this VITO used a black Mural board and participants could assess their feedback individually. For the second part of the concept VITO presented selected questions in the PPP. Participants answered in the chat box which allowed the moderation team to discuss the results immediately.

Finland

The user-needs workshop in Finland took place on the 13th January 2021 and was conducted by IZES, in collaboration with VTT. The online workshop was recorded. The structure and content of the workshop was the same as provided in the concept provided by IZES.

Austria

The online workshop in Austria was organized and conducted by EASt, TUW and IZES on the 14th January 2021. EASt and TUW found participants for the workshop. EASt and TUW organized a lottery for participants. Five winners won an energy saving set. The structure and the content of the workshops was the same as provided by IZES. The online workshop was recorded.

Greece

The online user-needs workshop in Greece was conducted by CRES and took place on the 13th January 2021. The structure and content of the workshop was the same as provided in the concept provided by IZES, with a few modifications which served to adapt the content to the national context of Greece.

Germany

The online user-needs workshop in Germany was held by IZES and took place on the 17th December 2020. The online workshop was conducted as suggested in the prepared concept. Due to long discussions during the first part of the workshop, 3 options of the second part were not discussed anymore. The online workshop was recorded.

Participants of the user-needs workshops

Table C,9: Overview of number of participants in the user-needs workshops

Country	Number of Participants		
	Total	End users	Other stakeholders
Spain	16	8	8
Belgium (Flemish Region)	5	3	2
Finland	6	3	3
Austria	12	1	11
Greece	13	8	5
Germany	8	3	5

Lessons learned

- In order to speed up and simplify the process regarding the recruiting of interviewees/participants it would be helpful to develop a digital version of the informed consent sheet and the short questionnaire and to combine the two documents (cf. EASt).
- The moderators should guide the conversations in order to receive answers on the questions and to stick to the time schedule.
- A lottery with prices that are related to energy-efficiency can be a nice reward for participants of the next workshops.