ePANACEA

Smart European Energy Performance Assessment & Certification

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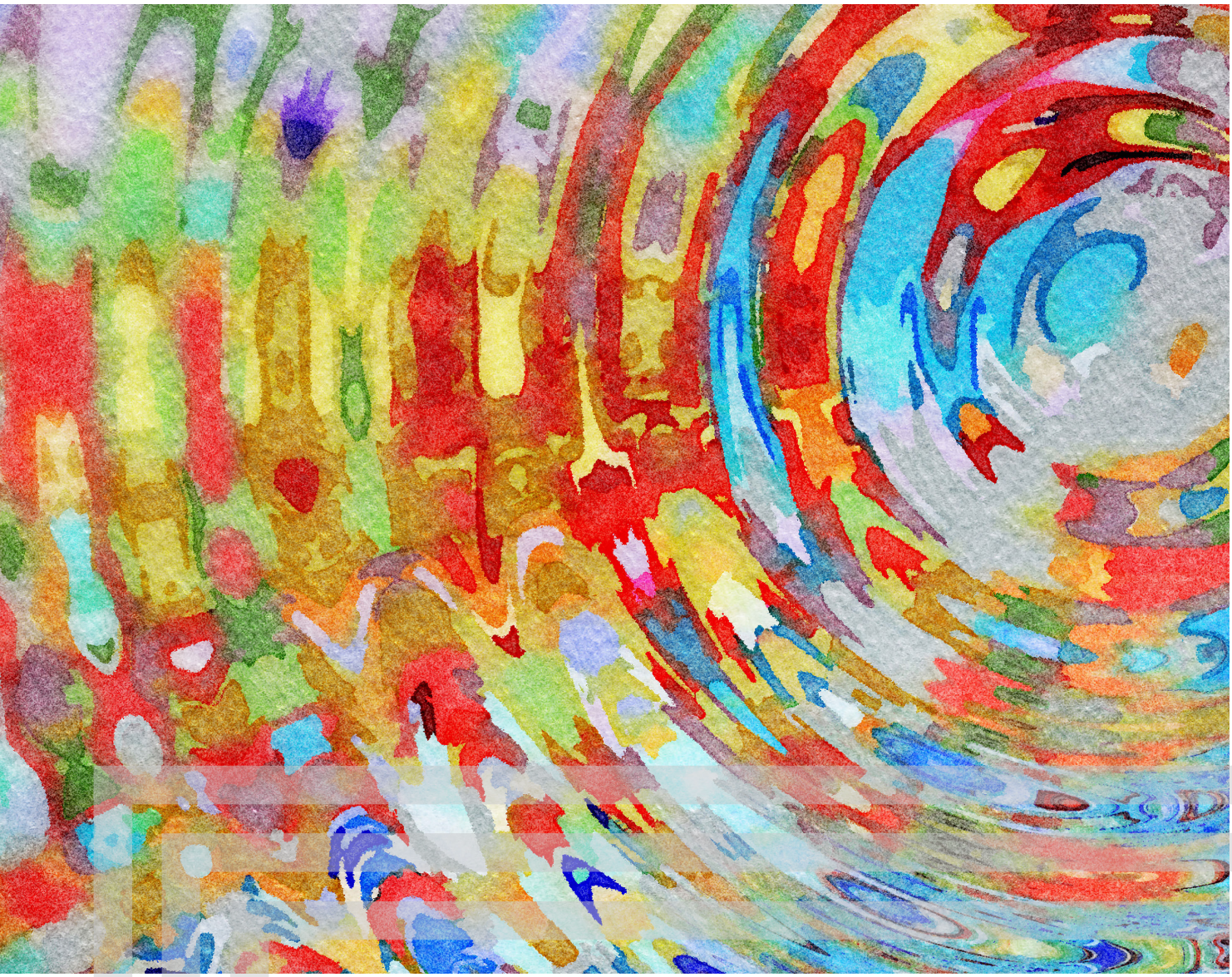

Assessing user-friendliness of proposals for a new Energy Performance Certificate (EPC)

Report on internal test and feedback of new EPC acceptance across the five pilot countries

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IZES gGmbH – Institut für Zukunftsenergie und Stoffstromsysteme

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TABLE OF CONTENTS

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

Technologies, and for this task in a broader sense the energy performance certificate (EPC), must be accepted by users in order to be used. Acceptance is influenced by different factors. For example, whether the technology is easy to use and appears useful. However, today's EPCs are rarely actually used. More often, they are put in the drawer as a mandatory document because they appear standardized. The ePANACEA consortium has set itself the task, among other things, of designing new EPC summary sheets for end-users that are accepted, because they provide information that is easy to understand and useful.

Within the framework of this task online user-acceptance workshops were conducted in the five ePANACEA pilot countries (Spain, Belgium (Flanders), Finland, Austria and Greece) to test users' acceptance of proposals for new EPC summary sheets, oriented towards end-users. The main target group for the acceptance workshops are end-users of EPC (i.e. tenants, building owners, occupants etc.); however, a good number of participants had a technical background in energy efficiency in buildings.

The proposals for new EPC summary sheets consisted of different illustrations, for example energy labels, final energy demand, partial performance indicators etc. The focus of the acceptance test was on the content, presentation and visualization of information, while data basis and plausibility of information were discussed on the side. The acceptance variables that were tested were: perceived ease of use (i.e. comprehensibility of information), perceived usefulness, perceived importance, behavioral intention to use and willingness to pay. Next to this, participants were also asked to indicate their preferences between options and their main interest in a set of indicators. In this way, the main components of an EPC (energy label, main, partial and additional performance indicators and recommendations etc.) were queried. In total 105 participants took part in the online acceptance workshops (ranging from 28 to 10 participants per workshop). Their answers were collected on the one hand through a software called poll everywhere and on the other hand through open discussions. Based on the results, we have drawn some initial conclusions that are: overall the majority of workshop participants showed rather high perceived importance, comprehensibility and usefulness of the proposals. However, summarizing the feedback from all workshops we recognise that there is potential for improvement regarding all proposed illustrations for new EPC summary sheets. Furthermore, common interests that catch the eye are: strong interest in annual energy costs as one of the main performance indicators in all countries, whereas primary energy use is also considered as highly important. Moreover, overall, indoor air quality and thermal comfort are the most interesting additional indicators to participants based on the results. However, these two points of all things still raise questions about the data basis and calculation methodology that make it possible for valid data to be made available. Because one thing became clear again: information that does not seem plausible or is not up-to-date or whose calculation basis is not transparent should not appear in the EPC summary sheets because it would create mistrust and confusion.

Within the further course of the ePANACEA project the objective is to revise the proposals for the new EPC summary sheets oriented toward end-users, based on the results from the acceptance workshops and suggestions for improvement. The revised draft for a new EPC will then be tested in a second round of acceptance workshops with end-users.

GLOSSARY

The following abbreviations are used in this report.

Att	Attitude
BI	Behavioural intention
DHW	Domestic hot water
EPB	Energy performance of buildings
EPB service	Building service included in the assessment of the energy performance (e.g. heating, cooling, ventilation, humidification, dehumidification, domestic hot water and lighting)
EPC	Energy performance certificate
GHG	Greenhouse gas
GLRB	Green labelled residential buildings
PEOU	Perceived ease of use
POPD plan	Protection of personal data plan
PU	Perceived usefulness
TAM	Technology acceptance model
WGA	Working group A
WGB	Working group B

1. INTRODUCTION

It is important that technology is accepted, since hardly accepted technologies are used less often, and have a smaller impact (Mlekus *et al.*, 2020). Surveys on the acceptance of energy performance certificate (EPC) carried out in the UK (Laine, 2011) and Germany (Amecke, 2012) both drew the conclusion that EPCs only have a modest or negligible impact on price negotiations and purchasers' decisions (Olaussen, 2017). Similarly, Backhaus *et al.* (2011) concluded that EPCs only have a small or negligible impact on homeowners' investment decisions (Olaussen, 2017). This suggests that EPCs are rather little used and accepted. Whether something is accepted or not depends on the interplay of subject, object and context related factors (Schäfer, Hempel & Keppler, 2013). Dwellers are often not able to understand the information provided in the EPC on their own. Because of this they need professional assistance. Their difficulty to understand the presented information might contribute to the low interest in (and use of) the document nowadays (Taranu & Verbeeck, 2018). Therefore, EPCs need to be improved such that they become more accepted and used, and thus contribute in influencing end-users to invest in energy efficiency. In order to make EPCs more user-friendly, content, presentation and visualization of information provided in an EPC can be improved (Taranu & Verbeeck, 2018). 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, 2017).

1.1. Objective of this report

The aim of the underlying task is to test the acceptance of proposed features for a new EPC with EPC users, whereof the main target group are end-users of EPC (i.e. non-experts). The minor focus is on other stakeholders (experts) who are also considered because on the one hand, they are also end-users and, on the other hand, they can provide an additional perspective on the EPC proposals due to their technical background. However, the goal is not only to determine whether the proposals for a new EPC (e.g. energy label, illustration of partial performance indicators) are accepted or not by users. The goal is also to understand *why* proposals are (not) accepted and how they can be improved for e.g. a European EPC or individual member states. In this context, this task seeks to increase understanding of how the visualization, presentation and content of information in EPCs can be improved such that it is better accepted by end-users. Hence, the focus is not on improving the implementation of the EPC as a policy tool or the generation of a new EPC (i.e. calculation methodology), but on improving the visualization, content and presentation of information in the EPC.

In the context of this task, the first round of acceptance workshops are conducted to test users' acceptance of the proposals for new EPC and to gather suggestions for improvement in the five ePANACEA pilot countries (Spain, Belgium (Flanders), Finland, Austria and Greece). This report documents the work that has been carried out under task "*Acceptance test of the new EPC".* Most importantly it presents the results of the first acceptance workshops conducted in the ePANACEA pilot countries. Also, it shows how the testing strategy for the acceptance workshop has been developed.

1.2. Outline of this report

Firstly, this report presents the theoretical background which prepares for the testing strategy for the acceptance workshops and provides insights on how the EPC can be improved for end-users. Then, the methodology used to test the acceptance of proposed EPC features among ePANACEA pilot countries is presented. After that, the results from each workshop of the ePANACEA pilot countries are summarized per question. The discussion chapter reflects on the methods that were used to explore users' acceptance and draws first conclusions from the presented results. The final chapter summarizes the research findings and provides an outlook on further processing and use of the results in the course of the ePANACEA project.

2. THEORETICAL BACKGROUND

This chapter provides the theoretical background for the task. It includes an introduction to the distinction between acceptance subject, object and context and presents the technology acceptance model (TAM) and additional factors that influence acceptance. From this chapter we derive the constructs that are used to test acceptance of the new EPC proposal in the acceptance workshops. The last section of this chapter presents suggestions for improvement of the EPC which can serve as input for working group B (WGB).

2.1. Acceptance subject, object and context and related factors

When we talk about acceptance we should acknowledge that there exist three dimensions of acceptance, namely **acceptance subject, acceptance object and acceptance context** (Schäfer, Hempel & Keppler, 2013). The three dimensions are introduced hereafter:

- The **acceptance subject** – is the entity that accepts something, e.g. individuals, groups or collective actors, as well as society as a whole. Within this task we explore the acceptance of end-users of EPC (e.g. renters, building owners, building occupants, landlords etc. with different socio-demographic backgrounds).
- **The acceptance object** can be of very different nature. It does not necessarily have to be a technical artefact or a thing of daily use. Plans, decisions, concepts as well as persons and institutions, opinions, interpretations of situations, ways of acting or values can just as well represent objects of acceptance. Technology as an object of acceptance can encompass e.g. individual technical artefacts as well as (large-scale) technical systems. In terms of the EPC we are talking about an information instrument that might become more technical if it was offered in a digital, interactive format.
- **Acceptance context**: In general, the context of acceptance consists of all factors that can neither be associated with the acceptance subject, nor the acceptance object, but which influence the acceptance development nevertheless. This can be e.g. the social and cultural context which surrounds the subject of acceptance.

Acceptance factors related to the acceptance subject/object or to the context shape acceptance (Ibid.). The following acceptance **subject related factors** in particular influence (technology) acceptance:

- Attitudes
- (personal) norms and values
- Emotions (affects)
- Socio-demographic factors such as age, gender, social classes, education/occupation

With regard to technology as an **object of acceptance**, the following factors are frequently named:

- Costs and benefits of technology deployment or use
- Ease of use or usability (cf. technology acceptance model)
- Aesthetic aspects of technology design, e.g. visual or auditory impairments or attractiveness

The following factors are typical **contextual factors:**

- The context of society as a whole: norms and values, legal framework, political climate and discussions, policy decisions, guiding principles, participation culture and experience, economic situation/price development.
- The way in which the technical innovation is introduced (procedural design), for example with regard to organised introductions to the use of a technology (training), design of the communication process, communication behavior of the introducers; opportunities for participation/co-design, trust or credibility of the persons shaping this process, procedural and fairness (Schäfer, Hempel & Keppler, 2013).

- In the context of the EPC, Amecke (2012) identified two contextual factors explaining the current low relevance of the EPC which are the legal status of EPC and the relevance of the purchase criterion 'energy efficiency'. Amecke (2012) reports that the EPC was perceived as significantly more trustful when an EPC was presented for all considered dwellings, rather than for only one or a few buildings. Furthermore, Amecke (2012) reports that energy efficiency might not become more important even when purchasing criteria such as location, price, outdoor spaces and condition of dwelling were comparable. This in turn has a weakening effect on the relevance of the EPC.

The interplay of subject, object and context related factors shapes acceptance. This is why the same characteristics of an object can provoke different reactions depending on the subject of acceptance (and context) (Schäfer, Hempel & Keppler, 2013). Therefore, it is important that we test the acceptance of the new EPC with different types of end-users (acceptance subjects).

2.2. The technology acceptance model

"The TAM with its key variables (i.e., perceived usefulness, perceived ease of use, and behavioral intention) is recognized to successfully explain user behaviors of various information and computer technologies" (Liu *et al*., 2018, p.153). The technology acceptance model was introduced by Fred Davis in 1986. Its final version, as presented in Figure 1, was developed by Venkatesh and Davis (1996).

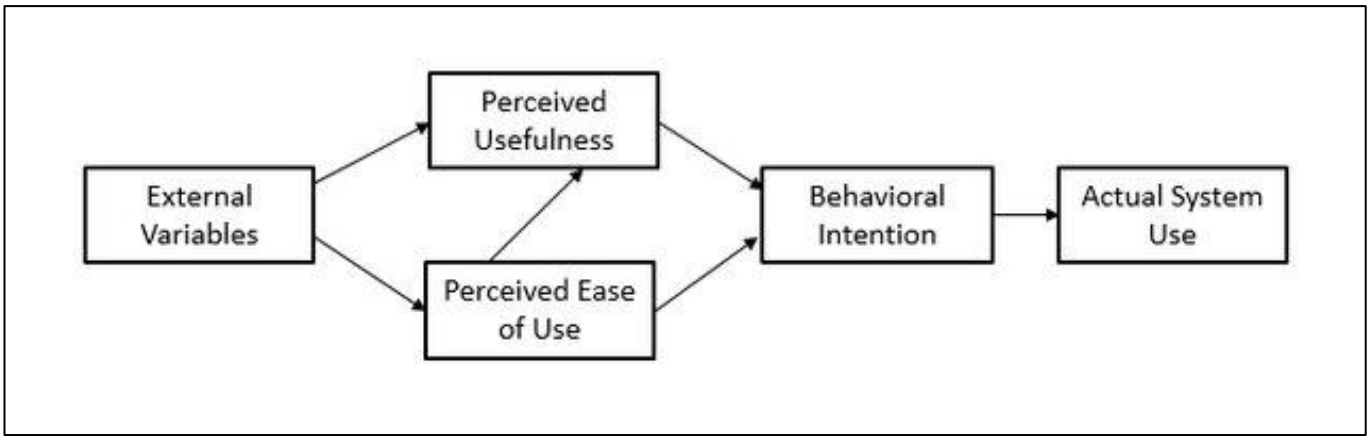

Figure 1: Final version of the Technology Acceptance Model (TAM) (Venkatesh & Davis, 1996)

The TAM is based on the assumption that two self-efficacy perspective variables, perceived ease of use (PEOU) and usefulness (PU) are influential antecedents which shape users' attitudes (Att) and behavioral intention (BI) (Davis, Bagozzi & Warshaw, 1989). However, for the final TAM, 'attitude' was removed from the model as it was found that perceived usefulness and perceived ease of use have a direct influence on behavioral intention. External variables (e.g. training and user support) indirectly influence acceptance by influencing perceived usefulness and perceived ease of use (Liu *et al.,* 2018).

- In this context perceived ease of use is defined as 'the degree to which individuals perceive how easy it is to use a technology' (Davis, Bagozzi & Warshaw, 1989). Put in other words, PEOU is' the degree to which individuals trust that utilizing the technology will be free of effort' (Davis, 1989).
- PU is defined as a person's belief to benefit from using a particular system (Davis, 1989).
    - Davis (1989) concluded that perceived usefulness is the strongest predictor of one's intention to use information technology.

2.2.1. Applications of the technology acceptance model to sustainability certification schemes

- ✓ Liu *et al*. (2018) applied the TAM to study acceptance of green labelled buildings (GLRBs). They explain that "GLRB is a combination of various new green technologies integrated into residential buildings" which makes the TAM a suitable model to test acceptance.
- ✓ Ma, Gam & Banning (2017) applied and tested TAM (Davis, Bagozzi & Warshaw, 1989) to the research context of sustainability labels **by viewing label using behavior as similar to the way consumers use new sources of technology.**
- ✓ Considering the EPC as an information instrument and the given probability that it becomes more technical (e.g. digital, dynamic EPC) we suggest the TAM as a suitable model to explain the acceptance of EPC. Also, taking the EPC into account for decision making could be considered as a process of using a new media for decision making. Therefore, the application of the TAM to understand the acceptance of EPC is expected to be appropriate.
    - If we apply TAM's key variables perceived ease of use and perceived usefulness to the EPC, we could suppose that citizens who perceive the information in the EPC as comprehensible and useful e.g. for decision making, are more likely to use the EPC, and subsequently are more likely to rent/buy more energy efficient homes and to initiate energy efficiency measures.

2.2.2. Additional factors influencing acceptance

Next to the TAM variables, additional variables that might influence the acceptance of the EPC were identified during literature research. They are described hereafter.

2.2.2.1. Knowledge, social trust and environmental attitude

In addition to the TAM variables, Liu *et al.* (2018) argue that in the green building context there are other psychological factors that explain acceptance of GLRB. More precisely, these are residents' **knowledge** about GLRBs, **social trust** in organizations responsible for GLRBs, and **environmental attitude** (the latter may be less relevant for EPC acceptance).

Knowledge: Liu *et al.* (2018) argue that residents' knowledge about features of GLRBs (e.g. usefulness and benefits of GLRBs) is essential to their attitudes and intentions to adopt GLRBs. The more knowledge people have about the **advantages** of a technology, the more likely they are to accept this technology. We suppose that knowledge regarding the EPC plays a similarly important role.

Social trust: Liu *et al.* (2018) suppose that social trust will have a specific role in the decision making process of accepting GLRBs. In cases when people do not know enough about science or technology or they do not have enough resources (e.g., time, abilities) to make decisions and to act, "they will use trust as a strategy to reduce cognitive complexity in risky decisions" (Earle and Cvetkovich, 1995, in Liu *et al.*, 2018, p. 153). In this sense, social trust is regarded as a positive predictor of behavioral intention to accept a new technology (Liu *et al.*, 2018). This may be applicable to the EPC as well, since e.g. end-users need to trust into the information it provides because they do not have the knowledge to determine the energy efficiency of their building themselves.

In the case of Liu *et al.* (2018) high social trust in organizations responsible for green buildings can motivate citizens to accept green buildings. Trust reduces the complexity of the public's decision processes for accepting green building. Transferring this information to the EPC, we may assume that high social trust in organizations responsible for EPC could have the same positive effect. The other way round, people might reject a technology directly without careful consideration if they perceive organizations responsible for a technology as untrustworthy. This shows that social trust in the responsible institutions is vital for a technology to be accepted.

Thirdly, Liu *et al.* (2018) suggest that the residents' **environmental attitude** may also play a critical role in the decision making process of adopting GLRBs, as GLRBs are pro-environmental products and thus adopting GLRBs is a specific pro-

environmental behavior. However, we expect that the environmental attitude might be less decisive for the acceptance and use of EPC because EPC predominantly communicate the financial benefits of energy efficient homes.

Liu *et al.* (2018) integrated the three aforementioned psychological factors into the TAM as antecedents to explain residents' attitude towards and behavioral intention to use GLRBs. They concluded that social trust is an antecedent of residents' perceived usefulness and intention to use GLRBs. The actual usage behavior was not measured during the study; its proxy behavioral intention was measured.

2.3. Suggestions for improvement of the EPC

This section presents insights from literature review on how EPC schemes can be improved such that they become more user-friendly. They are categorized into content of information, presentation of information and information basis for the calculation of the EPC.

2.3.1. Content of information

- Taranu & Verbeeck (2018) raise the question: **What is the intention of the new EPC supposed to be?** Roughly divided there are two possible purposes that will influence the length, content and layout (and costs!) of the EPC. Is it supposed to be a first insight into the current situation of the building and its potential energy performance with generic recommendations or is it a detailed and tailored energy advice? Currently, there exist EPCs which are halfway between the two models, i.e. they contain a lot of technical data although the recommendations are rather standard. These models delude the expectations of both dwellers and policy makers (Taranu & Verbeeck, 2018), as they are too technical and generic for the first and not detailed enough for the latter.
- In general, consumers need to **have a basic level of understanding of a topic** (in this case energy efficiency) before they can absorb new information about it. Hence, in the context of the EPC it could be worthwhile to explain the concept and motivations for energy efficiency before end-users are provided with more information (Harrington, 1997) for instance about the energy performance of their building and recommendations to improve energy efficiency. A good example of this can be found in the Belgian EPC, which gives **10 good reasons for improving the energy efficiency of a building.** This information would raise users' knowledge which could positively influence their acceptance (cf. Liu *et al.*, 2018).
- One more important hint towards improving the EPC for end-users is that **consumers' perceptions regarding price and variations in the market are critical;** i.e. if a consumer assumes that there is little variations in price or energy efficiency in the market, he/she is not expected to actively search for further information before decision making (Harrington, 1997). This shows why it is useful if end-users have a general understanding of the context of the information. Hence, **benchmarking, the comparison of the energy demand (and associated costs) to other similar buildings, can be helpful for end-users to understand the variability in energy efficiency and costs.** Similarly, it might be useful to show the CO_2 emissions associated with different energy efficiency classes to illustrate the differences.
- Another important aspect of the EPC is to **communicate the potential savings** that can be achieved through the energy efficiency measures that are recommended in the EPC. Savings can be presented in terms of energy savings, monetary savings, CO_2 reductions or the cost per ton CO_2 saved (Taranu & Verbeeck, 2018).
- An interesting remark is that either monetary or environmental impacts should be communicated in the EPC, not both. Providing monetary or environmental information both has disadvantages and advantages. However, using extrinsic (monetary) and intrinsic (environmental) motivations in the same document weaken the message (Taranu & Verbeeck, 2018).

2.3.2. Presentation of information

- The "danger" of heuristic thinking by end-users is favoured by complexity of the information, choice overload, lack of salience (Taranu & Verbeeck, 2017).
- Regarding the format of an energy label Harrington (1997) remarks that an accurate energy label is good, until it becomes too complex for users to read.
- Key in improving the EPC for end uses is "to render technical information more accessible without losing its credibility and trust" (Taranu & Verbeeck, 2018, p.1746).
- According to Taranu and Verbeeck (2018) end-users should be able to understand what the current and the potential energy performance of their building is without the explanations of an energy expert. This is why technical terms and concepts should be translated into self-explanatory content and images.
- Taranu and Verbeeck (2018) suggest regarding the format of EPC that it is **worthwhile to shorten the paper certificate and to provide more information online as it is the case in Denmark and the UK**.
- Regarding the presentation of information Harrington (1997) recommends that **large "annual" figures for energy consumption and costs have a greater influence on consumers' decisions compared to small, "daily numbers".** The reader can be manipulated through the presentation of data and the chosen units. This demonstrates

2.3.3. Information basis for the calculation of the EPC

In the same way as the selected program or type of operation for an appliance affects the data on the energy label (Harrington, 1997), the selected conditions of use influence the energy performance of a building. Furthermore, Harrington (1997) explains that the indication of energy consumption values without the references to assumed conditions of use or other performance attributes potentially misleads consumers. This is the reason why at least the chosen variables determining typical operation should be communicated, if no real conditions for calculating energy efficiency have been considered. **This would allow the user to know if the considered conditions of use fit to his/her type of operation (Harrington, 1997).**

The standard occupancy input for calculations does not reflect the actual energy-use patterns of the dwellers (Taranu & Verbeeck, 2018). This results in generally applicable recommendations that do not reflect the full potential of the energy efficiency measures (Taranu & Verbeeck, 2018). This is also the reason why we discuss in the ePANACEA project whether calculations should be based on actual conditions of use (in addition to calculations based on standard conditions of use). **For the incorporation of energy use patterns, Taranu & Verbeeck (2018) suggested an online tool**. An important aspect would be the link between the paper certificate and the online tool which could be facilitated by a QR code. In this way dwellers could easily access the online tool from the paper version. On this point we are only reminded again that higher quality (personalized energy advice) will be more costly than standard values and recommendations (Taranu & Verbeeck, 2018). Taranu and Verbeeck (2018) demonstrate the need to integrate user patterns into EPC, regardless of whether that happens online or is provided on paper. This is in agreement with the discussion in the ePANACEA project where we consider within the scope of working group A (WGA) and WGB which information on the EPC should be based on actual conditions of use (next to standard conditions of use). The reason for this is that the energy assessment and advice could go beyond the current default values and standard recommendations. This also reflects users' needs for more individual indications of energy performance and recommendations in the EPC that were collected during the user-needs analysis in the ePANACEA project.

Furthermore, Harrington (1997) emphasizes that on the one hand, most consumers express interest in the costs of energy use to run a building. However, on the other hand, conveying this information through an energy label has the problem that variations in energy tariffs within a country and in time ought to be taken into account in order to provide valid information. The question is whether a database is available here that could guarantee the validity of the information on energy costs on the basis of current information.

2.4. Conclusion of theoretical background

What does the information provided in this chapter mean in the context of acceptance testing of a new EPC and improving the EPC such that it becomes more user-friendly? What aspects can be derived for the planning of the testing strategy and for the further development of new EPC summary sheets oriented towards end-users?

First of all this chapter makes us aware of the fact that there are three dimensions – acceptance subject, object and context that all shape acceptance. In the context of EPC, we can speak of end-users (and other stakeholders) as acceptance subjects, the EPC (or draft of a new EPC) as acceptance object and the policy framework the EPC is embedded in as the acceptance context. The interplay of subject, object and context related factors shapes acceptance. Therefore, it is important that different user types are included in the acceptance test. When working on the summary pages for a new EPC we focus on improving the 'acceptance object' (EPC) and the related acceptance factors such as ease of use and usefulness.

Then, we can derive constructs for the acceptance testing from this chapter: from the TAM we understand that 'perceived ease of use' (how easy it is to understand the EPC) and 'perceived usefulness' influence acceptance. These variables are object-related acceptance factors. Other variables, applicable to acceptance of EPC may be 'knowledge' (what do users know about energy efficiency and the EPC) and 'social trust' (is the authority issuing EPCs trustworthy? Is the calculation methodology trustworthy?). Finally, this chapter delivers hints on how the content and presentation of information in the EPC can be improved such that it becomes more user-friendly. This information can be used for the preparation of a new EPC draft and can be compared to participants' suggestions for improvement. Also, it provides us with information regarding the data basis for the calculation of energy performance of buildings (EPB): Providing information based on actual user conditions in addition to information based on standard user conditions may be reasonable.

3. METHODOLOGY

This chapter provides the methodology used to explore users' acceptance of the new EPC. In this sense, it first describes the literature analysis that was conducted; then, it explains how the testing strategy for the first round of acceptance workshops was developed and how the acceptance workshops were conducted.

3.1. Literature analysis

Literature was reviewed in order to identify the most important factors that influence technology acceptance (we consider the EPC as information technology). For the selection of adequate literature sources we were looking on the one hand for acceptance objects similar to the EPC, such as other certification schemes in the field of energy efficiency or sustainability, as literature on acceptance of EPC is scarce. More specifically, studies on the acceptance of green labelled residential buildings (GLRBs) (Liu *et al.,* 2018) and on the acceptance of sustainability labels on apparel products (Ma *et al*., 2017) were taken into account. On the other hand, we considered studies that used the TAM in order to test acceptance. To identify factors that influence the acceptance of the EPC, we used the TAM as a basis. The TAM, with key variables 'perceived usefulness', 'perceived ease of use', ('attitude') and 'behavioral intention' is confirmed to successfully explain user behaviors of various information and computer technologies. Next to the TAM variables, we were scanning literature for possible additional factors that significantly influence acceptance of EPC.

3.2. Development of testing strategy

User acceptance workshops were planned for the five ePANACEA pilot countries in order to test the acceptance of the proposals for a new EPC. The testing strategy for the acceptance workshops was developed by IZES. The following three dimensions constitute the testing strategy:

1) Features of existing EPC schemes (energy label, main performance, partial and additional indicators etc.)
2) Variables influencing technology acceptance (e.g. perceived usefulness, perceived ease of use etc.)
3) Proposals for a new EPC oriented to end-users (e.g. illustrations of energy label, partial performance indicators etc. based on WGB).

Moreover, the testing strategy was adjusted according to the feedback on suitable indicators for EPC summary page for end-users by WGB. WGB also provided feedback on the first new version of an EPC from *The Report on the Use of Innovative Certification Schemes and its implementation* (DOI: 10.5281/Zenodo.4525223). The revision of this (e.g. presentations of energy labels, partial performance indicators etc.) was then used as input to the testing strategy.

3.2.1. Feature levels of the EPC

The following features of EPC are covered by the testing strategy:

- Energy label
- Main performance indicators (and units)
- Context of energy efficiency class: benchmarking and energy efficiency class in relation to national climate target
- Partial performance indicator (i.e. heat energy demand, final energy consumption disaggregated per energy service, performance indicators of building envelope elements, share of renewable/conventional energy).
- Additional performance indicators (e.g. comfort, indoor air quality, water consumption etc.)
- Recommendations (stepwise renovation, energy saving tips for every-day life)
- Standard and actual conditions of use

- Links to additional sources of information
- Format of EPC

3.2.2. Constructs for acceptance testing of the new EPC

The following constructs were selected in order to test users' acceptance of the proposals for a new EPC:

- Perceived importance
- Perceived ease of use (i.e. in the context of EPC interpreted as comprehensibility)
- Perceived usefulness
- Behavioral intention
- Willingness to pay

'Perceived importance' was added as a construct in order to generate more data on aspects we already collected data about in the first round of workshops (user-need-analysis). This provides us with a bigger data basis regarding certain user needs.

'Perceived ease of use' (i.e. in the context of the EPC interpreted as comprehensibility)', **'perceived usefulness'** and **'behavioral intention'** were adopted from the TAM. '**Willingness to pay'** was added as a construct in order to generate data which can be used as input for the project task '*Replication potential and related impacts'*. Willingness to pay results from a user's cost/benefit perception of EPC. During the first round of workshops we made the experience that laypersons might not be willing to pay higher prices for high quality EPC because they are simply not aware of the difference in quality among EPCs (e.g. in Germany). We expect a mismatch between users who want a qualitative EPC but who are not willing to pay for an improved EPC. The constructs that were not taken into account for the testing strategy of the first acceptance test might be useful for the testing strategy of the second acceptance test (knowledge; social trust). Not all constructs were taken into account this time because time during the workshops was limited. Moreover, it was difficult to ask about 'trust' in the ePANACEA methodology because it is not developed and available yet.

In addition to these constructs we asked about participant's **'preferences'** between different proposals for EPC features (such as energy labels or partial performance indicators). Finally, we asked about participants' '**main interest'** in different options (additional performance indicators, additional sources of information) to be able to prioritize the provision of information.

A mix of question types (or activities) was used during the acceptance workshops to obtain answers to the above constructs: multiple choice, ranking, and clickable image questions (selection of preferred option; indication on a 5 point Likert scale). In total, nine activities were used to test the understanding, four activities to test perceived usefulness, each three activities to explore the main interest and perceived importance, each two activities to explore preferences and willingness to pay and one activity to test willingness to use the new EPC.

In addition, open text questions were used to collect feedback on suggestions for improvement. The formulated questions can be seen in Appendix A Testing strategy for acceptance workshops, which contains screenshots from the poll everywhere activities for the Finnish edition of the acceptance workshop. We have added the questions for the respective constructs in the software poll everywhere (section 3.3.4)

In addition to that, open discussions were inserted between the activities in poll everywhere in order to understand 'why' participants selected a certain answer (or not) and to gather suggestions on how to improve the presented illustrations (which can be used by WGB).

3.2.3. WGB: working on an end-user-oriented EPC

WGB was established in the course of the project in order to work on EPC summary sheets, oriented towards end-users of EPC, while WGA was established to develop an EPC oriented towards experts. Put in other words, these working groups focus on improving the 'object related acceptance factors' regarding EPC (how can we improve the EPC so that it is more accepted

by A experts and B non-experts?). As leader of T.3.4 *Acceptance of new EPC* and responsible for the testing strategy of the acceptance workshops, IZES became leader of WGB. SYMPRAXIS, VITO, EASt, VTT, CENER and CRES are members of WGB. The task of WGB was to make a preselection of the indicators for an EPC oriented towards end-users and to update the draft EPC from *The Report on the Use of Innovative Certification Schemes and its implementation* (DOI: 10.5281/Zenodo.4525223). The tasks which were carried out by WGB are described hereafter.

3.2.3.1. Feedback on indicators for an EPC oriented towards end-users

Members provided their feedback on the suitability of indicators for an EPC oriented towards end-users. For this, they indicated in a table what indicators they find suitable for end-users and which not. The table also considered whether indicators should be calculated based on standard or actual conditions of use and whether indicators shall refer to EPB services or all services (e.g. in the case of greenhouse gas (GHG) emissions). IZES consolidated the input to the table by members of WGB (IZES, CENER, EASt, CRES, and VTT & VITO).

3.2.3.2. Selection of indicators for an EPC oriented towards end-users

It can be said, that mainly there is consensus among project partners on what indicators shall be included in an EPC oriented towards end-users, and which not. However, during the discussions it became clear that there is disagreement regarding the point whether and what information should be based on actual or standard conditions of use. The first recommendation that was formulated here was that indicators shall be calculated based on standard conditions as default and information based on actual conditions of use could be provided in addition. In this sense, the focus on the comparability of indicators of different buildings would be preserved.

Other concerns by participants of WGB:

- Feasibility to provide accurate information about certain indicators (annual energy costs).
- Definition of additional indicators like indoor air quality and comfort (and models to deliver information).
- Capability to distinguish e.g. between GHG emissions from EPB services and GHG emissions from other services. GHG emissions for EPB services can be calculated only per energy source (oil, electricity, natural gas, etc.). E.g. if heating and cooling are provided by the same energy source (electricity), it is not possible to distinguish the GHG emissions for each use based on calculations.

Based on this, the questions about indicators for the user workshops were adjusted, i.e. participants were presented with a pre-selection of indicators made by WGB. Moreover, as a result of discussions in WGB participants were asked how easy they found it to understand and how useful they found it to receive information based on standard and actual conditions of use (uncertainty regarding this issue in WGB).

3.2.3.3. Revision of the first EPC proposal

Members of WGB provided their feedback on how the first EPC proposal from *The Report on the Use of Innovative Certification Schemes and its implementation* (DOI: 10.5281/Zenodo.4525223) could be improved. Based on that and on impressions from the Danish and British EPC, a revision of the first EPC proposal was developed by IZES. The revision was the basis for the testing strategy for the first round of acceptance tests, i.e. participants were asked to evaluate the illustrations and information from the revision. The revised illustrations can be retrieved from Appendix A Testing strategy for acceptance workshops. For some EPC features (energy label and presentation of partial performance indicators) two options were proposed on which participants were asked to indicate their preference. Hence, when we talk of “the new EPC” we do not mean a final new version, rather the current new EPC proposals which will be revised a couple of times more during the ePANACEA project (based on users’ feedback, implementation feasibility etc.).

3.3. Conduction of acceptance tests

This section informs about the conduction of the acceptance tests. It describes the selected target group and target number for the first acceptance workshops, lists the hosts and dates of the conducted acceptance workshops and describes the material that was prepared for the workshop (presentations and activities in the data collection software 'poll everywhere'.

3.3.1. Target group and number for first acceptance workshops

The target group for first acceptance workshop were end-users of EPC. End-users encompass e.g. building owners, renters, building occupants, landlords, housing associations and building managers. However, this means that also experts in the field of energy efficiency in buildings could take part as they are also end-users of EPC. However, no prior knowledge was necessary in order to participate. The target number per workshop was 30, due to the original plan to make a T-test to compare the results of the workshops in the ePANACEA pilot countries. A T-test is said to be relatively robust from a sample size of 30.

Each partner involved in recruiting participants for the user workshops (CENER, VITO, VTT, EASt & TUW and CRES) had a budget of 12000€ for the rewards for participants of the workshops. The rewards ought to be related to energy efficiency and ought to be distributed equally among participants, i.e. with a target number of 30 participants/workshop, 40€ could be spent per participant.

Prior to the first acceptance workshop informed consent was collected from participants. The template is available from the POPD (protection of personal data) plan.

Socio-demographic data was collected at the beginning of the survey with poll everywhere. Data regarding gender, age and educational background of the participant were collected as well as the relation to the building (owning/renting etc.) and type of building (detached house, terraced house etc.). These variables are subject related acceptance factors that are expected to influence the acceptance of the new EPC.

3.3.2. Hosts and dates of the first acceptance workshops in ePANACEA pilot countries

The acceptance of proposals for new EPC summary sheets was tested in the five ePANACEA pilot countries (Spain, Belgium – Flanders, Finland, Austria and Greece). All first acceptance workshops took place online due to the ongoing COVID-19 pandemic.

- Finland: the first acceptance workshop was conducted in English on 14th January 2022 by IZES in collaboration with VTT.
- Austria: the first acceptance workshop was conducted in German on 25th January 2022 by IZES, EASt and TUW.
- Spain: the first acceptance workshop was conducted in Spain on 18th January 2022 by CENER.
- Greece: the first acceptance workshop was conducted in Greek on 18th January 2022 by CRES.
- Belgium: the first acceptance workshop was conducted in Flemish on 18th January 2022 by VITO.

3.3.3. Preparation of presentations for workshops

IZES prepared a google presentation for each acceptance workshop, containing an introduction to the topic and the ePANACEA project and linking the activities in poll everywhere. This ensured that the introduction to the first acceptance workshop was standardized, as well as the testing strategy. The feature levels of EPC we asked about via poll everywhere were shortly introduced in order to give participants with no previous knowledge on the topic a chance to understand which elements an EPC contains/could contain and why. Project partners who conducted the acceptance workshops in another language than English or German, translated the presentations themselves.

3.3.4. Data collection software: Poll Everywhere

The questions for the respective constructs were inserted in the software poll everywhere. Poll everywhere was used to make the user workshops interactive and to collect replies instantly. The tool allows participants to enter answers on their own device. Aggregated answers are then shown instantly on the screen of the presenter. This provides a good basis for discussion. The presenter can ask immediately e.g. why participants selected a certain answer. Also, the use of such a tool during a workshop makes sure that all participants can reply, instead of only a few who speak out during the discussion.

IZES bought a licence for one month (6th January – 6th February 2022) in order to have access to the creation of reports. IZES was the account owner and added VITO, CENER and CRES as presenter to the account such that these project partners could conduct the user workshops independently and simultaneously in the pilot countries. IZES put the prepared questions and illustrations into poll everywhere. Project partners who were added as additional presenter to the account could translate the questions.

After the Finnish edition of the acceptance workshop an online survey containing the questions on willingness to pay was sent to participants because they were not covered during the workshop for lack of time.

4. RESULTS OF FIRST ACCEPTANCE WORKSHOPS

This chapter presents the results of the acceptance workshops in the five ePANACEA pilot countries. Participants' answers are summarised regarding each item of the testing strategy (c.f. Appendix A) by stating how the majority of the participants (in %) answered. Moreover, the criticism and suggestions for improvement on the respective questions are listed sorted by topic (e.g. visualization, presentation of information, content etc.). Repetitions of the same points of criticism within one workshop are not reported.

In total 102 participants took part in the first round of acceptance workshops, of which 10 participated in Finland, 26 in Austria, 21 in Belgium, 27 in Spain and 18 in Greece.

4.1. Finland

In total, 10 participants took part in the Finnish edition of the acceptance workshop. The following sections present the summarised results of the Finnish workshop, arranged according to the testing strategy as found in Annex A.

4.1.1. Socio-demographics

Table 1: Socio-demographics of participants from Finland

Socio-demographic variables	Results Finnish Workshop
Role in relation to the EPC	Nine out of ten participants considered themselves as **end-users of EPC**, while 6 six out of ten indicated to be an expert (as well), i.e. energy advisor or researcher in the field of energy efficiency.
Gender	60% male, 40% female
Age	50% are between **35 and 44 years old**; 40% are between 55 and 64 years old.
Highest educational qualification	70% have a **Master's or equivalent level**; 30% have a doctoral or equivalent degree.
Relation to building	80% **own** the home they are living in.
Type of building	30% live in a detached house, 30% in a terraced house and 30% in a flat.

4.1.2. Energy label

- ✓ **Comprehensibility:** The majority (90%) finds the energy label A easy to understand. Here it needs to be mentioned that the energy labels (options A and B were slightly adopted, i.e. one additional main indicator 'heating energy demand' was added because it is included in the existing Austrian EPC scheme and would otherwise certainly have been missed by participants with a technical background.
- ✓ **Preference (Label A or B):** Label A (80%); label B (20%).
    - Label A **looks more familiar** (reminds of label of electrical appliances).

- Label A shows well that with a worse energy efficiency class, more energy is required (size of bars represents amount of energy need).
- Label B looks like a process (because of the arrows).
- Do not add more information to any of the two labels. Otherwise, it would be overloaded.
- Is there a rating scheme for GHG emissions?

4.1.3. Main performance indicators

- ✓ **Familiarity**: all presented indicators, total primary energy use, GHG emissions, annual energy costs and renewable energy ratio are known and comprehensible to the majority of participants (90% know and comprehend GHG emissions and renewable energy ratio, while only 50% know and comprehend total primary energy use and annual energy costs).
- ✓ **Main interest:** 1st primary energy use [kWh/m² year], 2nd annual energy costs [€/m² year]
  - However, the primary energy indicator is problematic because the primary energy mix varies with different locations in a country; however, for the EPC the average value for the whole country is used.
  - The answers depend on the building type in question, i.e. for non-residential buildings other indicators might be more important compared to residential buildings.
- ✓ **Unit of primary energy use:** most tangible unit is [kWh/(m² year)] (40%), 2nd is [kWh/year] (30%), and 3rd is [kWh/month] (20%).
  - Space efficiency of a building is also important (do not only consider kWh per m² but kWh used in total).

4.1.4. Context of the EPB

- ✓ **Perceived importance of benchmarking with other similar buildings:** the majority (55%) perceives that this information is very important (22%) or fairly important (33%). However, also 22% consider this information to be slightly important.
- ✓ **Perceived importance of climate target:** 50% perceive this information as fairly important, 30% as slightly important.
- ✓ **Understanding of illustration regarding benchmarking with other similar buildings:** all participants agree that the illustration makes the energy performance in relation to the evaluation of buildings easy to understand (30% strongly agree; 70% agree).
  - Participants expressed doubts that the buildings are comparable (due to different number of persons living in the buildings, different building uses). However, the ePANACEA team is aware that only similar buildings can be compared. What similar buildings are, needs to be well defined.
- ✓ **Comprehensibility of illustration regarding climate target:** the majority (90%) agrees that the illustration makes the energy performance of the building in relation to the national climate target easy to understand (while 10% disagreed).
- ✓ **Suggestions for improvement**
  - The 'granularity' should be changed: zoom into the classes 'my building' and most buildings are in; combine the bad energy efficiency classes into bigger ones.
  - Regarding the order to the labels underneath the illustration: change it such that it fits the order of classes in the diagram (i.e. best class comes first).
  - Combine the information underneath the illustration (the two labels) with the illustration; embed them in the graph.

4.1.5. Overview of energy flows (primary energy, final energy etc.).

- ✓ **Comprehensibility:** only 36% find the illustration easy to understand, while 27% do not find the illustration easy to understand. → Need for improvement.

- The illustration takes time to read, the text on the right should be better included in the illustration; avoid "legend".
- Summarize 'delivered non-renewable' and 'delivered renewable energy' as 'final energy'.
- The term 'renewable infrastructure related energy' is not understandable
- What about energy generated on-site (PV, solar thermal, geothermal etc.)?
- What does 'energy' refer to? Energy for heating or electricity, or both?

4.1.6. Partial performance indicators

- ✓ **Usefulness of information "thermal energy demand":** all participants find the information useful (73% strongly agree, 27% agree).
- ✓ **Comprehensibility of energy needs and costs disaggregated per energy service:** the majority (64%) find the information easy to understand; however, 36% are neutral or disagree.
  - Again: put the information next to the illustration, so one does not have to look up to what energy service a certain colour belongs. Place categories names or icons next to the pie charts.
  - In addition to kWh, also present information about consumed fuels in litres or kg (makes it more tangible)
  - Too much information in this illustration! Either include costs or kWh, not both.
  - Do not use abbreviations (DHW) which are not explained.
  - Idea: inform about energy used for showering separately as it consumes relatively much energy.
  - Feasibility: How can it be calculated? How can one distinguish between energy needed for cooling and energy needed for ventilation (if the energy source is the same: electricity)?
- ✓ **Comprehensibility of separate indicators for building components/ installations**: the majority (73%) finds the illustration easy to understand, while 9% disagree.
  - The evaluation of the solar heat gain factor is difficult as in some cases a high solar heat gain factor is desirable, while in other situations a lower solar heat gain factor is desirable (depending on the climate and building).
- ✓ **Preference figure A or B**: 82% prefer A, 18% prefer B.

  Figure B:
  - Why is the target not *zero*?
  - The colours are less indicative than in figure A.
  - Such an illustration would be more useful for design (too technical for an EPC oriented towards end-users).

  Figure A:
  - Adding 'indicative scale' (with 'worst' and 'best' limits) on top of the illustration improves the comprehensibility of the graph. Such a scale is missing in figure B.

  Both options:
  - Add an indicator for the performance of the 'building envelope'.
- ✓ **Comprehensibility of renewable energy ratio:** only 27% find the current and potential use of renewable energy easy to understand based on the illustration; 36% are neutral, while 36% disagree → Need for improvement.
  - What do the 17% refer to?
  - It is not clear how 'potential' is defined. Shouldn't it be 100%?
  - What does the circle represent? (The whole energy my building needs?)
  - Use bar charts instead of the pie chart for actual and potential renewable energy. With the bar charts one could visualize that a building produces more than it consumes (in case of positive energy).
  - What do the listed renewable energies refer to? Renewable energies from the grid or renewable energies generated on-site? The latter should be included! There are a couple of renewable energy technologies missing in the list.

4.1.7. Additional indicators

- ✓ **Interest in additional indicators:** most participants (28%) are interested in indoor air quality, followed by thermal comfort and water consumption (both selected by 24%).

Remark:

- How do we define indoor air quality? It encompasses a lot (e.g. emissions, humidity, etc.). However, it will be difficult to calculate emissions.

4.1.8. Recommendations

- ✓ **Comprehensibility of renovation roadmap**: the majority (70%) finds the presented renovation roadmap easy to understand, while 30% stay neutral.
- ✓ **Usefulness of renovation roadmap**: 38% find the renovation roadmap useful, 50% stay neutral and 13% disagree. → Mixed results.
- ✓ **Suggestions for improvement**:
  - The order of the measures should take the cost effectiveness of measures into account (cost effectiveness is country-specific as it depends on subsidies and investment costs). Indicate the most cost-effective measure.
  - The order of the measures is very important: (e.g. insulation of building needs to be improved before a heat pump is installed).
  - What are the justifications for this order? The most cost-effective first or the most effective one in terms of energy savings?
  - Roadmaps variations are needed, especially if there is no need in keeping renovations in this order: e.g. changing lamps could be first or last, no matter where this step occurs in the order.
  - There should be a note that the improvement of energy efficiency classes is the result of accumulative measures. Otherwise you could get the impression that by just changing the lights, you could obtain energy efficiency class A.
  - Some measures are easy to do yourself, while others need to be carried out by a specialist (e.g. changing lamps compared to improving insulation of walls).

4.1.9. Standard or actual conditions of use

- ✓ **Comprehensibility of difference between information based on standard and information based on actual conditions of use:** the majority (77%) finds the information easy to understand, 22% are neutral.
- ✓ **Perceived usefulness of information based on standard and information based on actual conditions of use:** 66% find the information useful, while 11% are neutral and 22% disagree. Hence, although participants find the information easy to understand, not all perceive it as useful.
- ✓ **Remarks:**

Positive:

- Information based on actual conditions are useful to plan renovations.
- Perceived as very important.
- Good to have both in parallel.

Negative:

- Information based on actual conditions of use next to information based on standard conditions of use is too much information.

Other remarks:

- Would it also be possible to include three different levels in the EPC (i.e. measured, calculated standard and calculated actual)? → Attention: 'measured' does not equal 'consumed'.

4.1.10. References to other sources of information

- ✓ **Perceived importance of the reference to other sources of information:** 30% perceive it as very important, 20% as fairly important while 40% perceive it as slightly important. Hence, the perceptions are mixed.
- ✓ **Interest in additional sources of information:** most participants (26%) would be interested in the digital building logbook, while 22% would be interested in HVAC inspection reports and available funding schemes, respectively.

Remarks:

- There are different meanings of the EU instruments among countries! Finnish names seem to be unclear.
- The results of possible energy audits should be included. And also recommendations given by professional energy management companies and online services.

4.1.11. Format of the EPC

- ✓ **Preference of format for EPC:** 56% of participants prefer a digital EPC, while 44% indicated to prefer to use both versions. The Finnish EPC is already perceived as digitized as the EPC are available as PDFs which can be printed.

4.1.12. Overall impression

- ✓ **Additional features an EPC would have to contain in order to be useful to participants:**
  - It would be good to show CO_2 emissions (perhaps also compared to average level of similar types of buildings in the same region)
  - EPC should be digital, connected to my building logbook, and updated once a year.
  - "The content is already sufficient" versus "It seems already pretty overloaded with information". → Do not add more.
  - Somehow show the added value (of the energy efficiency?) for the building/apartment, when selling it.
  - Information about available subsidies for energy efficiency improvements.
  - Quality and trust are important. Simple EPC that can be trusted is much more valuable than one with many different elements that are unreliable. "I would be interested to know the energy performance of the building I'm planning to buy compared to other buildings and without the effect of the current users. Also the measures on how the building could be improved would be interesting".

4.1.13. Willingness to pay for an improved EPC

- ✓ **Features of an EPC that would motivate to pay more for an EPC:** each 31% indicated that easy comprehensibility of how energy and costs can be saved and information about the total investments required for measures would be motivating to pay more for an EPC. 23% indicated that they would find easy comprehensibility of the energy performance as motivating.
- ✓ **Willingness to pay for an EPC that was easy to understand and useful to the participant: most participants** (43%) would pay more than 150€, 29% would pay between 75€ and 100€. Each 14% would not want to pay more than 50€ or between 50€ and 75 €. Hence, this group shows a comparatively high willingness to pay for an EPC that was useful and easy to understand.

4.2. Austria

In total, 26 participants took part in the Austrian edition of the acceptance workshop. The following sections present the summarised results of the Austrian workshop, arranged according to the testing strategy as found in Annex A.

4.2.1. Socio-demographics

Table 2: Socio-demographics from participants from Austria

Socio-demographic variables	Results Austrian Workshop
Role in relation to the EPC	19 out of 26 participants considered themselves as **end-users of EPC**, while 9 indicated to be energy consultants and four indicated to be policy makers.
Gender	65% male, 35% female
Age	30% are between **35 and 44 years old**; 35% are between 45 and 54 years old.
Highest educational qualification	70% have a **Master's or equivalent level**; 13% have a doctoral or equivalent degree. 12% have a degree lower than the bachelor's degree.
Relation to building	83% **own** the home they are living in; 17% are renters, 9% live in a semi-detached house, 4& in a terraced house.
Type of building	57% live in a detached house, and 30% in a flat.

4.2.2. Energy label

- ✓ **Comprehensibility:** The majority (74%) finds the energy label A easy to understand (26% strongly agrees; 48% agrees). However, 22% do not find the energy label easy to understand.
- ✓ **Preference (Label A or B):** Label A (75%); label B (25%).
  - "Regarding label A I find it more intuitive that the better values are higher up". Also, it is clearer because the three dimensions are divided into three columns.
  - Label A is better, although not optimal. "The colours which we can see well in option B are missing here".
  - Label B could be more intuitive if A and F were mirrored.
  - Labels similar to label A are better known (which does not necessarily mean that they are better).

4.2.3. Main performance indicators

- ✓ **Familiarity**: all presented indicators, total primary energy use, GHG emissions, heating energy demand are known and comprehensible to the majority of participants (65% know and comprehend primary energy consumption, while 74% know and comprehend GHG emissions and 87% know and comprehend heating energy demand).

- CO_2 indicator is considered problematic since it is not clear whether the CO_2 value of the building materials is added to the value of 18 kg CO_2 shown on the cover sheet or not. In the Austrian EPC, the OI3 index combines the CO_2 indicator with acidification and a value for resource consumption.

✓ **Main interest:** 1st annual energy costs [€/m² year], 2nd heating demand [€/m² year], 3rd total primary energy use.

✓ **Unit of primary energy use:** the majority (54%) finds the information about the primary energy use and the heating demand most tangible in [kWh/m² year]. 42% indicated that they found the unit [kWh/year] most tangible. Nobody is interested in receiving information about [kWh/person year].

4.2.4. Context of EPB

✓ **Perceived importance of benchmarking with other similar buildings:** the majority (67%) perceives that this information is very important (21%) or fairly important (46%). Only 8% consider this information to be slightly important.

✓ **Perceived importance of climate target:** less participants perceive this information as important (only 46%). 21% think this information is slightly important or not important at all.

- This information is less important to participants because he tries to reduce the energy demand and emissions as much as possible. Because of this, it is more interesting to see "what is possible", i.e. comparison to other buildings, than knowing what the climate target is.
- The overall objective may not be assessable. Also, this information might be of no use to many people.
- It would be interesting to know the minimum energy requirements for new buildings. "Then I could compare how far my building is from the standard or, for example, how much better my new building performs. Does it just meet the minimum requirements or is it 20% better?"

✓ **Understanding of illustration regarding benchmarking with other similar buildings:** 71% agree that the illustration makes the energy performance in relation to the evaluation of buildings easy to understand (17% strongly agree; 54% agree). However, 21% disagree.

✓ **Comprehensibility of illustration regarding climate target:** the majority (62%) agrees that the illustration makes the energy performance of the building in relation to the national climate target easy to understand (while 21% are neutral and16% disagree).

✓ **Suggestions for improvement**

- Equal distribution of values would be easier to understand for end-users.
- "The presentation is also somewhat confusing because it goes in exactly the wrong direction." The climate target which is indicated for 2050 is quite far ahead and therefore should be on the right hand side of the illustration.
- The description of the y-axis (number of buildings) is somewhat unintelligible. Perhaps use % instead of actual numbers.

4.2.5. Overview of energy flows (primary energy, final energy etc.).

✓ **Comprehensibility:** the majority (61%) find the illustration easy to understand (13% strongly agree; 48% agree), however 35% do not find the illustration easy to understand. → Need for improvement.

- Include the terms in the illustration, then the reader does not have to move the eye back and forth which is a cognitive performance.
- This illustration is very detailed and precise, probably technical. Perhaps it could be simplified for end-users and thus become clearer.
- Where should this be included in the EPC? "It could be extremely difficult to understand for an end-user". There is too much information.
- One could make more use of icons, such that one can understand without having to read all the text. For instance, use icons for industry and infrastructure. Also, use more colours (why are some arrows orange?).

4.2.6. Partial performance indicators

- ✓ **Usefulness of information "thermal energy demand":** the vast majority (88%) finds this information useful (29% strongly agree, 58% agree, only 8% disagree).

  Remarks:

  - Cooling demand was new to participants (it is not yet included in the Austrian workshop). Thus, it was not clear what was meant by 'cooling demand". Currently, cooling demand is relevant for office buildings in Austria.
  - For the calculation of the cooling demand – is it also considered if cooling energy comes from a renewable source (heat pump)?
  - Cooling demand is considered as important also for residential buildings by most participants.
  - Concern: the information about cooling demand could set social norms in the sense that air conditioners which need additional energy, become widely accepted. However, the European dimension is missing in this discussion: if there should be a common EPC among member states, then we also have to think of the southern Mediterranean. We cannot prescribe that they should not use air-conditioning systems, because we can still realise the cooling requirements through other measures such as planting and shading.

- ✓ **Comprehensibility of energy needs and costs disaggregated per energy service: almost half of the participants** (48%) find the information easy to understand; however, 35% and 17% disagree → Need for improvement.

  - Again: put the information next to the illustration. Regarding the pie charts: "of course one finds the colours on the left, however then one has to check what is written next to it. Instead one could colour the headings (…) the contrast should be great enough between the light green and the grey background".
  - Alternative: the icons could be placed next to the pie charts, so that one does not always have to look back and forth.
  - Suggestion: "you could show bars in the rows themselves where the numerical values are, so that you have the comparison there at a glance, so that you are already in the diagram."
  - Caution in the choice of terms! This is about the energy demand. It will not be possible to show the consumption in this level of detail, because it would have to be measured.
  - Comprehension question: Does the final energy consumption (broken down into fuels and electricity) add up from the values listed further below for heating, cooling, etc. or is this completely independent of this, an additional listing?
  - It is very confusing that there is a table and no reference to the first part of the table in the pie charts. That does not add up. "I only see 'fuels' and 'power' and then I see a lot of parts in the pie chart."
  - The information in [kWh/year] is a bit redundant and can be easily calculated yourself. At the moment it overloads the illustration very much. Only the first two columns should remain.
  - Regarding the validity of annual energy costs: the time of exhibition should be mentioned since prices are volatile. One could indicate how expensive one kWh is.
  - Prices for energy might be different among member states. That means, a 'euro-statement' is absolutely invalid, it is not comprehensible and not comparable among countries. It would make more sense to introduce a system of categories (similar to the evaluation of restaurants), then a pictogram could be used, indicating low or high energy costs (e.g. €; €€; €€€, etc.).
  - It only makes sense to indicate the information in such a detail if they are also available (calculated or measured). However, this might not be the case regarding 'lighting' and 'equipment". It would be clearer and more concise if only information about heating, DHW and cooling were provided.
  - Why are 'lighting and 'equipment' listed as individual points anyway?

- Expectation that smart metres and smart homes will play a bigger role in the future, information about energy use for these services could be added as it is expected that they consume a lot of energy.
- The median or arithmetic mean could be added.
- The focus of the EPC should be on cost-optimised improvements (instead of informing about weak spots?).

✓ **Comprehensibility of separate indicators for building components/ installations**: the majority (78%) find the illustration easy to understand (4% strongly agree, 74% agree), while 22% are neutral.

✓ **Preference figure A or B**: 48% prefer A, 52% prefer B.

Figure A:

- The targets are missing, which are included in figure B.
- Proposal for improvement: one could combine figure A and B (adding targets in figure A).
- There is an indicative scale, but I do not receive information about what the indication is (the evaluation scheme is not transparent). →That could arouse suspicion.

Both options:

- What about the issue of colour blindness? This concerns all proposals.
- Both illustrations look OK. But figure B appears to be more intuitive (in the sense of a progress bar). Again I am most interested in measures to improve energy efficiency. "If this could also be represented in the combination, or derived, that would be great". → Idea: linking the recommendations with the respective evaluation of each building component, similar to the Belgian EPC.
- The u-value is too abstract, the layperson does not understand this. Instead, just provide an indicative scale.

✓ **Comprehensibility of renewable energy ratio:** 61% find the current and potential use of renewable energy easy to understand based on the illustration; 13% are neutral, while 26% disagree → Need for improvement.

- Wind energy: it is rather unusual that wind energy is generated on small scale by private people in Austria.
- Hydropower, geothermal energy and biomass are missing in the list. Biomass is most common in Austria.
- The potential 17% appears to be quite small. This could be demotivating for the end-user.
- It is not comprehensible how thaw potential (17%) is calculated. The potential is almost arbitrary, also considering energy communities. → Explanation of estimation of potential is needed!
- Incomprehensible what the 80% refer to.
- Here again, there is the possibility of citing the specific measure or the specific recommendation. The layperson only wants to know: "what do I have to do now?" "How big does my PV system have to be, how can I install it?"

4.2.7. Recommendations

✓ **Comprehensibility of renovation roadmap**: the majority (78%) finds the presented renovation roadmap easy to understand, while 14% stay neutral and 9% disagree.

✓ **Usefulness of renovation roadmap**: 89% find the renovation roadmap useful (33% strongly agree; 56% agree), 11% stay neutral.

✓ **Suggestions for improvement**:

Visualization:

- Colours of assessment and symbols should generally be different from the spectrum.

Content:

- Take into account the use of renewable raw materials.
- Regarding the order of steps: there will also be measures that can be implemented in parallel; prioritise the measures based on the energy saved; distinguish between steps of actual content dependencies and steps that can be carried out any time.

Information about costs:

- It is best not to show any costs.
- Point out funding opportunities, if you indicate costs.
- Indicate costs and kWh, kWh would also be more comparable than costs. KWh seem to be of greater interest than costs.
- Cost representation could now persuade many to do nothing
- Are the ranges (of costs?) region-specific?
- It would also be interesting to know the payback period of the individual measures (payback period instead of cost savings?)
- Provide a better breakdown of the indicative costs.

4.2.8. Standard or actual conditions of use

- ✓ **Comprehensibility of difference between information based on standard and information based on actual conditions of use:** the majority (77%) finds the information easy to understand (9% strongly agree, 68% agree), 18% are neutral.
- ✓ **Perceived usefulness of information based on standard and information based on actual conditions of use:** 53% find the information useful, while 19% are neutral and 19% disagree. Hence, although participants find the information easy to understand, not all perceive it as useful.
- ✓ **Remarks:**

Positive:

- Participant perceives this information as reasonable in order to know the actual consumption compared to the assumed standard consumption. Since often, the standard temperature (22 degrees) is massively exceeded and if one could become aware of how much more energy is needed for this, this would be much appreciated.
- It could be reasonable and close to reality to also survey the actual situation.

Negative:

- Another participant considers the information about the alleged actual conditions of use to be dispensable for the EPC, since the EPC is meant to compare the energy efficiency of buildings (when buying or selling a building). For this purpose the standard specifications (22 degrees) are used. “The EPC is already so complicated. It should actually be simplified and not made even more complicated”.
- Another participant agrees that it is rather confusing when the actual conditions are added and that could even have the effect of deceiving the buyer or the customer. (→ However, the purpose is to only provide information based on actual conditions of use *in addition)*.

Remarks:

- Which values are used to calculate the actual use?

4.2.9. Format of the EPC

Here the question was changed compared to the other workshops as it was known that this question is obsolete, similar to the Finnish workshop, because the EPCs are nowadays only provided as PDF files that can be printed out. That is why, the reply options for the question ‘which format of the EPC would you prefer to use?’ were the following: a) pdf file for downloading b) EPC app c) combination of PDF file and EPC app d) I don’t know.

In Austria, the EPC is already digitized (PDF available for downloading and printing).

- ✓ **Preference of format for EPC:** 64% of participants prefer a combination of a PDF and an EPC app. 27% would like to maintain the option to receive a PDF for downloading, while 9% indicated to prefer an EPC app only.

  Remarks:

  - A PDF is not interactive and no digital application which can be much more diverse. For example, banks would like to be able to see the EPC (access could be granted more easily if it were available online/digitally). “But for me it would also be totally exciting if I could go in there now and click my way through....and that would then lead me, for example, to the measures, I think you could dock a lot of information there if it was interactive and not just in PDF”.
  - "An energy certificate must definitely be digital in the future"; “A digital form of the EPC is indispensable”.

4.2.10. Willingness to pay for an improved EPC

- ✓ **Features of an EPC that would motivate to pay more for an EPC:** 39% (12 participants) think that information about energy and costs savings, which are easy to understand, would increase willingness to pay more for an EPC, 29% (9 participants) think that information about the investments, that would be necessary to increase the energy efficiency and comfort, would increase willingness to pay more for an EPC. However, also 16% (5 participants) indicated that none of the listed or other improvements would be motivating to pay more for an EPC.
- ✓ **Willingness to pay for an EPC that was easy to understand and useful to the participant:** the majority (56%) would pay more than 150€, 22% do not know and 17% would pay between 75 and 100€. However, 6% would not want to pay more than 50€.

4.3. Belgium (Flanders)

In total, 21 participants took part in the Belgian (Flemish) edition of the acceptance workshop. The following sections present the summarised results of the Belgian workshop, arranged according to the testing strategy as found in Annex A.

4.3.1. Socio-demographics

Table 3: Socio-demographics of participants from Belgium (Flanders)

Socio-demographic variables	Results Belgium (Flemish) Workshop
Role in relation to the EPC	17 out of 21 participants considered themselves as end-users of EPC, while 11 indicated to an expert in the field (energy advisor or EPC issuer) 2 persons consider themselves as multiplier of EPC (landlord or real estate agent etc.).
Gender	68% male, 32% female
Age	58% are between 25 and 34 years old; 32% are between 35 and 44 years old, 11% are between 45 and 54 years old.
Highest educational qualification	47% have a Master's or equivalent level; 53% have a doctoral or equivalent degree.
Relation to building	95% own the home they are living in; 5% are renter.
Type of building	47% live in a detached house, and 37% in a semi-detached house and 11% in a flat.

15 out of 21 participants had a technical background within the topic of energy in buildings, which resulted in technical (detailed) feedback. This might be a bias in the gathered answers.

4.3.2. Energy label

- ✓ **Comprehensibility:** The majority (55%) finds the energy label A easy to understand (21% strongly agrees; 45% agrees). However, 35% do not find the energy label easy to understand (30% disagree and 5% strongly disagree).
- ✓ **Preference (Label A or B):** label B (95%), label A (5%)

  Remarks:
  - Option A is clear but when the two labels (total primary energy and GHG emissions) are closer together there might be an overlap.

4.3.3. Main performance indicators

- ✓ **Familiarity**: all presented indicators, total primary energy use, GHG emissions, annual energy costs and renewable energy ratio are known and comprehensible to the majority of participants (78% know and comprehend primary energy

consumption, GHG emissions, and annual energy costs while 67% know and comprehend the renewable energy ratio).

- ✓ **Main interest:** 1st total primary energy use [kWh/m² year], 2nd annual energy costs [€/m² year], 3rd GHG emissions.
- ✓ **Unit of total primary energy use:** the majority (48%) finds the information about the primary energy use most tangible in [kWh/year]. 29% indicated that they found the unit [kWh/m² year] most tangible. 10% find the unit [kWh/month] and 5% find the units kWh/ (person year) most tangible.

4.3.4. Context of EPB

- ✓ **Perceived importance of benchmarking with other similar buildings:** the majority (57%) perceives that this information is very important (33%) or fairly important (24%). However, 29% think that this information is only slightly important or not important sat all.
- ✓ **Perceived importance of climate target:** 62% perceive this information as important (38% perceive it as very important; 34% as fairly important). Only 10% think that this information is slightly important. In total this information is perceived as more important than the benchmarking with other buildings.
- ✓ **Understanding of illustration regarding benchmarking with other similar buildings:** 81% agree that the illustration makes the energy performance in relation to the evaluation of buildings easy to understand (29% strongly agree; 52% agree).
- ✓ **Comprehensibility of illustration regarding climate target:** the majority (81%) agrees that the illustration makes the energy performance of the building in relation to the national climate target easy to understand.
- ✓ **Suggestions for improvement**
  - Add a value for the median.

4.3.5. Overview of energy flows (primary energy, final energy etc.).

- ✓ **Comprehensibility:** only 14% find the illustration easy to understand, while 33% are neutral, 33% disagree and 14% strongly disagree. → Need for improvement.
  - The double arrows on top and bottom (number 4-7) are confusing.
  - It is incorrect for some energy flows (e.g. gas has no (or insignificant) losses during transport.).

4.3.6. Partial performance indicators

- ✓ **Usefulness of information "thermal energy demand":** the majority (76%) finds this information useful, 10% are neutral and 14% disagree.

  Remarks:

  - This information would be only useful if the building had a cooling system.
- ✓ **Comprehensibility of energy needs and costs disaggregated per energy service:** the answers are very mixed: 43% find the illustration easy to understand (10% strongly agree, 33% agree), while 34% disagree and 5% strongly disagree. → Need for improvement.

  Visualization:

  - Link symbols to pie chart (e.g. put symbols next to it)

  Presentation of information:

  - Some appliances can be joined together, now there are too many categories.
  - Provide the option to choose for yourself what you want to see (→ interactive EPC app)
  - Abbreviations cannot be used (c.f. DHW).
  - Round the numbers, limit the number of numbers after the comma.

Content:

- The pie charts are confusing, show max.1 pie chart.
- There is too much information, this cannot be accurate.
- Show either total energy use per year or per m^2, both are not necessary.
- What do you want to show with this graph? Choose one purpose (→ costs or energy)

Calculation methodology:

- Regarding implementation feasibility: How do you handle energy price changes over the years?

✓ **Comprehensibility of separate indicators for building components/ installations**: the majority (81%) find the illustration easy to understand (24% strongly agree, 57% agree), while 14% disagree.

✓ **Preference options**: 71% prefer B, 29% prefer A. This indicates that the majority of participants is satisfied with the current presentation of partial indicators in the Belgian (Flemish) EPC, where option B was adopted from.

Figure A:

- Symbols can be improved to be clearer.
- Average U-values are not very useful, as different envelope components can have a different performance in a building (for instance two types of walls in a building: one to be renovated and the other one not).
- Terminology unclear for the average citizen – just say "wall" "roof" etc. instead of "U_wall" "U_roof" …
- Solar gain factor strongly varies throughout the year. How is this average value determined?
- Figure A is nice but the targets should be added to the graph, the text should be improved and put information about the roof on top of the illustration because that is more intuitive; floor target 0.51 might be incorrect.

✓ **Comprehensibility of renewable energy ratio**: 57% do not find the current and potential use of renewable energy easy to understand based on the illustration; 29% are neutral, while only 15% find it easy to understand → Need for improvement.

- Potential (typo-mistake).
- This feeds the misconception that you should produce your own renewable energy in your own house, while there are also other possibilities (like a collective renewable energy source, renewable energy provider…)
- Raises the question why your potential is not higher.
- Definition of "potential" is not clear, does it only incorporate surface area of the roof for renewable energy? Or also space on the site elsewhere? How is the potential determined?
- Missing category: geothermal energy.

4.3.7. Additional indicators

✓ **Selection of additional indicators**: 32% think indoor air quality should be included, while 20% think thermal comfort should be included. 16% respectively think that information about water consumption and day lighting should be provided.

Remarks:

- Adding thermal comfort requires a change in calculation method, as often a constant indoor temperature is assumed.
- Water consumption is more influenced by the user behavior than by the building performance.

4.3.8. Recommendations

✓ **Comprehensibility of renovation roadmap**: the majority (85%) finds the presented renovation roadmap easy to understand (25% strongly agree, 60% agree), while 15% stay neutral.

- ✓ **Usefulness of renovation roadmap**: 89% find the renovation roadmap useful (33% strongly agree; 56% agree), 11% stay neutral.
- ✓ **Suggestions for improvement**:
  - Easy to understand, not easy to calculate/define.

  Visualization:

  - It might be possible that the different renovation measures (visualized as circles at the bottom) fall on top of each other, which will make the illustration confusing.
  - A drawing of a house is not useful for those who live in a flat.

  Presentation of information:

  - "I think the figure is fine (…) the proposals could be formulated differently (e.g. insulate at least 12 cm, replace the boiler with a more energy efficient installation (preferably heat pump) etc.
  - The step-by-step plan is not needed to maintain the order. This should be better illustrated figuratively (e.g. use of arrows, flow chart perhaps?).
  - Possibility to "click through the steps" for more explanation.

  Content:

  - Costs raise questions on accuracy. Despite the inaccuracy, it is good to give an indication of the cost, as it can help to determine whether one wants to buy a dwelling (they can consider the additional cost to renovate the building).
  - Renovation measures also have an impact on the market value of the dwelling, but this is hard to quantify.
  - Add a link to the current gas bill.
  - Facilitate community offers for households in the area with similar renovation needs.
  - An additional parameter could be the increase in market value or increased rentals (consequences/benefits).
  - Indicate how important the order is. Costs (date).
  - Add health outcomes.
  - Provide direct links to subsidies that apply to my house.
  - Provide connection to a local craftsman.

  Order of steps

  - Include all options of renovation measures, now it is too limited.
  - There are different ways possible to reach label A.
  - Avoid lock-ins: Adding solar panels to the roof as a first measure can result in more energy profit, but if the roof needs to be renovated later on, you have a problem. Attention to lock-in (warnings when users skip a step).
  - Why not start with LEDs first? (quick payback)
  - Add an explanation why each step is done in this order, but this can't be done on the illustration anymore, it would be too much.
  - Ordering is best, depending on what brings the most profit (since there is no lock-in).
  - I would like to know which category I fall into if I pursue a different order.

4.3.9. Standard or actual conditions of use

- ✓ **Comprehensibility of difference between information based on standard and information based on actual conditions of use:** the majority (80%) finds the information easy to understand (40% strongly agree, 40% agree), while 10% disagree.

- ✓ **Perceived usefulness of information based on standard and information based on actual conditions of use:** the majority 88% find the information useful, while 10% disagree. Hence, more participants find the information useful than easy to understand. This shows a need to improve the comprehensibility of the information.
- ✓ **Remarks:**
  - This strongly depends on the goal of the EPC. In Flanders, the EPC is now mainly imposed when a building is sold or rented, so the user changes afterwards. Then an EPC including user behavior is not very useful.
  - Actual conditions can only be shown in addition to the standard conditions, but not as a replacement to the EPC with standard conditions.
  - Info on actual conditions should be added in an appendix or in an online elaborated version of the EPC. Then the main goal of the EPC (comparing buildings with the same user conditions) will not be lost, and the additional info is still available for those who are interested. (Is in line with the view of the ePANACEA WGB).
  - Smartness and control of the techniques also have a large impact on how the building is used (→ true, with increasing smartness these techniques should be taken into account. Smart homes can make the operation of the building more predictable, therefore this should not be a counterargument).
  - An idea might be to create an interactive EPC where the building owner can change the user conditions (yes, as it was also the idea in ePANACEA.)

  Negative
  - It can be an additional complexity to define whether a building meets the target of energy performance or not. What happens when according to the theoretical value (standard conditions) the building performance is not good enough, while according to the actual value (actual conditions) the building performs good enough? (→ Then energy performance according to theoretical values should be taken into account).
  - Adding both conditions can make it very unclear for the end-user. Too much additional info increases the risk of people not understanding the information.

  Positive
  - Perceived as useful to reduce the energy performance gap.
  - Perceived as useful to improve the dimensioning of the techniques; often the techniques are over dimensioned based on unrealistic user behavior.

- ✓ **Usefulness of energy saving tips:** this information appears to be useful to the majority (48%, whereof 16% strongly agree and 32% agree), however, 32% are neutral and 11% disagree.
  - **Remark:** do not add this information as it is not building related.

4.3.10. References to other sources of information

- ✓ **Perceived importance of references to other sources of information in the EPC:** the majority (53%) perceives this information as important (16% find it very important, 37% find it fairly important); however, 21% find it only slightly important and 11% do not find it important at all.
- ✓ **Selection of additional sources of information:** most participants (34%) selected a detailed building renovation map, while 23% selected available funding schemes and 19% the digital building logbook.

4.3.11. Format of the EPC

- ✓ **Preference of format for EPC:** 58% of participants prefer a digital EPC, 37% would like to use both versions, while nobody indicated to prefer to use the analogue EPC.

Remarks:

- Digital allows dynamic EPC, fit for the user.
- Paper version of the EPC can be lost.
- Paper version is needed, as there is still a large number of people who do not have digital skills.
- Idea: Paper version with basic info, elaborated digital version (in line with the idea of the ePANACEA team).
- Differentiate between must haves and nice to haves.

4.3.12. Overall impression of EPC

- ✓ **Willingness to use the EPC when renting/buying a dwelling/building:** the majority (88%) would take the EPC into account (47% strongly agree, 41% agree), while only 12% are neutral.
- ✓ **Additional features an EPC would have to contain in order to be useful to participants:**

Presentation of information

- The difference between the current energy level and the target, expressed in costs and difference in annual energy costs.
- Do not include too much information in one illustration or on one page.
- Be brief, but refer to additional information. Include less information, such that one becomes aware of the essential points.
- Distinguish between the time of sale and the time of use.

Calculation methodology

- It is a mystery to me how PV is added to the building envelope properties. I would like to see a separate evaluation for EPC between building properties and other energy services.
- Total annual electricity and gas consumption in terms of actual final consumption, not primary consumption.
- An estimate of the energy bill for standard use (or possibly even based on expected actual use).

4.3.13. Willingness to pay for an improved EPC

- ✓ **Features of an EPC that would motivate to pay more for an EPC:** 42% would find information about the total investments required for measures as motivating to pay more for an EPC.30% indicated that they would find easy comprehensibility of how to save energy and costs as motivating, while 15% chose 'easy comprehensibility of energy performance'.
- ✓ **Willingness to pay for an EPC that was easy to understand and useful to the participant:** the distribution of answers is heterogeneous: on the one hand, 30% would pay more than 150€, on the other hand 20% would not pay more than 50€. 15% each would pay between 50 and 75€ and between 100 and 150€.

4.4. Spain

In total, 27 participants took part in the Spanish edition of the acceptance workshop. The following sections present the summarised results of the Spanish workshop, arranged according to the testing strategy as found in Annex A.

4.4.1. Socio-demographics

Table 4: Socio-demographics of participants from Spain

Socio-demographic variables	Results Spanish Workshop
Role in relation to the EPC	20 out of 28 participants (59%) considered themselves as end-users of EPC, while 11 indicated to be an expert in the field (energy advisor or EPC issuer) 2 persons considered themselves as craftsmen.
Gender	52% male, 45% female
Age	46% are between 45 and 54 years old; 29% between 35 and 44 years, 14% between 45 and 64 years old.
Highest educational qualification	The majority (36%) has a Master's degree or equivalent.
Relation to building	86% own the home they are living in; 10% are tenants.
Type of building	79% live in an apartment. 10% in a detached house.

4.4.2. Energy label

- ✓ **Comprehensibility:** The majority (75%) finds the energy label A easy to understand (46% strongly agrees; 29% agree). 17% are neutral, only 4% disagree.
- ✓ **Preference (Label A or B):** label A (55%), label B (45%) → relatively balanced compared to other countries.

  Label A:
  - The pyramid is intuitive because it gives you the efficiency status. In the same image it gives you more information.
  - The pyramid is visually more comfortable, clearer, what is at the top is better (more efficient) and what is at the bottom is worse. „It reminds me of a podium, the best and most efficient at the top, it is like a league table in sports, from first to last place that reinforces it from smallest to largest".
  - Option A is more comfortable because you are more familiar with these images (in household appliances...)
  - I like A better because the negative portions are bigger and the best ones are at the top. What could be improved is the right hand side of the graph itself, which could be clearer.
  - I like the A better but I would put the pyramid filled with the colours of the B.

  Label B:

- In image B the best value should be on the left and not on the right (the order in which we read).
- I like the colour range better, just for aesthetics.
- I prefer B because of the colours and because it is more intuitive and clearer. The green/red theme is well understood, it looks like the food labels. Therefore, it is more familiar to those who are not involved in the energy efficiency sector.
- The fact that the primary energy value appears at the top and CO_2 emissions at the bottom seems better because it helps to differentiate the values more.

4.4.3. Main performance indicators

- ✓ **Familiarity**: all presented indicators, total primary energy use, GHG emissions, annual energy costs and renewable energy ratio are known and comprehensible to the majority of participants (52% know and comprehend primary energy consumption, 72% know and comprehend GHG emissions, 64% know and comprehend annual energy costs while 58% know and comprehend the renewable energy ratio).
- ✓ **Main interest:** 1st annual energy costs [€/m² year], 2nd GHG emissions [€/m² year], 3rd total primary energy use.
- ✓ **Unit of total primary energy use:** the majority (69%) finds the information about the primary energy use most tangible in [kWh/m² year]. 15% indicated that they found the unit [kWh/ year] most tangible.

4.4.4. Context of EPB

- ✓ **Perceived importance of benchmarking with other similar buildings:** the majority (84%) perceives that this information is important (24% think it is very important, 60% think it is fairly important). Only 12% think that it is only a a little important or not important at all.
- ✓ **Perceived importance of climate target:** 71% perceive this information as important (29% perceive it as very important; 42% as fairly important). Only 12% think that it is only a little important or not important at all.
- ✓ **Understanding of illustration regarding benchmarking with other similar buildings:** 76% agree that the illustration makes the energy performance in relation to the evaluation of buildings easy to understand (40% strongly agree; 36% agree), while 20% are neutral.
- ✓ **Comprehensibility of illustration regarding climate target:** the majority (71%) agrees that the illustration makes the energy performance of the building in relation to the national climate target easy to understand (29% strongly agree, 42% agree), while 29% are neutral.
- ✓ **Suggestions for improvement**
  - There is a typo in the units of the climate target (in the English version it is correct).
  - The graph is stretched too far to the right with values that are not relevant.
  - As a concept it is very good.
  - Looking at the comparison of my building with the rest of the buildings, the “median” line is superfluous, it does not provide any information. The median line could be less marked, perhaps in grey, dashed...

4.4.5. Overview of energy flows (primary energy, final energy etc.).

- ✓ **Comprehensibility:** the answers are wide-ranging: 44% find the illustration easy to understand (24% strongly agree, 20% agree), while 28% are neutral and 20% disagree. → Need for improvement.
  - To make this image more understandable for the end-user, the words "primary energy" should be clearly included on the left side and "final energy" on the right side.

4.4.6. Partial performance indicators

- ✓ **Usefulness of information "thermal energy demand":** the majority (64%) find this information useful (40% strongly agree, 24% agree), while 32% are neutral.
    - In this illustration column headings, indicating what the first and second data items correspond to, are missing.
- ✓ **Comprehensibility of energy needs and costs disaggregated per energy service:** 88% find the figure easy to understand (36% strongly agree, 52% agree), while 12% are neutral.

  Presentation of information:
    - The pie chart is fine but a Pareto chart with the % ordered from highest to lowest would be better.
    - Using a bar chart would be more intuitive.
    - Pie charts are more appropriate than bar charts. (Hence, opposite opinions).
    - The graphs should be placed on the left so that there is more connection with the colour of the icons. (Same perception as in other workshops: hard to relate information to pie charts, different suggestions for improvement).
    - Perhaps some of the variables could be unified in order not to be so many.

  Visualization:
    - The colours of each icon (service) should be more distinguishable, clearer.

  Content:
    - The m^2 of the dwelling being discussed should be specified and the energy source with which each service is being covered should be clarified.
    - The data should (not?) appear in kWh/m^2 year *and* in kWh/year, as in the end it provides little information and is repetitive (see other workshops). In the case of keeping all the information, group the energy and € columns together.
- ✓ **Comprehensibility of separate indicators for building components/ installations**: the majority (96%) find the figure easy to understand (64% strongly agree, 32% agree), while 4% are neutral.
- ✓ **Preference options**: 72% prefer A, 28% prefer B.

  Figure A:
    - I would choose A with the information in B. The target data should be incorporated in figure A.
    - Visualisation B gives more information for a technician, but for a non-technical user, A is more suitable.

  Figure B:
    - "I like B because of the targets."
    - In figure B it seems that the target is to make U as large as possible (hence it is misleading)
    - In figure A, it seems difficult to determine where the target is placed, i.e. would the target numerical value always be the same or will it vary depending on the type of building? (→ This statement mirrors that the scale is not clear, i.e. it is not clear what numerical values are the basis.
    - If it is aimed at the consumer the main thing is the visualization. The less text the better, so choose good icons.
- ✓ **Comprehensibility of renewable energy ratio**: the majority (68%) find the current and potential use of renewable energy easy to understand based on the figure (36% strongly agree, 32% agree); 24% are neutral.→ This does not necessarily indicate a need for improvement compared to the results of other workshops.
    - Without an explanation of the figure, it is not clear what information is intended to show.

- What does the 17 % of renewable energy potential of the dwelling/building refer to? Is the 100% the total energy consumption of the building/dwelling? A small explanatory text should be added to the section.
- A power BI "metre" chart could be used.
- For the sake of simplicity, energies that are not potentially applicable could be removed. And geothermal energy should be added to the list of renewable energies.

4.4.7. Additional indicators

- ✓ **Selection of additional indicators**: 26% think that thermal comfort should be included, while 24% think day lighting should be included. 19% respectively think that information about water consumption and indoor air quality should be provided.

4.4.8. Recommendations

- ✓ **Comprehensibility of renovation roadmap**: all participants find the presented renovation roadmap easy to understand (44% strongly agree, 56% agree).
- ✓ **Usefulness of renovation roadmap**: Similarly, almost all participants (96%) find the renovation roadmap useful (58% strongly agree; 38% agree). According to this there is no need for improvement, however:
- ✓ **Suggestions for improvement**:

Order of measures:

- It is somewhat misleading that a specific order of actions is proposed.
- Do not indicate an order or indicate why it is put.
- The order should be prioritised according to cost/benefit.
- Allow the end-user to choose the order of measures.
- By choosing only one action, it is not possible to know the score obtained.
- I strongly disagree with the fact that the map shows the order in which action should be taken. This should be defined by a technician on a case-by-case basis.

Content:

- In the reform, it would be useful to know the consumption that would be made after the reform to know if it pays off or not (→ indicate saved kWh)
- Pointing out the impact of each improvement separately.
- I see this as quite comprehensive, but include the energy footprint that is involved in retrofitting.
- Missing is the identification of the indicator (→total primary energy use)

4.4.9. Standard or actual conditions of use

- ✓ **Comprehensibility of difference between information based on standard and information based on actual conditions of use:** the majority (78%) find the information easy to understand (39% strongly agree, 39% agree), while 22% are neutral.
- ✓ **Perceived usefulness of information based on standard and information based on actual conditions of use:** However, 60% perceive this information as useful (35% strongly agree and 35% agree). 26% are neutral.
- ✓ **Remarks:**
  - It can be very useful for a person who wants to improve his/her housing or consumption habits, but if it is for selling or renting, it does not make sense (only if you would enter your consumption patterns and socio-demographics in a user profile; could that be practicable? Perhaps with an EPC app).
- ✓ **Usefulness of energy saving tips:** this information appears to be useful to the vast majority (96%, whereof 50% strongly agree and 46% agree).

4.4.10. References to other sources of information

- ✓ **Perceived importance of references to other sources of information in the EPC:** the majority (91%) perceives this information as important (9% find it less important).
- ✓ **Selection of additional sources of information:** most participants (44%) selected a detailed building renovation map, while 25% selected available funding schemes and 15% HVAC inspection reports.

4.4.11. Format of the EPC

- ✓ **Preference of format for EPC:** 50% of participants prefer a digital EPC, 46% would like to use both versions, while nobody indicated to prefer to use the analogue EPC.

4.4.12. Overall impression of EPC

- ✓ **Willingness to use the EPC when renting/buying a dwelling/building:** the majority (84%) would take the EPC into account (42% strongly agree, 42% agree), while only 8% are neutral.
- ✓ **Additional features an EPC would have to contain in order to be useful to participants:**

  Content

  - Provide information about the insulation of the dwelling from the outside
  - Comparison with local environmental certificates; comparison with certificates in my local geographical area.
  - Strategies for improvement, guidelines, examples.
  - Quality of space.
  - Embedded energy/life cycle.
  - Information about materials and their recyclability.
  - Actual tightness of the dwelling.

4.4.13. Willingness to pay for an improved EPC

- ✓ **Features of an EPC that would motivate to pay more for an EPC:** 33% would find information about the total investments required for measures as motivating to pay more for an EPC. 30% indicated that they would find easy comprehensibility of how to save energy and costs as motivating, while 23% chose 'easy comprehensibility of energy performance'.
- ✓ **Willingness to pay for an EPC that was easy to understand and useful to the participant:** the distribution of answers is heterogeneous: the majority (33%) indicated to be willing to pay between 75 and 100€, 21% each indicated to be willing to pay not more than 50€ or that they do not know. 13% are willing to pay more than 150€.

4.5. Greece

In total, 18 participants took part in the Greek edition of the acceptance workshop. The following sections present the summarised results of the Greek workshop, arranged according to the testing strategy as found in Annex A.

4.5.1. Socio-demographics

Table 5: Socio-demographics of participants from Greece

Socio-demographic variables	Results Belgian Workshop
Role in relation to the EPC	7 out of 18 participants (58%) considered themselves as end-users of EPC, while 25% indicated to be an expert in the field (energy advisor).
Gender	55% male, 45% female
Age	45% are between 35 and 44 years old; 45% between 45 and 54 years old.
Highest educational qualification	The majority (58%) has a postgraduate diploma.
Relation to building	92% own the home they are living in.
Type of building	58% live in an apartment.

4.5.2. Energy label

- ✓ **Comprehensibility:** All participants find the energy label easy to understand (67% strongly agree, 33% agree).
- ✓ **Preference (Label A or B):** label A (60%), label B (40%) → relatively balanced compared to other countries.

Remarks:

Label A

- Figure A is more familiar because of the same visualization on the electric appliances.
- Energy ratings in figure A should be coloured as in figure B
- Vertical line should be deleted in figure A.
- Units should be on the top next to the labels with brackets (?)
- It is confusing that the energy class "C" is highlighted in contrast with the CO_2 emissions class "B".

Both labels

- The range of the current energy rating and CO_2 emissions should be displayed somehow (e.g. with an asterisk).

4.5.3. Main performance indicators

- ✓ **Familiarity**: all presented indicators, total primary energy use, GHG emissions, annual energy costs and renewable energy ratio are known and comprehensible to the majority of participants; 85% know and comprehend primary energy consumption, annual energy costs and the renewable energy ratio, slightly fewer participants (69%) know and comprehend GHG emissions.

- ✓ **Main interest:** 1st primary energy use [kWh/m² year], 2nd annual energy costs [€/m² year], 3rd GHG emissions.
- ✓ **Unit of total primary energy use:** the majority (64%) finds the information about the primary energy use most tangible in [kWh/m² year]. Each 18% indicated that they found the unit [kWh/year] and [kWh/month] most tangible.

4.5.4. Context of EPB

- ✓ **Perceived importance of benchmarking with other similar buildings:** the majority (58%) perceives that this information is important (33% think it is very important, 25% think it is fairly important). 17% think that it is only a little important.
- ✓ **Perceived importance of climate target:** 49% perceive this information as important (42% perceive it as very important; 17% as fairly important). Only 17% think that it is only a little important.
- ✓ **Understanding of illustration regarding benchmarking with other similar buildings:** 79% agree that the illustration makes the energy performance in relation to the evaluation of buildings easy to understand (29% strongly agree; 50% agree), while 14% are neutral.
- ✓ **Comprehensibility of illustration regarding climate target:** the vast majority (80%) agrees that the illustration makes the energy performance of the building in relation to the national climate target easy to understand (36% strongly agree, 45% agree).

4.5.5. Overview of energy flows (primary energy, final energy etc.).

- ✓ **Comprehensibility:** 92% think that the illustration is easy to understand (54% strongly agree, 38% agree).

4.5.6. Partial performance indicators

- ✓ **Usefulness of information "thermal energy demand":** the majority (64%) find this information useful (40% strongly agree, 24% agree), while 32% are neutral.
- ✓ **Comprehensibility of energy needs and costs disaggregated per energy service:** all participants find the illustration easy to understand. (69% strongly agree, 31% agree).

  Content:
  - The type of fuel (e.g. diesel, natural gas) should be indicated.

  Visualization:
  - The rows of the table should have the same colours with the corresponding energy service.
  - The symbols of the energy services should be displayed on the pies (same feedback in other workshops).

- ✓ **Comprehensibility of separate indicators for building components/ installations**: the majority (74%) find the illustration easy to understand (47% strongly agree, 27% agree), while each 13% are neutral or disagree.
- ✓ **Preference options**: 81% prefer B, 19% prefer A.

  Content
  - Option B is better because there are clear targets for each building component.

  Calculation methodology
  - In option A the rating methodology of the energy performance indicators should be indicated (e.g. based on national legislation/technical guidelines or based on similar buildings' performance; → the rating system should not be arbitrary.)

  Visualization
  - It is not clear if the colouring of the energy performance indicators range is the same with the colouring of the energy rating range (→ again, information about the underlying rating system is missing).

- ✓ **Comprehensibility of renewable energy ratio**: the majority (92%) find the current and potential use of renewable energy easy to understand based on the illustration (each 46% strongly agree or agree); 8% are neutral.

4.5.7. Additional indicators

- ✓ **Selection of additional indicators**: 32% think that thermal comfort should be included, while 22% think indoor air quality should be included. 19% think that information about water consumption should be provided.

4.5.8. Recommendations

- ✓ **Comprehensibility of renovation roadmap**: the vast majority (93%) finds the presented renovation roadmap easy to understand (27% strongly agree, 67% agree), only 7% disagree.
- ✓ **Usefulness of renovation roadmap**: Similarly, all participants indicated that they found the renovation roadmap useful (67% strongly agree, 33% agree).
- ✓ **Suggestions for improvement**:
  - Link with funding schemes, payback period and incentives (e.g. tax relief etc.)

4.5.9. Standard or actual conditions of use

- ✓ **Comprehensibility of difference between information based on standard and information based on actual conditions of use:** the vast majority (92%) find the information easy to understand (71% strongly agree, 21% agree), while only 7% are neutral.
- ✓ **Perceived usefulness of information based on standard and information based on actual conditions of use:** Also, the majority (69%) perceives this information as useful (46% strongly agree and 23% agree). 15% each are neutral or disagree.
- ✓ **Usefulness of energy saving tips:** this information appears to be useful to the vast majority (84%, whereof 67% strongly agree and 17% agree).17% are neutral.

4.5.10. References to other sources of information

- ✓ **Perceived importance of references to other sources of information in the EPC: Also here, the overall result is very positive -** the majority (84%) perceives this information as important (67% find it very important, 17% think it is fairly important).
- ✓ **Selection of additional sources of information:** most participants (34%) selected a detailed building renovation map, while 23 % selected available funding schemes, 19% selected a digital building logbook, and 17% HVAC inspection reports.

4.5.11. Format of the EPC

- ✓ **Preference of format for EPC:** 57% of participants prefer a combination of a digital EPC and analogous EPC, 43% would prefer to only use the digital version, while nobody indicated to prefer to use the analogue EPC.

4.5.12. Overall impression of EPC

- ✓ **Willingness to use the EPC when renting/buying a dwelling/building:** the vast majority (93%) would take the EPC into account (62% strongly agree, 31% agree), while only 8% are neutral.

4.5.13. Willingness to pay for an improved EPC

- ✓ **Features of an EPC that would motivate to pay more for an EPC:** each 35% would find information about the total investments required for measures and easy comprehensibility of how to save energy and costs as motivating to pay more for an EPC. 22% indicated that they would find easy comprehensibility of how to save energy and costs as motivating.
- ✓ **Willingness to pay for an EPC that was easy to understand and useful to the participant:** the distribution of answers is very heterogeneous: each 21% indicated to be willing to pay between 75 and 100€, between 100 and 150€ and that they do not know. Each 14% indicated to be willing to pay not more than 50€ or more than 150€.

5. DISCUSSION

This chapter briefly discusses the used methodology (i.e. testing strategy and conduction of acceptance workshops), provides insights on a preliminary comparison of results among ePANACEA pilot countries and draws attention to the difficulty to implement some suggestions for improvement for the EPC summary sheets oriented towards end-users.

5.1. Discussion of used methodology

- The level of detail of the discussions varied between the workshops. This may be caused by the different the moderation and the participants themselves (how willing they were to talk, how much they had to say). This led to the fact that in some workshops, not all prepared questions in poll everywhere were answered (because questions before were discussed in more detail). However, it was not mandatory that all questions were answered. Also, we can draw the conclusion that these points were important for participants, when they discussed something in greater detail and scope. Therefore, it would not have been right to stop the discussions just to get answers to all the prepared questions.
- The results are not representative for all EPC end-users, since a high portion of the participants had a technical background in energy efficiency of buildings. However, this has allowed us to gain insights into different user perspectives. Also, participants with technical background provided very helpful suggestions for improvement which are not to be expected from laypersons. For the next round of workshops, it is important that even a wider variety of users participate and that the proportion of laypersons in particular is more strongly represented.
- The original target number of 30 participants per workshop was not reached in ePANACEA pilot countries. But, still a good number of participants (10-28) took part in each workshop, thanks to the efforts by CENER, VITO, VTT, EASt, TUW and CRES in recruiting participants from their countries. This still allowed us to gain valuable insights on the research topic. The rewards, related to energy efficiency, were perceived as supportive in the recruitment process by the project partners.
- Poll everywhere worked well as a tool: it provided variety for the workshop (mix of poll everywhere activities with different questions types, display of live results) and a lot of interactivity (display of results seemingly invited participants to explain their answers) and it was easy to use for participants. Finally, it has shown the opinion of every single person who has participated which is often not achieved in group discussions. However, the down-side of this tool became apparent when reporting the results: The results of the individual activities are listed in the report in an incomprehensible order.
- Some questions were obsolete for some workshops, e.g. the question whether EPC users preferred a digital version of the EPC or not, since the EPC is already digitized in Finland and Austria. Therefore, the question was adopted slightly as indicated in the results section. This makes the answers less comparable with results from other workshops, however it allowed us to collect meaningful data in the case of the Austrian and Finnish workshop.

5.2. Preliminary comparison of results among ePANACEA pilot countries

A first overview of the results of the acceptance test in the five ePANACEA pilot countries provides Table B,6. Table B,6 indicates the most preferred options, main interests per pilot country, and indicates how high or low the perceived comprehensibility, importance, usefulness, willingness to use and to pay are per country. For this, the following rating system was used:

Evaluation	Percentage
Very high	80 - 100%
High	60 - 80%
Medium	40 - 60%
Low	20 - 40%
Very low	0 - 20%

The percentage refers to the portion of participants that indicated finding an illustration easy to understand, useful, important etc. Here it was determined that a participant finds an illustration important, if he/she answers "very important" or "fairly important". Likewise, it was determined that a participant perceives an illustration as useful/easy to understand, if he/she answers "fully agree" or "agree". Hence, for the ratings, the combined values for the response options fully agree and agree; very important and important were used in each case.

Based on this, most participants find the presented illustrations for a new EPC oriented towards end-users **easy to understand and useful**. However, in most of the cases there is also a fraction of participants that do not find the illustrations easy to understand or useful. The latter may result from the difficulty to understand. If you take the feedback from all the workshops together, then **there is potential for improvement with regard to all the proposals and the corresponding suggestions for improvement.** Based on the results from all workshops, the greatest need for improvement is in the following areas: Overview of energy flows (too technical), information about final energy demand disaggregated per services (too complex and not intuitive) and presentation of the ratio of renewable and non-renewable energy (not understandable, not intuitive, missing explanation of information).

Noticeable is the fact that participants who **are laypersons showed a better acceptance of the EPC proposals than those with technical background.** It could be that laypersons wanted to indicate that they are capable to understand the information and therefore evaluated the comprehensibility as rather good compared to participants with technical background who have taken into account in their assessment their assumption that that laypersons would be overwhelmed because the proposals were (still) too technical (cf. rather high acceptance of illustrations in Greek and Spanish workshops with a lower proportion of experts compared to a rather low acceptance of illustration in the Austrian, Belgian and Finnish Workshops with a high proportion of experts).

- ✓ No statement can be made about **which options (energy labels and illustration of partial performance indicators) are preferred overall**, as the preferences in the countries are very different.
  - Participants have a **tendency to prefer the option that looks more familiar** because it is similar to another existing label. However, participants from different countries associate different labels with the proposed energy labels. (e.g. Spain: association of option B with the food label; while in Austria, Finland and Greece association of option A with the efficiency label for electric appliances). This does not mean that the respective more familiar option is also better, however it might be an advantage in terms of ease of understanding (as explained by participants).
  - It appears that in the case of the Belgian edition of the workshop participants have **the tendency to prefer the options that are currently included in the Belgian (Flemish) EPC.** (This concerns the energy label and the presentation of partial performance indicators). The vast majority of Belgian participants preferred options B regarding the energy label and presentation of partial performance indicators, which were each adopted from the existing Belgian (Flemish) EPC.

- ✓ **Main interest regarding the main performance indicator**: 'annual energy costs' is always rated under the top 2. However, three times 'primary energy use' is selected as the first main indicator (Belgium, Greece & Finland). This confirms users' needs to be informed about annual energy costs.
- ✓ **Most preferred unit for primary energy use indicator** is kWh/ (m^2 year)! This is surprising, since during the previous workshops this unit was often described as too complex for end-users.
- ✓ **Additional performance indicator:** indoor air quality and thermal comfort are the additional performance indicators in which participants showed the highest interest in all countries (except for Spain where day lighting was preferred over indoor air quality). For both additional indicators it is not yet clear how they will be calculated.
- ✓ **Additional source of information:** most interest in detailed building renovation roadmap (Belgium, Spain and Greece). In Finland: digital building logbook.
- ✓ **Format of EPC:** based on the answers from participants in all ePANACEA pilot countries we can say that there is a strong support for a digital EPC (with wishes for an interactive, digital EPC from Austrian participants like an EPC app since a PDF file in not really considered as digital application). In all ePANACEA pilot countries the digital version was selected as the most preferred option, followed by using a combination of a digital and analogous EPC.
- ✓ **Intention to use the EPC:** in the three countries where answers on the intention to use the EPC were collected (Spain, Belgium and Greece) participants showed a high intention. However, we cannot conclude from tis to actual behavior.
- ✓ **Greatest motivation to pay more for an improved EPC** is to receive information about the total investments required for measures.
    - It is striking that again and again the information on costs seems to be important (annual energy costs, investment costs, cost savings etc.). This is in line with the collected user-needs from the user-needs-workshops. However, as has become clear once again, prices for energy and materials are quite volatile and also vary from region to region. This information should only be made available if it is reasonably accurate, which could at best be done by calculation based on current databases.
- ✓ **Willingness to pay**: in Finland and Austria most participants selected to be willing to pay more than 150€, followed by participants who are willing to pay between 75 and 100€. However, within these two groups the awareness of the work of an EPC issuer seemed to be high. In other countries the answers are very mixed.

5.2.1. Critiques and suggestions for improvement

During this round of workshops **we talked about the EPC on a more detailed level than before in the user-needs-workshops**. This time, main points of criticism were e.g. presentation and visualization of information while in the user-needs-workshops there was more discussion about the introduction of the EPC as a policy instrument and the generation of EPC. Still, there was feedback related to the purpose of EPC during this round of workshops (which can be seen as confirmation of already available information).

Feedback (criticism and suggestions for improvement) can be assigned to various aspects that make up a user-friendly EPC (i.e. visualization, representation of information, content of information) and aspects that ensure high quality of EPC (generation of information, calculation methodologies).

Some **first principles that should be considered in the new design of an EPC**, as they can already be derived from the compiled results, are the following:

- ✓ **Validity of information:**
    - **Increase trust by providing** explanations on how information (e.g. indicators / order of recommendations etc.) was generated and provide information about the underlying evaluation system. This serves to raise trust in the provided information because interested users can comprehend what the information is based on.

(Trust was not included as construct in the testing strategy although it was described as important in terms of technology acceptance by Liu *et al*. (2018)).

- **Only include information that is valid and updated.** Leave out information if this cannot be guaranteed (e.g. annual energy costs). Also, during the discussion in WGB as well as during the acceptance workshops it became apparent that regarding some indicators it might be **difficult to provide accurate information** (e.g. annual energy costs), or that **some indicators can be defined in different ways** (e.g. thermal comfort, indoor air quality). Also, the calculation methodologies to generate information about these additional indicators is not clear.

✓ **Content**:

- Less is more! For instance, show either total energy use per year or per m^2, both are not necessary (feedback form Belgian and Austrian workshop). The message was often that less information belongs in the EPC and in the illustrations that were presented, rather than more.
- Also, good practices in currently existing EPC schemes of ePANACEA pilot countries became apparent (again). For instance, the Austrian EPC provides an indicator on the heating energy demand of the building. Thereby, it informs the user about the energy that is needed to warm the building which is expected to be of great interest next to the total primary energy use which might be less tangible for the end-user. Besides that, the Austrian EPC includes the OI3-indicator (eco-index) which determines the ecological quality of building materials based on the environmental indicators 'global warming potential', 'acidification potential' and the 'demand for non-renewable primary energy'. Such a comprehensive indicator could be a good solution in providing information about the ecology of the building, but not overwhelming the end-user with too much additional information. Alternatively, the three different indicators used to evaluate the ecology of building materials: CO_2 indicator, a value for acidification and a value for resource consumption, could be listed individually, according to an expert's opinion.

✓ **Visualization: Make the illustrations more intuitive,** then they become easier to understand. For instance, include terms in the illustration itself instead of providing a 'legend'; put icons next to the graphs (pie charts) to reduce cognitive effort to understand information (feedback from Belgium, Finland, Austria).

6. CONCLUSION AND OUTLOOK

This report presented the testing strategy and the results of the acceptance workshop in the five ePANACEA pilot countries that were conducted in order to test users' acceptance of proposals for a new EPC.

Based on the results from the acceptance workshops in the five ePANACEA countries, we can conclude that overall the majority of participants find the presented illustrations for a new EPC oriented towards end-users rather important, easy to understand and useful. It is noticeable that the first overview of the results shows that groups in which mostly lay people were present (Greece and Spain) more often indicated that they understood the proposals and found them useful.

However, summarizing the suggestions for improvement from all workshops, **there is potential for improvement with regard to all the proposals (illustrations).** The greatest need for improvement is regarding the following: illustration of the overview of energy flows, presentation of final energy demand disaggregated per energy service and the ratio of renewable and non-renewable energy. **Suggestions for improvement mainly address the content, presentation and visualization of information in the EPC, whereas the validity and plausibility of information was also criticized** (e.g. provision of annual energy costs, underlying rating systems of partial performance indicators, valuation basis for recommendations). In total the message is: the information should be clear, reduced to the necessary and possibly conveyed by means of intuitive illustrations. Besides, the valuation basis should be made transparent. Also, only valid data should be provided. The EPC should become digital, perhaps also provided as an interactive EPC app. This would facilitate the provision of additional information for interested users. Although, where data was collected, participants showed a high willingness to use the EPC we cannot conclude that they would actually also use a (new) EPC.

Regarding main performance indicators there is a strong interest in annual energy costs in all countries (always rated under the top 2.), whereas primary energy use is also considered as highly important. The unit kWh/(m^2 year), of which we thought that end-users would find it difficult to understand, is the most preferred unit for the indication of primary energy use according to the results. Overall, indoor air quality and thermal comfort are the most interesting additional indicators. A detailed building renovation roadmap was selected as the most interesting additional source of information by participants from Spain, Greece and Belgium. In all countries information about the total investments required for measures would present the biggest benefit that could motivate participants to pay more for an EPC. Except for in Austria, where information about energy and costs savings would be of biggest interest**. It is striking that again the information on costs seems to be important (annual energy costs, investment costs, cost savings etc.)**. This is in line with the collected user-needs from the user-needs-workshops. However, as has become clear once again, prices for energy and materials are quite volatile and also vary from region to region. This information should only be made available if it is reasonably accurate, which could at best be done by calculation based on current databases.

In the continuation of this task the acceptance of EPC features will be analysed further and compared between countries/ types of users. Within the course of the project the draft for a new EPC will be updated a second time, taking into account the critiques and suggestions for improvement we received from participants of the first round of acceptance workshops. For this, it must be weighed up beforehand which proposals can and should be implemented. Thereby, attention will be paid to what extent country-specific needs and particularities should be taken into account. It will also be thought through again whether there should be two separate summary sheets (one for end-users and one for experts), or whether there should be a common summary page in addition to the two separate summary sheets. These considerations will most likely be made by WGB. Then, in January 2023 the second round of acceptance workshops is planned, where users' acceptance of the final proposal for a new EPC will be tested.

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7.2. Table of figures

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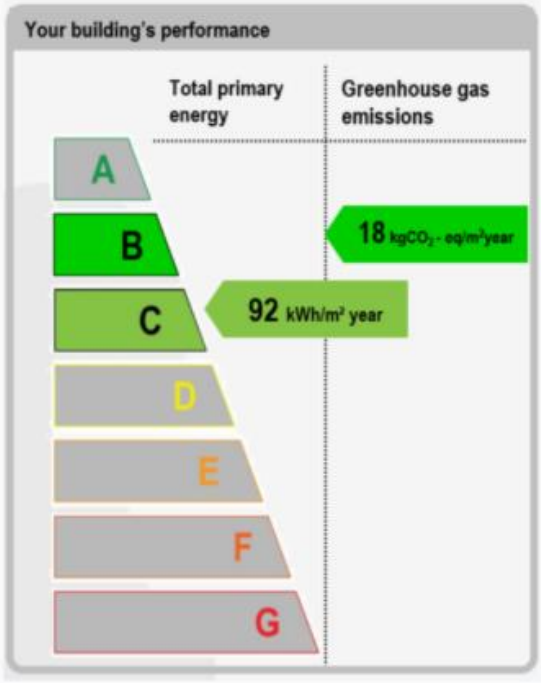
8. ANNEX

Appendix A Testing strategy for acceptance workshops

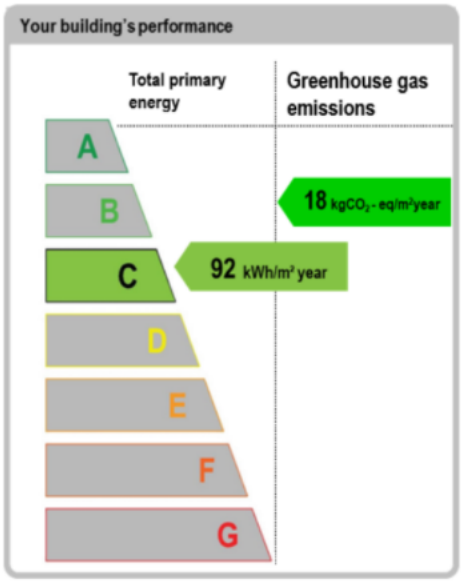
Example from Finnish edition of the acceptance workshop in English

Energy label

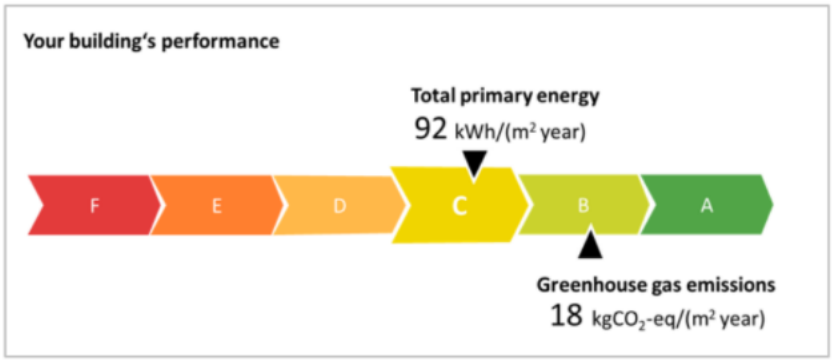
"I find this figure easy to understand"



Which figure do you like better (A or B)? Please click on the figure you prefer.



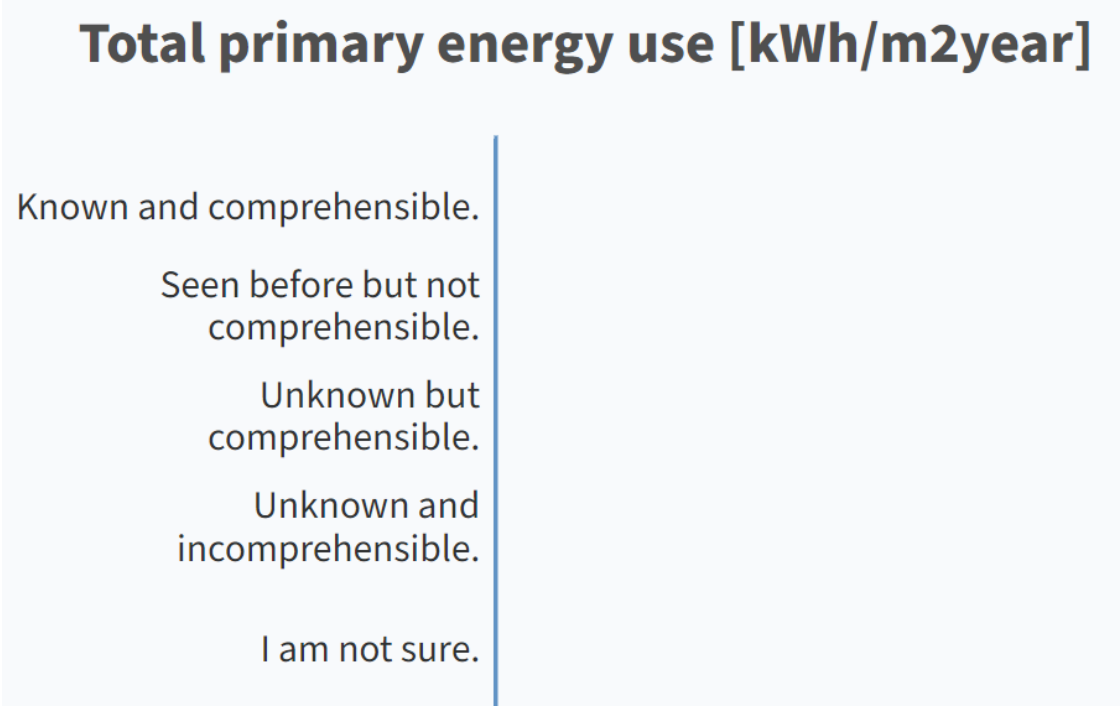
A



B

Main performance indicators

Familiarity with main performance indicators



- Same item regarding the indicators GHG emission [$kgCO_2/m^2$ year]; annual energy costs [€/m^2 year], renewable energy ratio [%].

Please rank the following main performance indicators according to your interest in them (from top to bottom = from high interest to low interest)

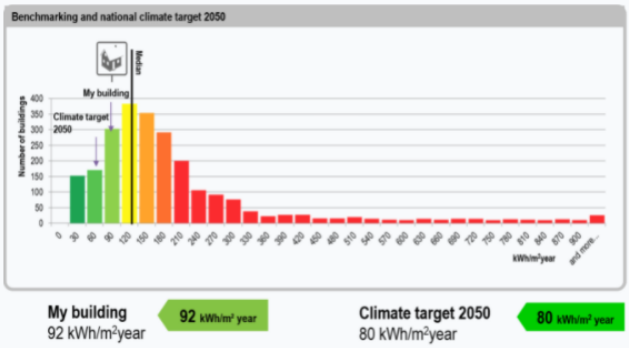
- Total primary energy use [kWh/m2year]
- Green house gas emssions [kgCO2/m2year]
- Annual energy costs [€/m2year]
- Renewable energy ratio [%]
- Other.

In which unit do you find information about the primary energy use of your building most tangible?

- kWh/(m2 year)
- kWh/year
- kWh/month
- kwh/(person year)
- I don't know.
- Other.

Context of EPB

"Based on this figure I find it easy to understand how my building performs in relation to other buildings."



- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

- Same item regarding comprehensibility of the EPB in relation to the national climate target.

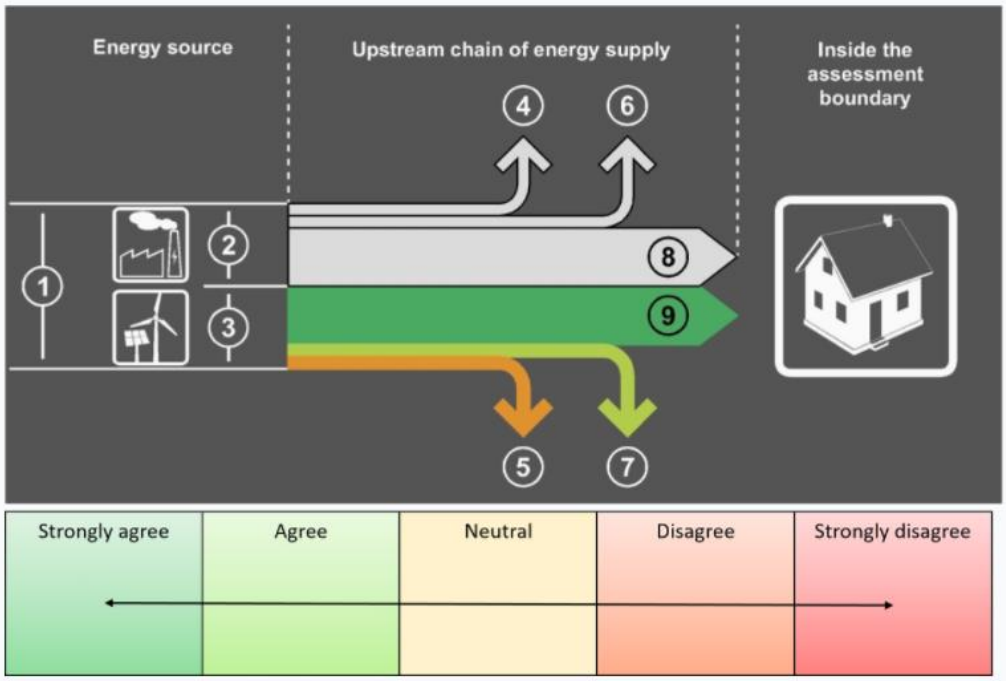
Partial performance indicators

"This information is useful to me."

Thermal energy demand		
Space heating	70 kWh/m²year	8400 kWh/year
Space cooling	35 kWh/m²year	4200 kWh/year

- Strongly agree.
- Agree.
- Neutral.
- Disagree.
- Strongly disagree.

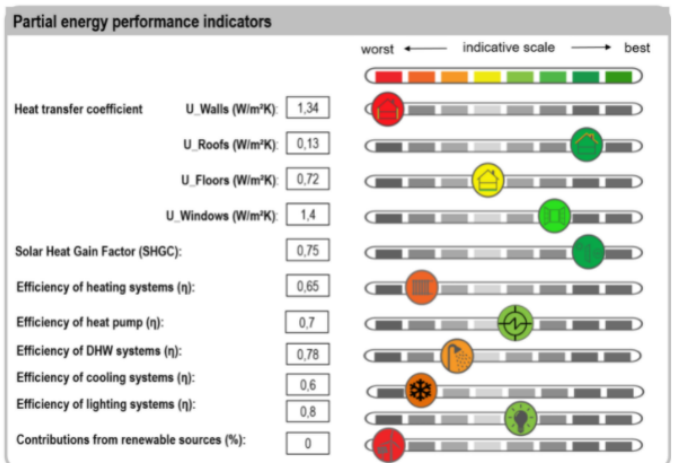
"Based on this figure I easily understand the difference between primary energy and final energy use".



1 Total primary energy
2 Non-renewable primary energy
3 Renewable primary energy
4 Non-renewable infrastructure related energy
5 Renewable infrastructure related energy
6 Non-renewable energy to extract, refine, convert and transport
7 Renewable energy to extract, refine, convert and transport
8 Delivered non-renewable energy
9 Delivered renewable energy

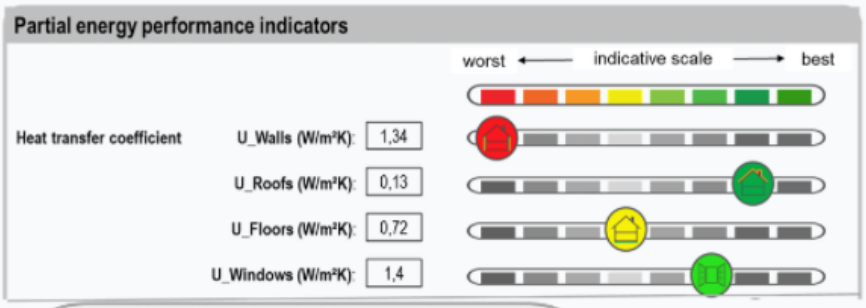
"Based on this figure I find it easy to understand what the energy use and costs disaggregated per energy service are".

"Based on this figure I find it easy to understand where the weak spots in the building are".



- Fully agree
- Agree
- Neutral
- Do not agree
- Do not agree at all

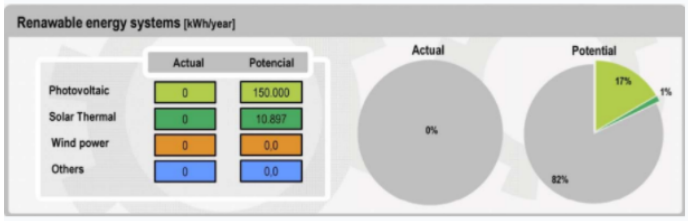
Which visualization do you like better? (A or B?) Please click on the visualization you prefer.



A

B

"This figure makes it easy for me to understand the current and potential use of renewable energy".



- Strongly agree.
- Agree.
- Neutral.
- Disagree.
- Strongly disagree.

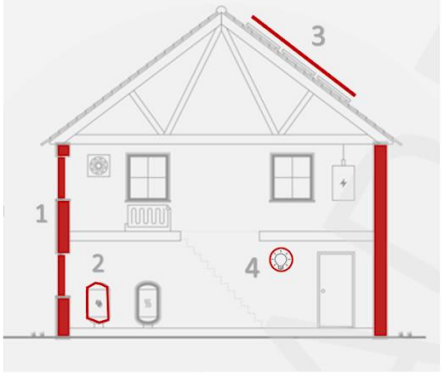
Additional performance indicators

Please select the additional indicators you think the EPC should include.

- Thermal comfort.
- Indoor air quality.
- Water consumption [m3/month].
- Smart readiness indicator [%].
- Day lighting [hours/year].
- Other.
- No additional indicator.
- I don't know.

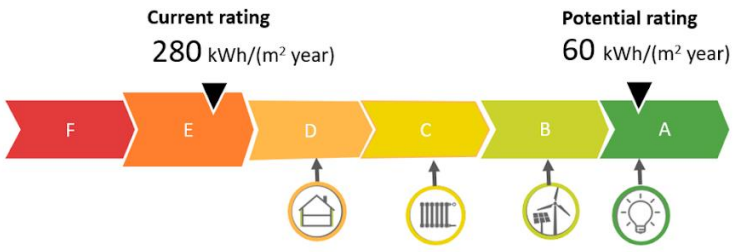
Recommendations

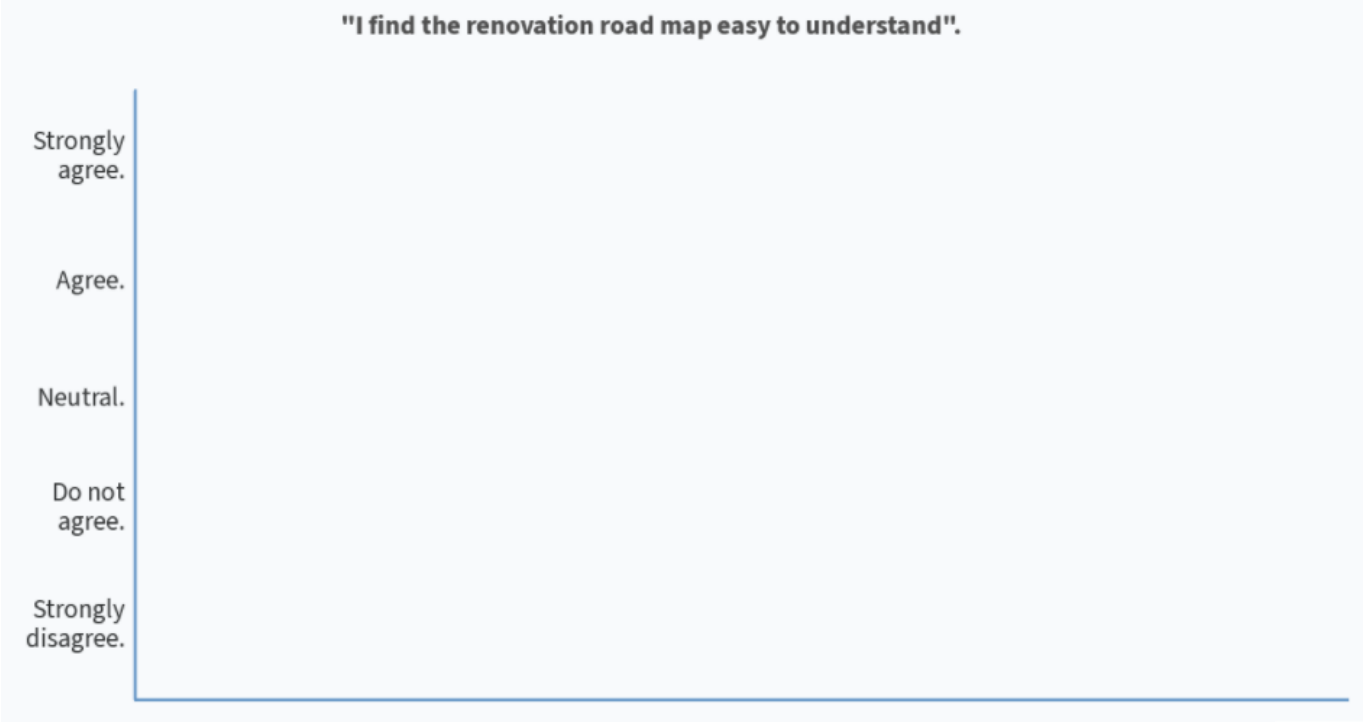
Stepwise Renovation

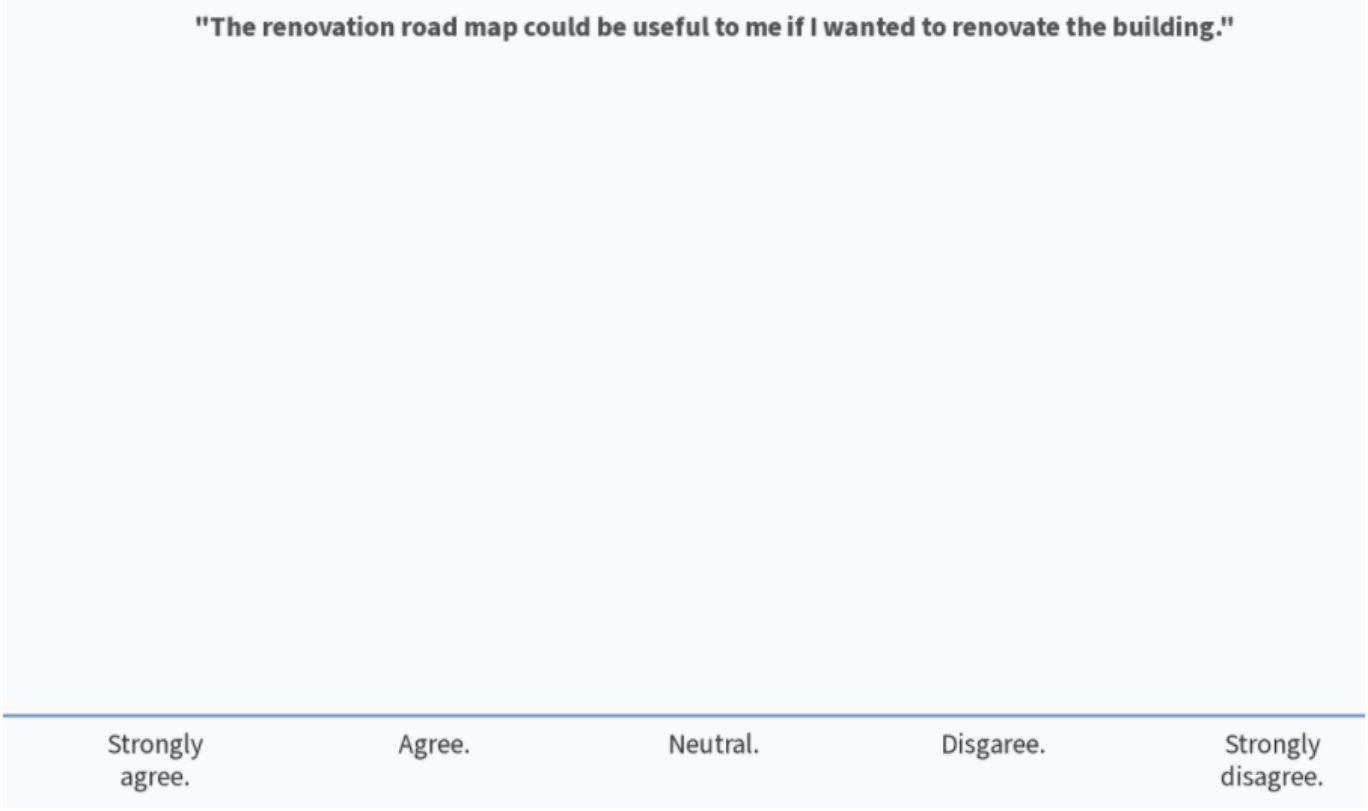


Step	Recommendation	Indicative cost	Typical savings per year	Rating an after improvement
1	Improve insulation of walls to 12cm, 200m²	2000€	43€	D
2	Replace boiler with a new condensing boiler	2500 – 3000€	185€	C
3	Solar water heating, install a solar thermal system	6000 – 8000€	45€	B
4	Install LED lamps	200€	40€	A

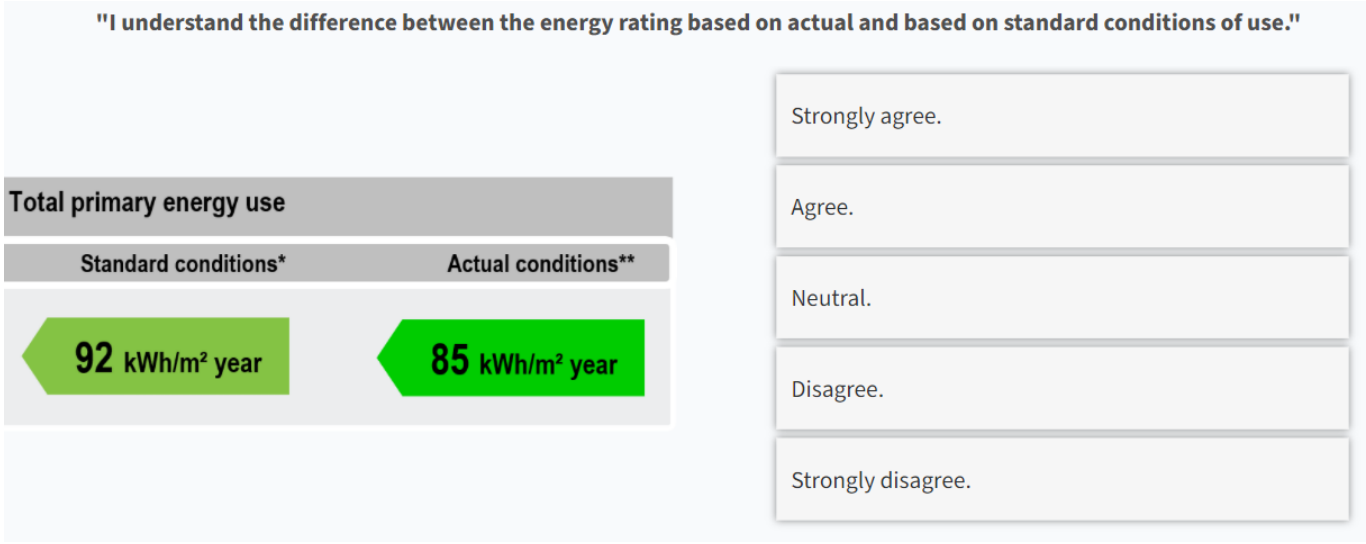
Energy label after implementation of the recommendations



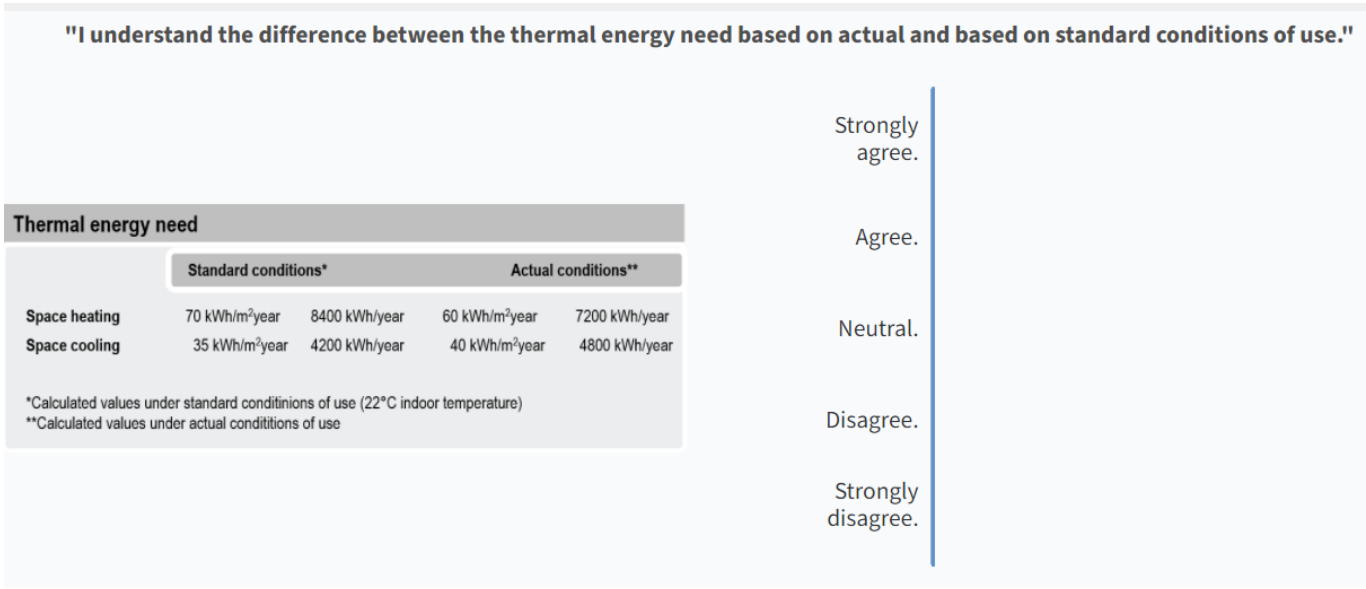

"I find the renovation road map easy to understand".
Strongly agree.
Agree.
Neutral.
Do not agree.
Strongly disagree.


"The renovation road map could be useful to me if I wanted to renovate the building."
Strongly agree.
Agree.
Neutral.
Disgaree.
Strongly disagree.

Standard and actual conditions of use to calculate EPB



Same item regarding the perceived usefulness of this information.



- Same item regarding the perceived usefulness of this information.

Energy saving tips

1. Fridge: Increase temperature
Saves 5€/year (≙ ca. 9kg CO_2)

2. Freezer: Defrost the freezer compartment regularly
Saves 9€/year (≙ ca. 15 kg CO_2)
(in comparison to a 1cm thick layer of ice)

3. Washing maschine: Use the energy-saving programme (Eco programme).
(Saves 8€/year (≙ ca. 13 kg CO_2)
(Assumption: wash twice a week)

4. Washing maschine: Fill the machine completely instead of only half full
Saves 25€/year (≙ ca. 43 kg CO_2)
(Assumption: wash twice a week)

5. Kettle: boil only the amount of water you really need.
Saves 14€/year (≙ ca. 25 kg CO_2)
(Assumption: Assumption: every day 1l of water was boiled too much)

6. Oven: Bake with convection instead of upper-lower heat
Saves 18€/year (≙ ca. 13 kg CO_2)
(Assumption: bake once a week)

7. Cooker: use the lid when cooking
Saves 27€/year (≙ ca. 46 kg CO2)
(Assumption: 3 times cooking/week)

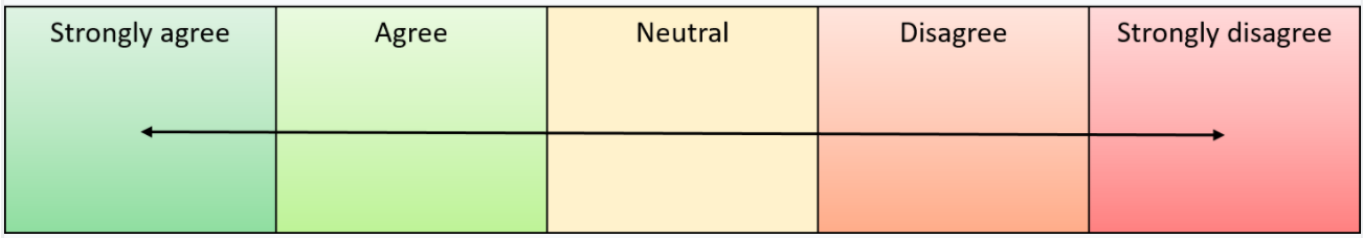
8. Lighting: Replace incandescent lamps with LED lamps.
Saves 55€/year (≙ ca. 95 kg CO_2)
(Assumption: replacement of three ceiling lamps

9. Router: switch off in the evening/at night
Saves 12€/year (≙ 21kg CO_2)

10. Computer: Put the computer to sleep, instead of activating the screen saver
Saves 17€/ year (≙ ca. 30 kg CO_2)
Assumption: Avoid the screen saver for 2 hours a day

11. General: Avoid stand-by mode and always switch off all household appliances completely using a power strip.
Saves up to 60€/year (≙ ca. 100 kg CO_2)

The presented energy saving tips are useful for me.



Other sources of information

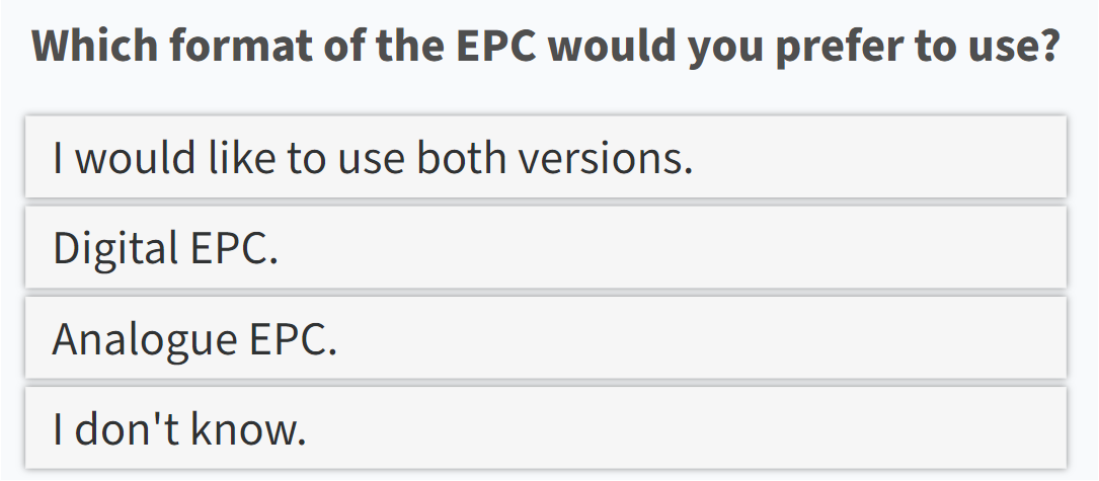
How important would it be for you that the EPC provides references to other sources of information related to your building?

Very important	Fairly important	Important	Slightly important	Not at all important
←				→

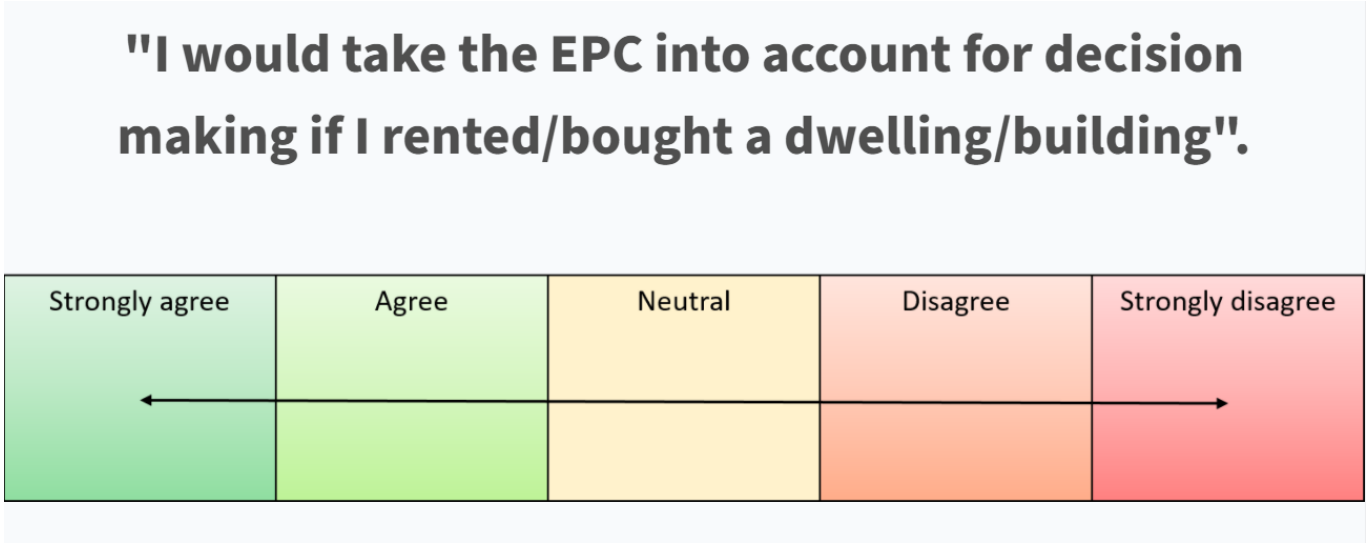
Please select the additional sources of information you would be interested in.

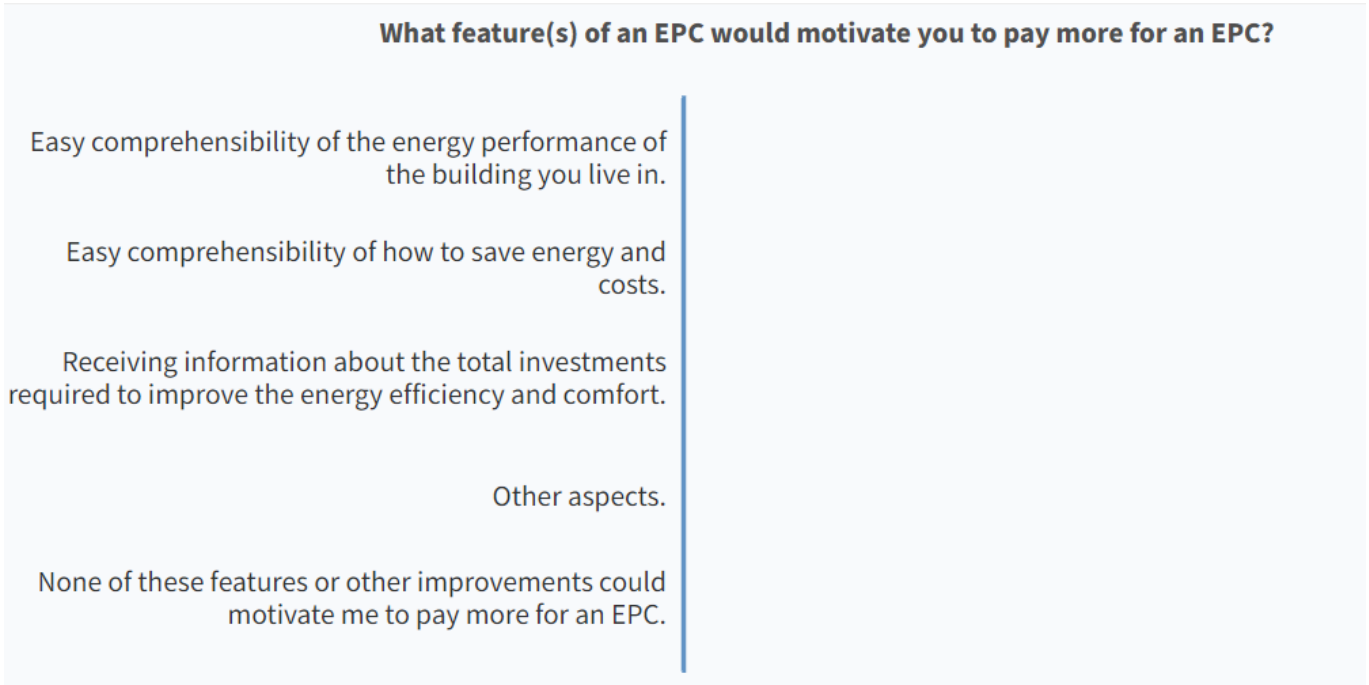
- Detailed building renovation map.
- Digital building logbook.
- HVAC inspection reports.
- Available funding schemes.
- Other.
- No reference to additional sources of information needed.
- I don't know.

Format of EPC



Overall impression of EPC





Willingness to pay for an improved EPC

What feature(s) of an EPC would motivate you to pay more for an EPC?

- Easy comprehensibility of the energy performance of the building you live in.
- Easy comprehensibility of how to save energy and costs.
- Receiving information about the total investments required to improve the energy efficiency and comfort.
- Other aspects.
- None of these features or other improvements could motivate me to pay more for an EPC.

How much would you be willing to pay for an energy certificate that was designed to be understandable and useful to you?

- Not more than 50€.
- Between 50 and 75€.
- Between 75 and 100€.
- Between 100 and 150€.
- More than 150€.
- I don't know.

Appendix B – Overview and preliminary evaluation of results

Table B,6: Overview and preliminary evaluation of results from acceptance workshops of ePANACEA pilot countries

EPC feature	EPC sub feature	Construct	Finland	Austria	Belgium	Spain	Greece
Energy label		Comprehensibility	very high	high	medium	medium/high	high
		Preference	A	A	B	**A**/B	**A**/B
		Main interest	Primary energy use; Annual energy costs	Annual energy costs Heating energy demand Primary energy use	Primary energy use Annual energy costs GHG emissions	Annual energy costs GHG emissions Primary energy use	Primary energy use Annual energy costs GHG emissions
	Unit of primary energy use		kWh/(m² year) kWh/year	kWh/(m² year) kWh/year	kWh/year kWh/(m² year)	kWh/(m² year) kWh/year	kWh/(m² year) kWh/year; kWh/month
Context of EPB	Benchmarking	Importance	medium	high	medium	very high	medium
		Comprehensibility	very high	high	very high	high	high
	Climate target	Importance	medium	medium	high	high	medium
		Comprehensibility	very high	high	very high	high	very high
Overview energy flows		Comprehensibility	low	high	very low	medium	very high
Partial performance indicators	Thermal energy demand	Usefulness	high	very high	high	high	high
	Final energy demand	Comprehensibility	high	medium	medium	very high	very high
	Building components/installations	Comprehensibility	high	high	very high	very high	high
		Preference	A	A/**B**	B	A	B
	Renewable energy ratio	Comprehensibility	low	high	very low	high	very high
Additional performance indicators		Interest	Indoor air quality thermal comfort; water consumption	/	Indoor air quality thermal comfort	Thermal comfort day lighting	Thermal comfort indoor air quality
Recommendations	Renovation roadmap	Comprehensibility	high	high	very high	very high	very high
		Usefulness	low	very high	very high	very high	very high
	Energy saving tips	Usefulness	/	/	medium	very high	very high
Data basis for conditions of use		Comprehensibility	high	high	very high	high	very high
		Usefulness	high	medium	very high	high	high
References to other sources of information		Importance	medium	/	medium	high	very high
		Interest	Digital building logbook	/	Detailed building renovation roadmap	Detailed building renovation roadmap	Detailed building renovation roadmap
Format of EPC		Preference	Digital combination of digital & analogous EPC	Combination of a PDF and an EPC app PDF	Digital combination of digital and analogous EPC	Digital combination of digital and analogous EPC	Digital combination of digital and analogous EPC
Overall EPC		Willingness to use EPC	/	/	very high	very high	very high
		Willingness to pay: motive	Total investments required for measures	Information about energy and costs savings	Total investments required for measures	Total investments required for measures	Total investments required for measures, easy comprehensibility of how to save energy and costs
	Price range	Willingness to pay	More than 150€ between 75€ and 100€	More than 150€ between 75€ and 100€	Very mixed results	Very mixed results	Very mixed results