ePANACEA

Smart European Energy Performance Assessment & Certification

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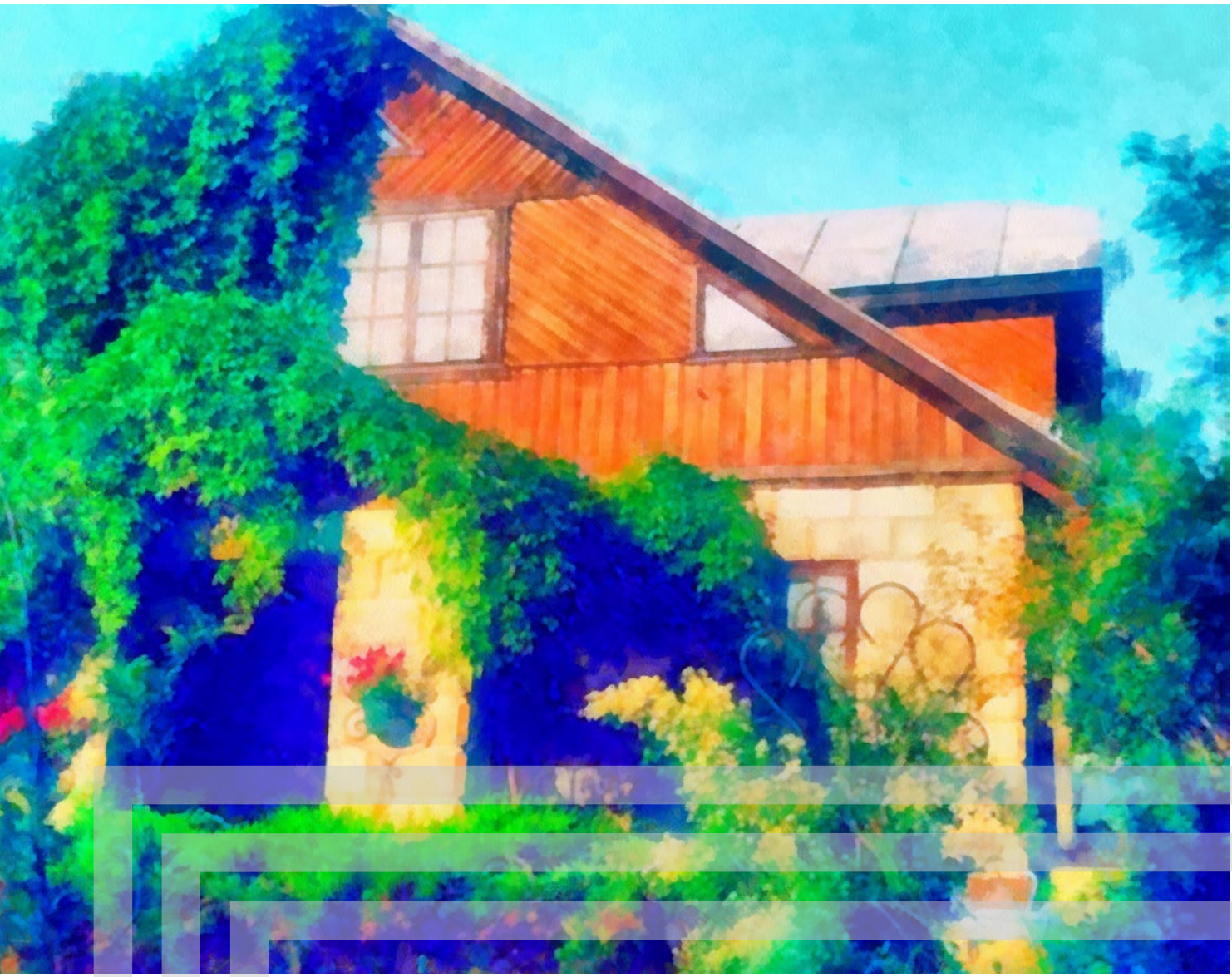

User acceptance of new Energy Performance Certificate (EPC) summary pages

Report on the outcome of the final acceptance test and impact assessment from user perspective regarding the new EPC

Version 1, June 2023

IZES gGmbH – Institut für Zukunftsenergie und Stoffstromsysteme

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V.1.2	26.05.2023	IZES	Version after review
V.1.3	29.05.2023	IZES	Review
V.1.4	31.05.2023	IZES	Final version after review

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OVERVIEW OF THE ePANACEA PROJECT

After 10 years of track record, the current EPC schemes across the EU face several challenges which have led to a not full accomplishment of their initial objectives: lack of accuracy, a gap between theoretical and real consumption patterns, absence of proper protocols for inclusion of smart and novel technologies, little convergence across Europe, lack of trust in the market and very little user awareness related to energy efficiency.

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

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

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

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

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

EXECUTIVE SUMMARY

This report documents two tasks carried out in the ePANACEA project: the developing process of the new EPC summary pages and the final acceptance test – testing and comparing the acceptance regarding current EPC schemes of the ePANACEA pilot countries (Spain, Belgium (Flemish region), Finland, Austria and Greece) and the new EPC summary pages.

The new EPC summary pages are the result of the integration of reflected feedback received from previous user interviews, workshops, REB meetings and project partners. Therefore, the version of this project first of all includes the information that the market demands, following what the ePANACEA methodology can deliver and what the revision of the EPBD envisages.

Within the ePanacea project, a series of accompanying acceptance research methods were conducted including interviews, standardized questionnaires and user workshops. For the final acceptance test, a third round of online user workshops with end-users and other stakeholders of EPC was conducted in the ePANACEA pilot countries (Spain, Belgium (Flemish region), Finland, Austria and Greece). The acceptance of the participants was mainly surveyed through online questionnaires, which were filled out during and after the workshop. To compare the acceptance regarding the EPC versions, workshop participants were divided into two groups, while one group received the current and the other group the new EPC. The acceptance of EPC versions was tested based on e.g. the understanding of information, the perceived ease of use and usefulness of the EPC, feelings regarding the presented EPC, attitude towards the presented EPC and the use intention. A t-test was calculated in order to find out whether the differences in answers between EPC groups was significant. In total 159 participants took part in the third round of workshops, meeting the target number of 30 participants per workshop in four of five pilot countries.

The analysis of the questionnaires shows that there are not many significant differences between the evaluation of the current EPC and the new EPC within one pilot country, looking at the main themes used to explore acceptance of EPC. But, in Belgium the current EPC scored significantly better in terms of perceived ease of use, perceived usefulness and appropriateness than the new EPC summary pages. Also, in Belgium the current EPC scored higher compared to the current EPCs of the other pilot countries, matching the impression that the Belgian (Flemish) EPC is already progressive and user-friendly. The new EPC was evaluated significantly better (looking at the main mentioned themes) regarding feelings towards EPC in Austria, regarding appropriateness and attitude in Greece and regarding reliability of information in Belgium. To improve reliability of EPC was one of the main goals of ePANACEA. However, from this we cannot conclude that the new EPC is significantly accepted better in these countries or performs better in certain aspects.

The results rather show a tendency that the current and new EPC are *equally well accepted* in the other pilot countries. However, considering the perceived usefulness of the EPC to receive information about additional indicators such as comfort, IAQ and costs associated with running the building, the new EPC scored significantly higher in Austria, Belgium, Greece and Spain, indicating that an improvement regarding the additional indicators was achieved. Furthermore, the new EPC seems to have gained in usefulness and individuality but lost in clearness and organization compared to current EPCs in the ePANACEA pilot countries. This could also be the reason why the new EPC was not rated as easy to understand by 70%, 53% and 50% in Austria, Spain and Belgium, respectively, although most of the information was understood correctly. The appealing visualization, presentation of recommendations in a roadmap and the benchmarking were repeatedly praised by new EPC group participants.

The comprehension test shows that it is not clear yet what THE energy label/energy rating for the building is as there are three main *rated* indicators and all of them are provided based on standard and actual conditions of use. Also, in general the provision of information based on standard and on actual conditions is not clear enough, as participants still ask for the difference and the purpose of it, asking for more explanations. Other information that was newly introduced in the new EPC (e.g. benchmarking, potential energy rating, and share of renewable energy etc.) was understood correctly by the majority of participants although many participants mentioned to not fully understand the boxplots presenting the IAQ and comfort.

Also, it appears that that the division of pages between the target groups was not clear. That a division of the pages is necessary is supported by the fact that participants often criticized the use of technical terms which are not understandable by laymen. Moreover, participants of all pilot countries repeatedly criticized that there is too much information which is presented in small space which leads to confusion and loss of focus on the most important information. Additional information could therefore be provided in a different additional format. On the other hand, additional explanations in the EPC or a manual in order to understand the provided information would be appreciated by the majority of participants in all pilot countries. Both – separating main and additional information and providing additional explanations - could be realized in a digital/online-version of the EPC. Although the new EPC has received criticism and there are several suggestions for improvement asking for further development of the new EPC summary pages, the behavioral intention to use the new EPC - as well as with regard to the current EPC - e.g. for decision making when buying/renting a house or before renovating is high throughout all ePANACEA pilot countries.

This is surprising as in previous stakeholder interviews and workshops most end-users stated that they are not aware of the EPC or consider it as a mandatory document which is not useful. This may be because the change in context within the last year (war in Ukraine, energy crisis) has strengthened the sense and need for energy efficiency. This supports the theory that it is not only the quality of the EPC alone that influences its usage, but also the context within which it is applied.

However, the majority of participants indicated to not be willing to pay high prices for the EPC – with no significant differences between current and new EPC groups.

GLOSSARY

Att	Attitude
BI	Behavioral 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
IAQ	Indoor air quality
PEOU	Perceived ease of use
POPD plan	Protection of personal data plan
PU	Perceived usefulness
TAM	Technology acceptance model

1. INTRODUCTION

This report documents the developing process of the new EPC summary pages and corresponding user perspectives. Therefore, a final acceptance test exploring whether the new EPC summary pages perform better than the current national EPC schemes in terms of user acceptance and several impacts (e.g. impact on understanding and awareness of energy efficiency of buildings, understanding and awareness of the impact of behaviour on energy efficiency of buildings, attitude towards energy efficiency of buildings, and the intended use of EPC) was applied. Moreover, the results of the acceptance test provide final feedback on the new EPC summary pages before possible implementation. Therefore, user workshops (third round) were conducted in the ePANACEA pilot countries (Spain, Belgium (Flemish region), Finland, Austria, and Greece). The acceptance of the participants was mainly surveyed through online questionnaires, which were filled out during and after the workshop.

Within the ePanacea project, a series of accompanying acceptance research methods were conducted including interviews, standardized questionnaires and user workshops.

During the first acceptance test, conducted in January 2022 and documented in *Assessing user-friendliness of proposals for a new Energy Performance Certificate (EPC) (DOI: 10.5281/zenodo.6334736),* preferences between different options of EPC elements (e.g. energy label, overall main performance indicators, additional performance indicators etc.) and the acceptance of proposals of EPC elements were tested. Hence, we aimed to collect data on how to design a new EPC draft. During this final acceptance test the aim was to gain accurate evaluations of the new EPC summary pages and to compare that evaluation to the current state of respective national EPC schemes.

As in the first acceptance test, the focus of this acceptance test is on the content and presentation of information in the EPC. Discussions about the generation of EPC (i.e. calculation methodology) are still excluded, as the participants do not have the expertise to evaluate the calculation methodology. The usability and adequacy of the ePANACEA methodology is tested during the testing and demonstration phase.

This report provides theoretical background for the conduction of the acceptance test in chapter 2, the methodology that was used in chapter 4 and presents the results of the developing process of new EPC summary pages in chapter 4.1, while the results of the acceptance tests are presented in subchapter 4.2. Chapter 5 contains a discussion of the methodology and the results. Chapter 6 summarizes the conclusions.

2. THEORETICAL BACKGROUND

This chapter provides the theoretical background for this task. It includes a short recap about the dimensions of acceptance as well as the technology acceptance model (TAM). Furthermore, additional factors that possibly influence acceptance of EPC are explained. From this chapter we derive the constructs that are used to test the acceptance of EPC versions in the user workshops.

2.1. Acceptance subject, object and context and related factors

There are three dimensions of acceptance. The first dimension is the *acceptance subject* – it is the entity that accepts something. The four acceptance subject related factors that influence acceptance in particular are:

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

The second dimension is the *acceptance object*. It does not necessarily have to be a technical artefact or a thing of daily use but can also be a decision, a concept as well as a person or an institution. With regard to technology as an object of acceptance, the following factors are frequently named to influence acceptance:

- Costs and benefits of technology deployment or use
- Ease of use or usability (see also technology acceptance model)
- Aesthetic aspects of technology design, e.g. visual or auditory impairments or attractiveness
- Additionally, Taranu and Verbeeck (2018) mention that in the context of EPC the layout, wording and content are important aspects.

The third and last dimension is the *context of acceptance*. This contains all factors that can neither be associated with the acceptance subject, nor the acceptance object, but which influence the acceptance development nevertheless.

The following factors are typical contextual factors:

- The context of society as a whole: norms and values, legal framework, policy decisions, participation culture and experience, economic situation/price development. etc.
- Introduction of the acceptance object, for example with regard to organised introductions to the use of a technology (training), design of the communication process, opportunities for participation/co-design, trust or credibility of the persons shaping this process, procedural and fairness (Schäfer, Hempel & Keppler, 2013). Regarding the EPC, the legal status is an important contextual factor (Amecke, 2012).

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).

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).

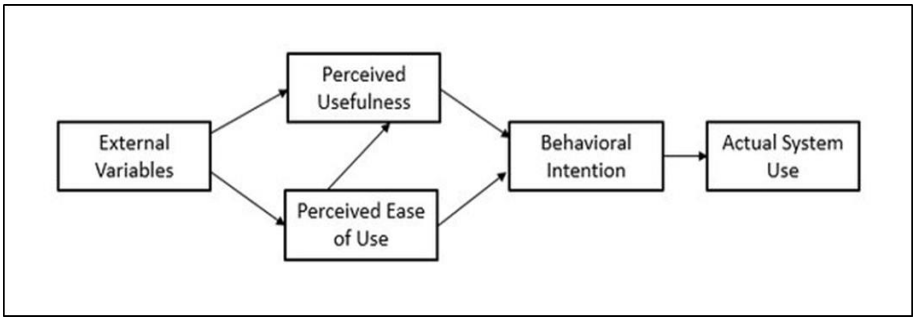

Figure 1: The technology Acceptance Model (TAM) (Venkatesh & Davis, 1996, p.453)

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 the 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).

- PEOU 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, it 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).
- BI is determined by PEOU and PU and describes someone's attitude towards using a technology. BI only describes the intention, so it does not automatically mean that the technology is actually used.

2.2.1. Extensions to the TAM-Model

The TAM is the most influential and common model in technology acceptance research. In 2000, Davis and Venkatesh created a new version of the model, the TAM 2 as depicted in Figure 2. It differs from the original one, in the respect that 'social influence processes' and 'cognitive instrumental processes' were added to further explain perceived usefulness. The social influence processes consist of subjective norm, voluntariness, and image, while the cognitive instrumental processes consist of job relevance, output quality, result demonstrability, and perceived ease of use. From these factors only the first two (**subjective norm and voluntariness**) were considered as relevant for the EPC by Wu *et al.* in 2011.

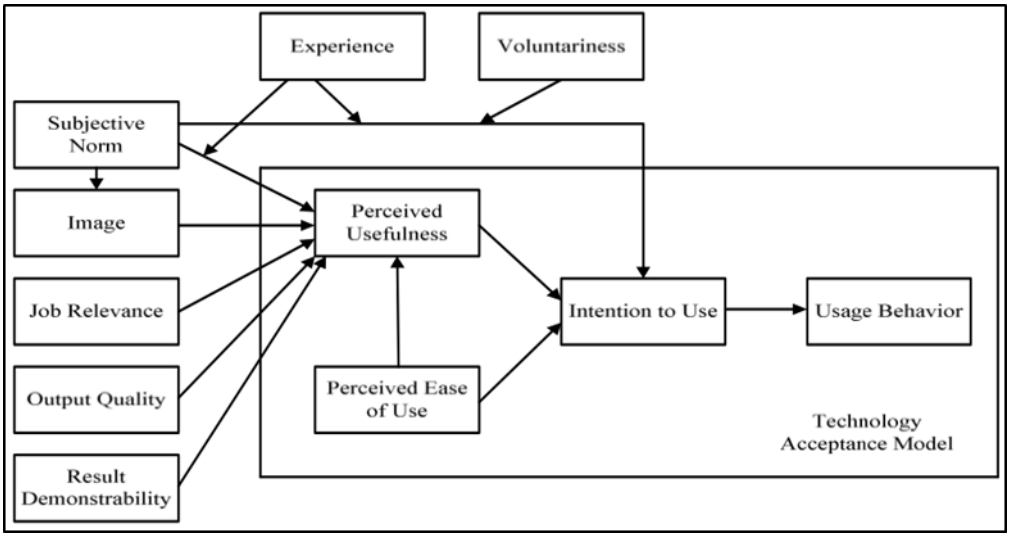

Figure 2: The Technology Acceptance Model 2 (TAM2) (Wu et al., 2011, p.136)

2.2.2. Additional factors influencing technology acceptance

It is important to acknowledge that the TAM is only one of many models that aim to explain acceptance. For instance, the Unified Theory of Acceptance and Use of Technology (UTAUT) presents another approach to explain technology acceptance. It considers among other things the **socio demographic data** (Halter, 2022). It is important to collect data about gender and cultural background as well because there are studies which illustrate the effect of these variables on the acceptance (Lee et al., 2003).

Additional variables that might influence the acceptance of EPC were identified during literature research. They are described hereafter. It should be noted that there are overlaps between some studies, so some factors are mentioned multiple times (for example personal norms and values).

- **Knowledge, social trust and environmental attitude:** Liu et al. (2018) identified these additional factors to influence the acceptance of green labelled buildings (GLRBs). Knowledge could contribute positively to the acceptance of EPC by influencing attitude and intention. Similar to social trust, which can also influence behavioural intention to accept a new technology (Liu et al., 2018). In the case of the EPC end-users need to trust the information it provides because they do not have the knowledge to determine the energy efficiency of their building and related energy efficiency measures themselves. 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. Also important to mention is that (social) trust is influenced by perceived competence, fairness and **transparency** (Schuitema et al., 2020).
- **Aesthetic**: Another study from Liu et al. from 2010 tested the acceptance for online learning courses with the help of the TAM. Liu et al. (2010) tested among other things the User-Interface Design and the Online Course Design and found out that both had a significant impact on PU as well as PEOU. From this it can be concluded that design, i.e. the aesthetics of the technology (or EPC) is relevant for the acceptance.
- Moreover, **affections** are another factor, influencing attitude towards something and therefore also acceptance (Quiring, 2006). The affect heuristic proposes that people seem to base their evaluations of a technology not only on what they think about it (e.g., benefit and risk perceptions) but also on how they feel about it (e.g., positive feeling or negative feeling) (Liu et al., 2019). Affect heuristic was at first suggested to explain how affect leads risk and benefit assessments. Emotions or affects influence judgements and decisions in the manner that positive affect can increase benefit perception and decrease risk perception, while negative affect has the opposite impacts on benefit and risk evaluations (Liu et al.,

2018). One shortcoming of TAM as well as of TAM2, TAM3 and UTAUT is that they have neglected emotions (i.e. affects) as influential factors on technology acceptance (Lee, Thi & Lin, 2017).

Figure 3 presents an overview of the theoretical background as it assigns the afore-mentioned variables, influencing acceptance, to the three dimensions acceptance-subject, -object and -context. Since awareness is considered as the first step necessary for acceptance in the phase model from Riedemann (2011) and the dynamic model from Kollmann (1998), it is at the very top of the acceptance subject related factors (Schäfer, Hempel & Keppler, 2013). The arrow between subject and object symbolises the process of acceptance, where the subject evaluates the object. The figure includes the factors that we consider important for the acceptance testing of the new EPC summary sheets at this stage of the development, as well as those factors that only become relevant once EPC was introduced as a new policy instrument. The latter are included in grey font in the figure and encompass reliability of the issuing of the EPC as well as contextual factors (status of the new EPC, the introduction and the communication with the people and the general social norms and values regarding the new EPC) (Schäfer, Hempel & Keppler, 2013) which are not covered in this acceptance test. The factors in black font are covered in this acceptance test which is described in more detail in the next chapter.

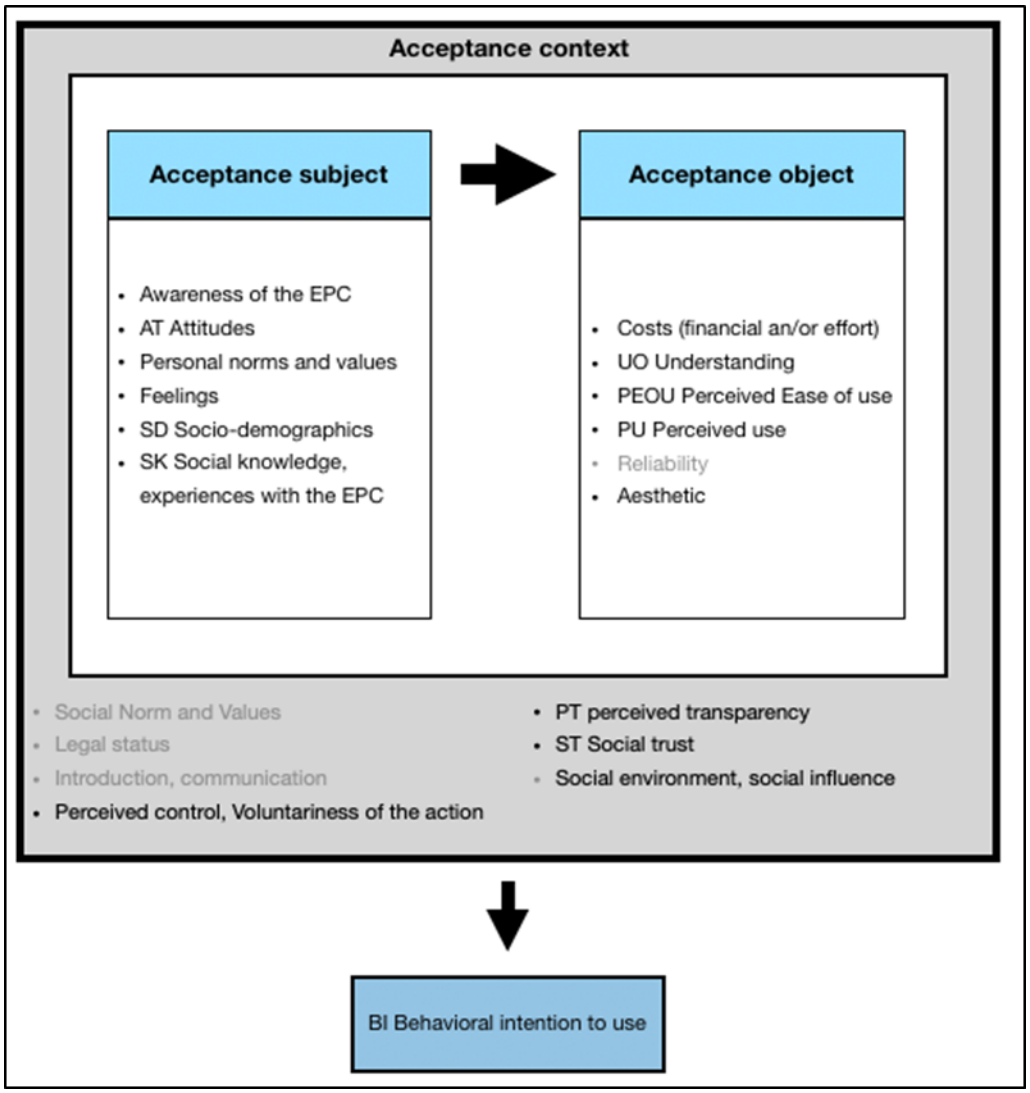

Figure 3: Overview of the acceptance factors which are considered important for EPCs (own illustration)

3. METHODOLOGY

This chapter provides the methodology that was used to develop the new EPC summary pages and to test the acceptance and impacts of the current EPC schemes and new EPC summary pages with users.

3.1. Development process of the new EPC summary pages

The development of a new EPC in ePANACEA started in November 2020 with the first draft, provided in *The Report on the Use of Innovative Certification Schemes and its implementation* (DOI: 10.5281/Zenodo.4525223). After that, the development process was characterized by several feedback loops with EPC users as well as the project consortium, as visualized in Figure 4.

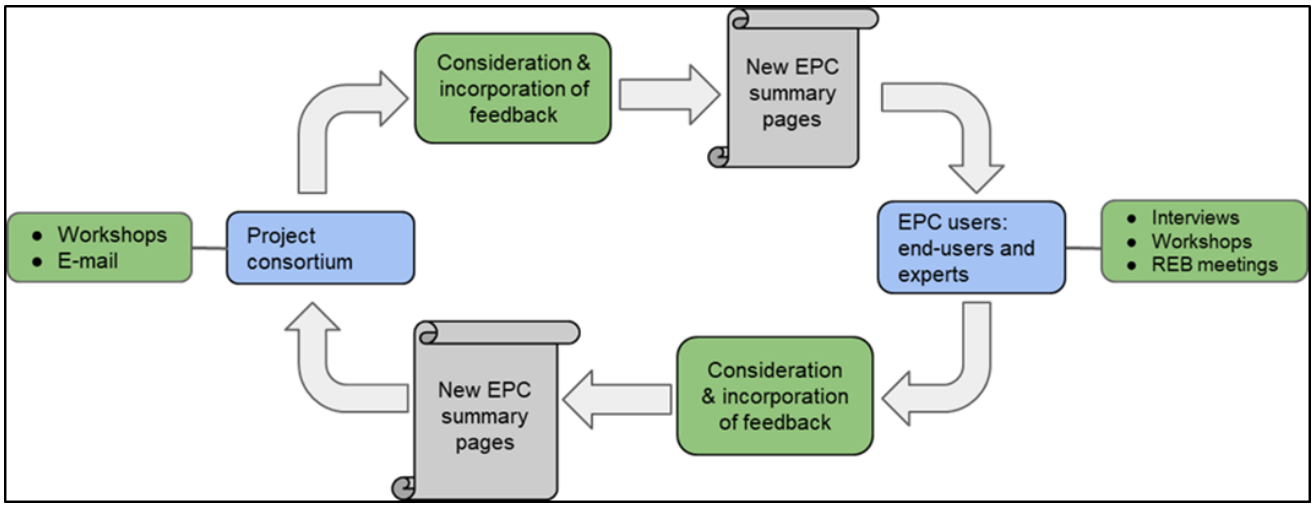

Figure 4: Development process of new EPC summary pages (own illustration)

After the development of the first draft, and the decision to develop separate EPC summary pages for experts and for end-users, two working groups (A+B) were established in order to advance the development of EPC summary pages. Working group A (led by EASt) was established for EPC summary pages oriented towards experts, while working group B (led by IZES) was established for EPC summary pages oriented towards end-users. Throughout the developing process EASt and IZES collaborated and considered the feedback from user-workshops, REB meetings and the project consortium.

The following list shows the versions of new EPC summary pages that were developed and evaluated during the project life time:

- ✓ **November, 2020:** First draft of a new ECP in The Report on the Use of Innovative Certification Schemes and its implementation (DOI: 10.5281/Zenodo.4525223).
  - Parts of it were evaluated in the second round of REB meetings in November 2021 and user-workshops in January 2022.
- ✓ **April 2022:** Update of EPC summary pages based on feedback from second REB meetings and second user workshops by EASt and IZES, April 2022.
  - This version contains 1 common, page, 1 page oriented towards experts and 2 pages oriented towards end-users
  - This version was evaluated and discussed during a workshop with the project consortium in Pamplona/online via Poll Everywhere and open discussions in April 2022.
- ✓ **May, 2022**: Update of EPC summary pages based on feedback from project consortium by EASt and IZES

- This version contains 2 common pages and 2 pages oriented towards end-users.
- Feedback via email by project partners in June, 2022.

✓ **October, 2022**: Final version of new EPC summary pages by EASt and IZES after last feedback implementation from project partners. This version is used in the third round of user workshops.

3.2. Test of acceptance of the new EPC summary pages

For the second and final acceptance test, a third round of user workshops was conducted in the ePANACEA pilot countries (Spain, Belgium, Finland, Austria and Greece). The used materials and procedures of the workshops are described below. Within the workshops, online questionnaires were used to accompany the discussion and to gather quantitative data.

3.2.1. Testing strategy

- **Test subjects (target group):** end-users and other stakeholders of EPC are the target group of the third round of user workshops. The target number is 30 per workshop and 15 per group. We considered a target number of 30 participants as realistic looking at the achieved numbers of participants of the last workshops. The more data is available for the t-test, the more robust are the results. We consider building users, owners, and managers as end-users of EPC and consider architects, energy advisors, policy makers, craftsmen, multipliers of EPC (private land lords, housing associations, real estate companies) as other stakeholders of EPC.
- **Test objects:** current EPC schemes of ePANACEA pilot countries & new EPC summary pages (version October, 2022).

Here we need to be aware that we cannot compare the acceptance of new EPC summary pages with the complete current national EPC schemes because the latter are more comprehensive. That is why project partners were asked to select the EPC pages that could be considered as summary pages of the respective national EPC schemes (e.g. pages that are representative for the whole EPC scheme). The following pages from current EPC schemes were chosen in the ePANACEA pilot countries:

- Austria: complete EPC scheme as it consists only of 2 pages
- Greece: complete EPC scheme as it consists only of 2 pages
- Belgium (Flanders): first 4 pages of the EPC scheme as they can be considered summary pages of the complete EPC scheme
- Finland: complete EPC scheme, which consists of 8 pages. It was considered to use the complete Finnish EPC scheme because it is less compact than the new EPC summary pages, which condense the information on less pages. The complete EPC scheme is considered to contain about the same element as the new EPC summary pages.
- Spain: the complete EPC scheme, which consists of 6 pages. It was considered as difficult to take single elements out of the scheme in order to reduce the number of pages. However, a short case example was chosen, keeping the length of the EPC short.

Similar to the way the first 4 pages of the Belgian EPC are considered as a summary of the whole EPC, the new EPC summary pages are considered as proxy of the report that can be generated based on the ePANACEA methods 1, 2 and 3 that are developed during the project. The ePANACEA project develops three different calculation methods to assess the energy performance of buildings, with different demands (e.g. on data) and complexity.

In order to make the new EPC summary pages and current EPC schemes more vivid for the workshop participants and allowing to ask comprehension questions (e.g. what is the primary energy use of the building?) different case examples were developed to illustrate a concrete user case.

3.2.2. Hosts and dates of the third user 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). Dates and languages of the third user workshops are presented in Table 1.

Table 1: Dates, languages and hosts of the third online user workshops in ePANACEA pilot countries:

ePANACEA country	Date	Language	Project partners
Austria	29th November 2022	German	IZES; EASt & TUW
Belgium	29th November 2022	Dutch	VITO
Spain	1st December 2022	Spanish	CENER
Greece	2nd December 2022	Greek	CRES
Finland	19th December 2022	English	VTT

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 had 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 third round of user workshops informed consent was collected from participants. The template is available from the POPD (protection of personal data) plan.

3.2.3. Workshop procedure

At the beginning of each workshop a **standardized introduction** was provided: at first, the ePANACEA project, the context and purpose of the third round of user workshops were introduced. Also, the conditions of participation (informed consent and rewards for participation) was repeated and the further course of the workshop was explained.

After that, **the group was divided into two subgroups** (group 1 and group 2) of as equal size as possible. For this purpose, the automated assignment function of Webex, Teams or Go to Meeting was used to randomly divide the participants into two groups.

Group 1 received the new EPC summary pages and group 2 received the respective current national EPC scheme (in each case a pdf file via a link). The EPC versions were not introduced or explained to the groups because the EPC is supposed to be self-explanatory. In order to test participants' acceptance and impacts of the EPC versions, participants received an online-questionnaire about the EPC. **After answering the questions, the participants were invited to reflect and discuss about the EPC versions in the two subgroups.** For this, the respective EPC version that participants did not receive at the beginning, was presented (i.e. in case of subgroup 1 participants received the new EPC summary pages in the beginning and are now provided with the current national EPC). This provided a basis to compare the two EPC versions and to discuss which version is preferred. Participants were expected to address the aspects that are particularly important to them. **After the subgroups were dissolved, the moderators of the subgroups summarized the discussions of the subgroups.** Then, the workshop was closed by thanking the participants for their participation and giving an outlook on the next steps in ePANACEA.

3.2.4. Content of online questionnaire

The last user workshops had shown that the difference in background knowledge among end-users and other stakeholders influences their perspective and evaluation of EPC proposals. Therefore, at the beginning of the online questionnaire participants were asked with which **role** they can identify themselves in relation to the EPC (e.g. end-user, architect, energy advisor etc.), in order to put the answers they provide into context. For the same reason, participants were asked about the **experience** they have made so far with the EPC.

Also, **socio-demographic data** was collected at the end of the questionnaire. Information regarding gender, age and educational background of the participant were collected as well as the participant's housing situation (owning/renting the building etc.) and the type of building the participant lives in (detached house, terraced house etc.). These variables are subject related acceptance factors that are expected to influence the acceptance of the EPC versions. They can be used to put the received answers into context.

As mentioned above, during the third round of user workshops, mostly closed questions were used in order to improve comparability of workshop results. Regarding the questionnaire design we considered that the questions used to compare the acceptance of new EPC summary pages and current EPC schemes must possibly be applicable to both, the current national EPC schemes and the new EPC summary pages. Therefore, questions address the EPC as a whole or elements that are possibly included in both, the new EPC summary pages and current EPC schemes, e.g. energy label, recommendations, context of energy performance of building, partial performance indicators etc. heterogeneous.

However, the current national EPC schemes of Belgium (Flanders), Finland, Spain, Austria, and Greece are heterogeneous. That means in terms of the understandability test not all questions can be answered in regard to all current EPC schemes. Questions that cannot be answered in regard to a specific current EPC scheme were taken out of the respective survey.

In addition, there are questions that only address the new EPC summary pages as the elements subject to the question are not included in the current EPC schemes of ePANACEA pilot countries: For instance, the question if the division of pages for end-users and other stakeholders is adequate and questions about the provision of information based on standard and actual conditions can only be asked in terms of the new EPC summary sheets. Answers to these questions deliver valuable insights about the acceptance of the new EPC summary pages.

The questions address users' understanding of information and visualizations (linked to perceived ease of use), perceived ease of use of, perceived usefulness of information and visualizations, attitude towards EPC and behavioral intention to use the EPC. These are key variables in the technology acceptance model (TAM). In addition to these constructs, users' awareness of EPCs, perceived transparency of values in the EPC, social trust in institutions issuing and controlling EPC, overall perception and feelings towards EPC, personal norms and values, social impact regarding the use of EPC, voluntariness of using the EPC as well as the willingness to pay for EPC are enquired, as we consider them to be relevant as regards acceptance of EPC. These variables are also included in black font in Figure 3 which summarizes factors influencing acceptance.

The following lists shows what topics in regard to EPC were enquired in what order in the questionnaires:

- **Relation to EPC and experience with EPC:** assignment to stakeholder of EPC, description of experience with EPC
- **Understandability test of EPC:** current energy rating, current primary energy use of the building, benchmarking of final energy rating, recommendations, potential energy rating, potential primary energy use, share of renewable energies, building components/installations in need of renovation, energy service using most energy, energy consumption factors, use of EPC, purpose of EPC, energy efficiency benefits
- **Perceived ease of use of EPC:** self-explanatoriness of EPC, perceived ease of use of EPC, importance of assistance to understand EPC
- **Perceived usefulness of EPC**

- **Overall perception of EPC:** attributions of EPC, expectations regarding EPC, appropriateness of content, language, length, layout and visualization of EPC, suggestions for improvement of afore-mentioned aspects
- **New EPC** features information based on standard/actual conditions, division of pages
- **System around EPC:** transparency of information in the EPC, trust in institutions issuing EPC, trust in institutions checking quality
- **Feelings about EPC**
- **Attitude towards EPC and energy efficiency**
- **Behavioural intention to use EPC:** voluntary use of EPC, importance of influencing factors (buying a house), importance of sources of advice (renovation), willingness to pay for EPC
- **Any other feedback**
- **Socio-demographics:** country, gender, age, highest level of completed education, housing situation, type of building

Different questions types were used:

- Multiple choice (single and multiple selection)
- Likert scale (5 levels)
- Open text
- Open mentions

By means of concrete comprehension questions we aimed at collecting information about how comprehensibly the EPC conveys information to the readers (understandability).

Some open text answers were foreseen as well in order to receive information on *why* participants answered in a certain way and what needs to be done in order to improve the EPC versions. The questionnaire mostly collects quantitative data while collecting qualitative data in addition in order to better comprehend the answers. The analysis and conclusions of the collected data is presented in chapters 4.2 and 6.

3.2.5. Software for online questionnaire: *So Sci survey*

SoSci survey (https://www.soscisurvey.de/) was used as software for the online questionnaires. In total, 10 questionnaires were established – two for each pilot country (one for the group referring to the current EPC scheme and a second one for the group referring to the new EPC summary pages). Questions were formulated in English, translated and provided as csv-files to project partners in order to check the translations. This was the preparatory work for making the questionnaire multilingual.

Other workshop material:

- Presentations for the whole group and the two subgroups
- Translated new EPC summary pages
- Case examples of current EPC schemes of pilot countries

3.2.6. Mitigation measure: online-questionnaire via e-mail

The target number of 30 filled-in questionnaires was not reached by means of the third user workshops in Belgium (Flanders), Finland and Austria. A mitigation measure was conducted in order to obtain more filled-in online questionnaires. For this, the respective questionnaires were sent to potential participants via e-mail.
In order to create a situation which was similar to the workshop (random allocation to a group), the following preparations were met:

- ✓ E-mail template for project partners to contact potential participants
- ✓ Adaptation of the questionnaires to evaluate the current EPC scheme and new EPC summary pages:

- Integration of the informed consent in the first page of the questionnaire (instead of the separate informed consent template)
- Introduction to the ePANACEA project and study in order to compensate for the missing introduction from the workshop
- Random allocation to a questionnaire (either to evaluate the current or the new EPC) after accepting to take part in the study
- Integration of the respective EPC template in the questionnaire for evaluation
- Integration of the respective other EPC template at the end of the questionnaire for interested people (i.e. all get to see the current and new EPC, if interested)

In this way, we created a frame which was similar to the participation in the workshop, which allows us to summarize and evaluate the answers collected during and outside the workshop. The only part that was missing with this mitigation measure was that participants of the mitigation measure could not take part in the open discussion. Partners from pilot countries who reached n=30 also participated in the mitigation measure in order to increase the total sample size.

3.2.7. Data processing

The data collected via SoSci survey was downloaded and processed before analysis:

- The answers to the comprehensions questions were checked for correctness and coded (1 = correct; 2 = false; -9 = no answer).
- Qualitative data collected via the online questionnaires was separated from the quantitative data and put into word document.
- Qualitative data collected via the online questionnaires was translated to English.

In addition, project partners summarized the discussions in the subgroups during the workshops based on recordings and minutes and sent the summary (1-3 pages) to IZES. The summaries included the negative and positive aspects mentions regarding the two EPC versions as well as the suggestions to improve the new EPC summary pages.

3.2.8. Analysis of quantitative data

Quantitative data was analysed in the statistical programme *Jasp*. It was used to calculate T-tests and for descriptive analysis. The t-test can be used to evaluate whether two groups significantly differ from each other (e.g. current EPC versus new EPC). Hence, the t-test will allow us to answer, whether participants of an ePANACEA pilot country significantly accept the new EPC summary pages better than the current national EPC scheme.

Our null hypothesis is: "the new EPC summary pages perform worse than/ as good as the current national EPC schemes in Spain, Belgium (Flanders), Finland, Austria, and Greece". We are only interested whether the new EPC summary pages perform better. Undesired outcomes are that the new EPC summary pages perform as good as/ worse than the current national EPC schemes. **Ho: $\mu 1 \leq \mu 2$**

Our alternative hypothesis is: "the new EPC summary pages perform better than the current national EPC schemes in Spain, Belgium (Flemish region), Finland, Austria and Greece". H_1:$\mu 1 > \mu 2$

Therefore, we use a one-tailed T-test (directional T-test) because we are interested in whether the new EPC summary pages perform better than the current EPC schemes.

Risk of wrong conclusion: $\alpha = 0.05$. This means there is a risk of 5% to conclude that the mean of the group that received the new EPC summary pages is higher when in fact it is not.

A t-test was calculated for items which are expected to depend on the presented EPC versions (e.g. perceived ease of use, perceived usefulness). Mean-composite variables were formed if a topic (e.g. behavioural intention to use EPC) was tested based on several items. In this way, we can e.g. explore whether the overall behavioral intention differs significantly, which is more meaningful than if the results regarding one item are significantly different. The following mean-composite variables were formed and tested:

- **Understanding of EPC features** was formed based on the means of the understanding of EPC elements which were present in the respective current and new EPC.
- **Characterization of EPC:** The mean-composite variable "characterization of EPC" was formed based on the means of four items testing the characterization of EPC.
- **Appropriateness of EPC":** A mean-composite variable "appropriateness of EPC" was formed based on the means for the aspects visualization, layout, length, language and content of EPC.
- **Feelings about the EPC** was formed based on the means for the items "motivated", "confused", "overwhelmed", "bored", "determined", "alert" and "interested" in order to show whether the feelings regarding the new EPC in general are more positive than regarding the current EPC. For the comparison the reversed scores of the items "confused, overwhelmed and bored" were formed.
- **Attitude towards EPC** was formed based on the means of three items testing attitude towards EPC.
- **Behavioral intention to use EPC** was formed based on the means of four items testing the behavioral intention

For other categories summarizing variables were used in the questionnaire, e.g. for perceived ease of use and perceived usefulness. The results of these summarizing variables are also expected to be more meaningful than the result of single items in the category. The overall acceptance of EPC is expected to be most apparent in the answers to the questions enquired by: "attitude regarding EPC"/ "willingness to use".

Variables which are independent of the presented EPC such as socio-demographics, were analysed descriptively per group. There are also variables for which we did not distinguish between the two groups, such as factors influencing the decision to renovate or to buy a house as the answers are expected to be not dependent on the presented EPC.

In order to visualize the results histograms and profile lines were developed. The histograms show the distribution of answers to a single item or a summarizing variable. The profile lines show the means of a group for different items within one category. In the results chapter all significant t-test are mentioned. Results are reported in chapter 4.2.

4. RESULTS

This chapter provides the results of the development process of the new EPC summary pages and the acceptance tests. The results of the acceptance test are first presented per country – comparing the results regarding the current and new EPC and then among countries – only comparing the answers regarding the new EPC pages.

4.1. Development process of the new EPC summary pages

This subchapter provides the documentation of new EPC versions and the feedback that was taken into account from users and the project consortium. It also comments on the received feedback (explains why feedback was taken into account or not). Feedback was incorporated (or not) after careful consideration by EASt team and IZES.

The initial tasks and discussions by working group A + B about the summary sheet indicators are documented in *Assessing user-friendliness of proposals for a new EPC (DOI: 10.5281/zenodo.6334736).* Based on this the proposals for elements of a new EPC were formulated and presented in the second user workshops and REB meetings. Based on the feedback and preferences by end-users and experts the second version of new EPC (Version 12/04/2022) was developed.

4.1.1. New EPC summary pages – Version 12/04/2022

The most important choices and improvements that were made based on feedback from the second users workshops and REB meetings (cf. *Assessing user-friendliness of proposals for a new EPC (DOI: 10.5281/zenodo.6334736 and Minutes of 2nd Set of Meetings of Northern, Western, Central, Southwestern and South-eastern Regional Exploitation Boards (REBs) (DOI:10.5281/zenodo.6334763))* are listed hereafter:

- ✓ **Energy label**
  - colours of classification were made more intuitive
  - energy label, which is reminiscent of the energy label for electronic devices, was selected
- ✓ **Overall main performance indicators**
  - For both target groups, experts/administration and end-users, primary energy use, final energy use and GHG emissions were chosen as overall main performance indicators.
- ✓ Short explanatory texts of visualizations for end-users were added
- ✓ Calculation basis of values in the EPC is presented (e.g. to make transparent how costs and potentials were calculated in order to increase the comprehensibility).
- ✓ Benchmarking of final energy use: the granularity of the graph was changed; zoom into the classes 'my building' and most buildings are in, the bad energy efficiency classes were combines into bigger ones
  - Visualization of energy flows: illustration was simplified. The term 'primary energy' is clearly mentioned on the left side and "final energy" on the rights side.
- ✓ **Partial performance indicators**
  - Final energy consumption and break down into separate energy services:
    - Most improvements concern the linking of information with the graphs. In this course, icons were place in the pie charts, a building icon was added to show the sum of the energy use of the displayed energy services.
    - The amount of displayed information was reduced: the information about energy use in [kWh/year] was removed as energy use is also indicated per square meter, in [kWh/m2 year].
  - The more sophisticated proposal was chosen for the summary pages for administration/experts, while the easier version was chosen to be included on the summary pages for end-users. In this way, U-values are not provided on the summary pages for end-users. Instead of this, only an indicative scale is provided.

- ✓ **Graphs of actual and potential renewable energy use**
  - This visualization has been changed in the sense that the share of primary renewable and non-renewable energy use is now presented in a separate visualization. The pie charts are continuously used to show the actual and potential renewable energy systems on-site of final energy use. Also, the list of considered renewable energy technologies was extended by geothermal and biomass, while wind energy was removed from the list.
- ✓ **Recommendations for stepwise renovation**
  - The expected energy savings for each measures were added.
- ✓ **Additional performance indicators**
  - Indoor air quality (IAQ) and thermal comfort are included on the summary pages for end-users, while the SRI and IAQ indicator are included on the summary pages for administration/experts (SRI is not understandable to end users, while thermal comfort is not interesting for administration/experts).
- ✓ **Standard and actual conditions of use**
  - Information about the energy efficiency rating based on actual conditions of use *in addition* to energy efficiency rating based on standard conditions of use is maintained for the EPC summary pages for end-users.
- ✓ **Format of EPC**
  - Appreciation of a more dynamic and digital, even interactive EPC is recognized among users of EPC. However, the implementation of this will not be covered by ePANACEA. This could happen e.g. in a follow-up project.

4.1.2. Validation and discussion of changes at GA in Pamplona/online, 13/04/2022

The changes described above and specific questions were presented, validated and discussed during a workshop at the GA in Pamplona and online. For the validation of changes and collection of answers the software poll everywhere was used. The most important remarks and recommendations are listed here after:

- ✓ **Overall comments**: the target group does not only contain administration but also experts.
- ✓ **There was a controversial discussion about providing information about costs at all**. It is valuable to provide at least *an estimation* of costs of energy uses to end-users based on the energy prices on the date of issuance of the EPC.
- ✓ **Overall main performance indicators:**
  - The two indicators primary energy use and GHG emissions indicators shall be displayed on the first summary pages, while other main performance indicators (e.g. final energy use) shall be displayed on the pages oriented towards authority/experts or end-users.
  - Leaving room for a national specific indicator on the first page of the EPC (so e.g. a renewable energy use indicator can be chosen for the Spanish EPC).
  - No annual cost indicator should be displayed as overall main performance indicator on the first page, despite the great interest from end-users, because accuracy of this information cannot be guaranteed.
  - Controversial discussion about rating more than one overall main performance indicator (primary energy use). Conclusion was to rate the primary energy use and GHG emission indicator.
- ✓ **Partial performance indicators for building components/installation:** the simplified version for end-users was appreciated (use of an indicative scale instead of U-values and targets). However, it was recommended to stick to the use of colours to indicate the energy performance instead of stars.
- ✓ **Standard and actual conditions of use:** 70% of the project partners (n=10) agree to only provide information based on actual conditions of use in addition to information based on standard conditions of use on the summary sheets oriented towards end-users.

Based on the validation and remarks a next version of EPC summary sheets (30/05/2022) was developed by the leads of working group A (EASt) and B (IZES). The most important changes are listed here after.

4.1.3. New EPC summary pages – Version 30/05/2022

- The orientation of summary pages was adjusted in the way that in this version the first two pages are oriented towards all (experts/administration and end-users), whereas the proceeding two pages are oriented towards end-users. Still, all pages shall be accessible to all because there is a lot of information that is interesting for both groups.
- In the energy label space is provided for a national overall main performance indicator.
- Clear indication of how costs (in this case financial savings) were calculated ("calculated at the date of issue of the EPC; price taken from the data base 'statistic Austria').
- The ALDREN tail[1] was used to replace the comfort indicator and IAQ indicators since the ALDREN tail encompasses fours dimensions of comfort (thermal, acoustic and luminous environment and IAQ).
- Improvement of visualization of energy rating of building components and installations (colours used instead of stars)
- Potential of renewable primary energy used on-site from different renewable energy sources: decision to indicate the potential per renewable energy technology, not as total. Also here room was added for an additional national indicator that can be selected. In addition, this section contains information about how the potential can be achieved.

4.1.4. Feedback loop with project consortium via E-mail in May-June 2022

This section shows insights into the main cumulated feedback points from project partners, received via e-mail in May and June 2022. The feedback was also incorporated in the new EPC summary pages by EASt and IZES.

4.1.4.1. *Insights in main feedback from project partners*

✓ **Structure of the EPC summary pages**

- It is important to separate the most important information (EPC ratings, EPC main indicators and the potential of the energy efficiency measures) from additional indicators (such as SRI and comfort) or complementary information such as the breakdown of the different EPC indicators per service and energy needs (heating, cooling, DHW, etc.).

✓ **Add explanations of information**

- Highlight the purpose of the document
- Make clear what the purpose of the visualization of energy flows is
- Indicate whether information is based on calculated energy performance with standard conditions or on calculated energy performance with actual conditions.
- Final energy use and associated costs of energy services: In equipment/other services maybe 'non-EPB services' should appear to notice that they are the rest of services (not considered in calculation of energy performance of building).

✓ **Standard/actual conditions of use as information basis**

- The energy rating should be based on standard conditions to make the buildings comparable, but the selection of the package of EEMs can be based on actual conditions. The advantage of this approach is to have more accurate EEMs, adapted to real conditions and real end-user behaviour, as well as actual socio-economic personal situation. The disadvantage is that information based on actual conditions should be changed when the end-user pattern changes.
- -> Provide information of the rated main performance indicators based on standard and on actual conditions.
- -> Base recommendation on actual conditions of use

✓ **Recommendations**

[1] ALDREN available from https://aldren.eu/aldren-tail/ [Accessed 11th July 2022]

- Do NOT include payback times or similar information based on energy costs, because of energy performance gap and volatility of energy prices.
- Indicate total investment but not investment per year.
- In line with the EPBD draft, the recommendations "*shall provide an estimate for the energy saving and the reduction of operational greenhouse gas (GHG) emissions…*" -> add information about GHG emission savings

✓ **Partial performance indicators**

- Add values to partial indicators (and not only rating scale); for instance system efficiency for space heating, system efficiency for space cooling, system efficiency for DHW (domestic hot water))

✓ **Additional performance indicators**

- Show information about IAQ [CO2 concentration in ppm] and thermal comfort (according to the Fanger model) as it can be delivered by the ePANACEA methodology instead of using the ALDREN tail.

✓ **Annex V of the draft of the new EPBD**

It includes a list of all the information that the EPC must contain. Although EPC *summary pages* were prepared, which do not claim to cover all information, this list may be useful.

The incorporation of the most feedback points from project partners resulted in the Final draft version before third user workshops (cf. Annex). However, the new EPC summary pages are not fully aligned with the ePANACEA methodology yet, as these were developed in parallel in the project. The new EPC summary pages are therefore more a result of the needs and wishes of the users and project partners with whom we spoke during the development process.

4.2. Results of acceptance tests

First, this subchapter presents the results of the acceptance test per country – comparing the results regarding the current and new EPC. In the second half of the subchapter the results regarding the new EPC pages are compared among pilot countries.

For the comparison within the pilot countries, the socio-demographics, stakeholder types and previous experiences with EPC per group are presented. The chapter proceeds with the results of the comprehension test of EPC features, perceived ease of use and usefulness of EPC, characterization of EPC and evaluation of appropriateness of EPC, per EPC group as well as the fulfilment of expectations towards EPC. After that, the evaluation of new EPC features (division between pages by target group and provision of information based on standard and actual conditions) is presented, which is followed by the report on the feelings towards EPC, attitude towards EPC and energy efficiency, behavioural intention to use EPC including willingness to pay and any other feedback we received per EPC group. The subchapter closes with an overview of the discussion during the workshop and a conclusion on the comparison of acceptance between the two groups.

For the afore-mentioned topics the histograms, profile lines and results of-tests are reported, as well as the supplementary qualitative insights. The asterisks behind an item indicate that an item is significant regarding the difference between the new and current EPC group. All significant differences of mean-composite, summarizing and individual items are reported.

The target number of participants was reached or exceeded in 4 (out of the 5) ePANACEA pilot countries, as presented in Table 2. The table also informs about what number of online questionnaires were filled-in within the context of workshops or under the mitigation measure.

Table 2: Number of participants in the third round of user workshops

Pilot country	Format	Current EPC		New EPC		Total	
		Responses	Target	Responses	Target	Responses	Target
Austria	context of workshop	6		18		**24**	
	mitigation measure	10		1		**11**	
	Total	**16**	**15**	**18**	**15**	**35**	30
Belgium (Flanders)	context of workshop	4		6		**10**	
	mitigation measure	10		10		**20**	
	Total	**14**	**15**	**16**	**15**	**30**	30
Spain	context of workshop	**15**		**15**		**30**	
	mitigation measure	**4**		**4**		**8**	
	Total	**19**	**15**	**19**	**15**	**38**	30
Greece	context of workshop	15		18		**33**	
	mitigation measure	2		4		**6**	
	Total	**17**	**15**	**22**	**15**	**39**	30
Finland	context of workshop	7		7		14	
	mitigation measure	1		2		0	
	Total	8	15	9	15	17	30
Total n participants		**74**	**75**	**84**	**75**	**159**	**150**

target met/exceeded
target almost met
target not met

4.2.1. Austria

The following subchapter presents the results of the third user workshop in Austria. In total 35 questionnaires were filled in in Austria, with 16 responses regarding the current EPC and 18 responses regarding the new EPC.

4.2.1.1. *Socio-demographics*

As presented in Figure 5, in the current EPC group the proportion of males was significantly larger with 71% of participants being male. In the new EPC group the genders were roughly equally distributed with 53% males and 47% females. The majority in both groups is owning the house they live in (63% of the new EPC group and 59% of the current EPC group). The second largest group is renting their home (29% of the current EPC group and 26% of the new EPC group). Other mentions in both groups consist of "flat owner".

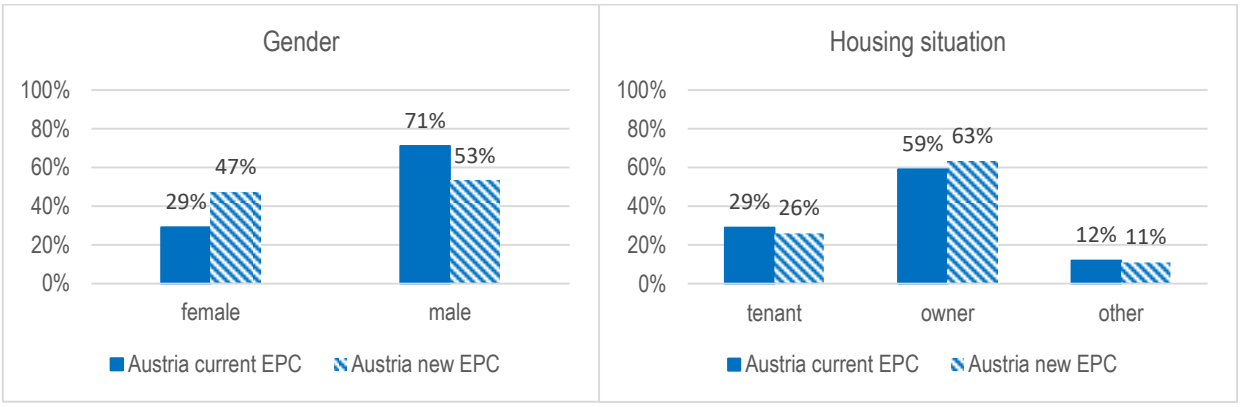

Figure 5: Gender and housing situation of Austrian participants

The majority of participants of the new EPC group lives in a terraced house (50%), while 39% indicated to live in a detached house. From the current EPC group 41% indicated to live in apartment blocks, while 29% live in a terraced house and 18% in a detached house. A wide age range was represented in the two groups, ranging from 20-24 years to 65 years or older in the new EPC group and 15-19 years to 65 years or older in the current EPC group. In general, the age groups are about equally represented, with the highest fraction of participants being 50-54 years old (26%) in the new EPC group and the highest fraction of participants being 25-29 years old (18%) in the current EPC group. The great majority of participants has a university degree (82% of the current EPC group and 74% of the new EPC group).

4.2.1.2. *Relation to EPC and experiences with EPC*

Figure 6 shows that different types of stakeholders were present in both groups. The largest stakeholder group is made of end-users (71% in the current EPC group and 68% in the new EPC group). Besides, in the new EPC group policy makers, EPC issuers, energy advisors and architects as well as other experts in the field like energy planners and operators of heating plants were present. In the current EPC group as well, EPC issuer, energy advisors, architects and multiplier of EPC as well as a representative of a building authority were present.

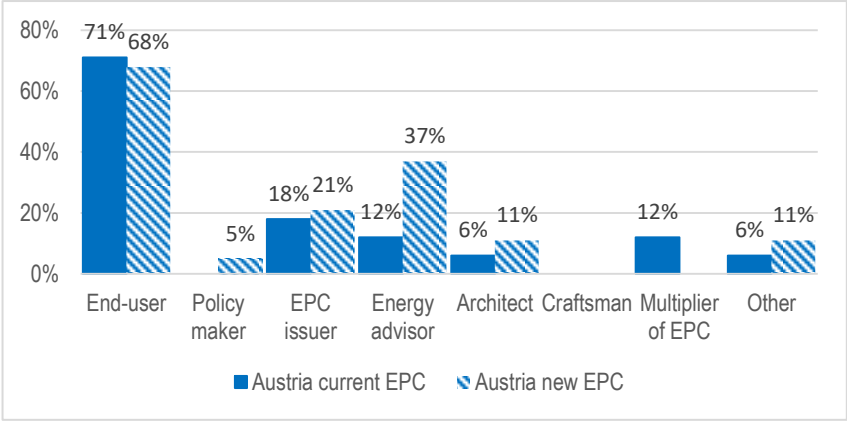

Figure 6: Stakeholder types in the Austrian workshop

The majority of participants in both groups had experience with the EPC before the workshop (88% of the current EPC group and 74% of the new EPC group indicated so). In addition, in the current EPC group a participant identified him/herself with a building authority. In the new EPC group participants mentioned to work at a local heating plant and to work as energy planner. The described experiences are summarized in Table 3. They show that participants were in contact with the EPC before in a professional context (during their job) and as end-users (apartment-hunting, during house building) in both groups.

Table 3: Description of experience with EPC in Austria

Current EPC group	New EPC group
• Building/buying a house • Apartment-hunting • As a landlord • During my work (e.g. as energy advisor) • Energy renovation • Curiosity	• During my job • During house/apartment building • Apartment-hunting, real estate adverts • Heating system change to local heating plant • As a landlord

4.2.1.3. *Understanding of EPC elements*

The answers are coded as 1 for a correct and 2 for a wrong answer. The means per group (current and new EPC) for each item of understanding of EPC elements are shown in Figure 7. Except for understanding of current energy rating the profile lines for the two groups have a similar course: purpose of EPC, energy efficiency benefits and use of EPC is understood better than the current primary energy use and energy consumption factors in both groups.

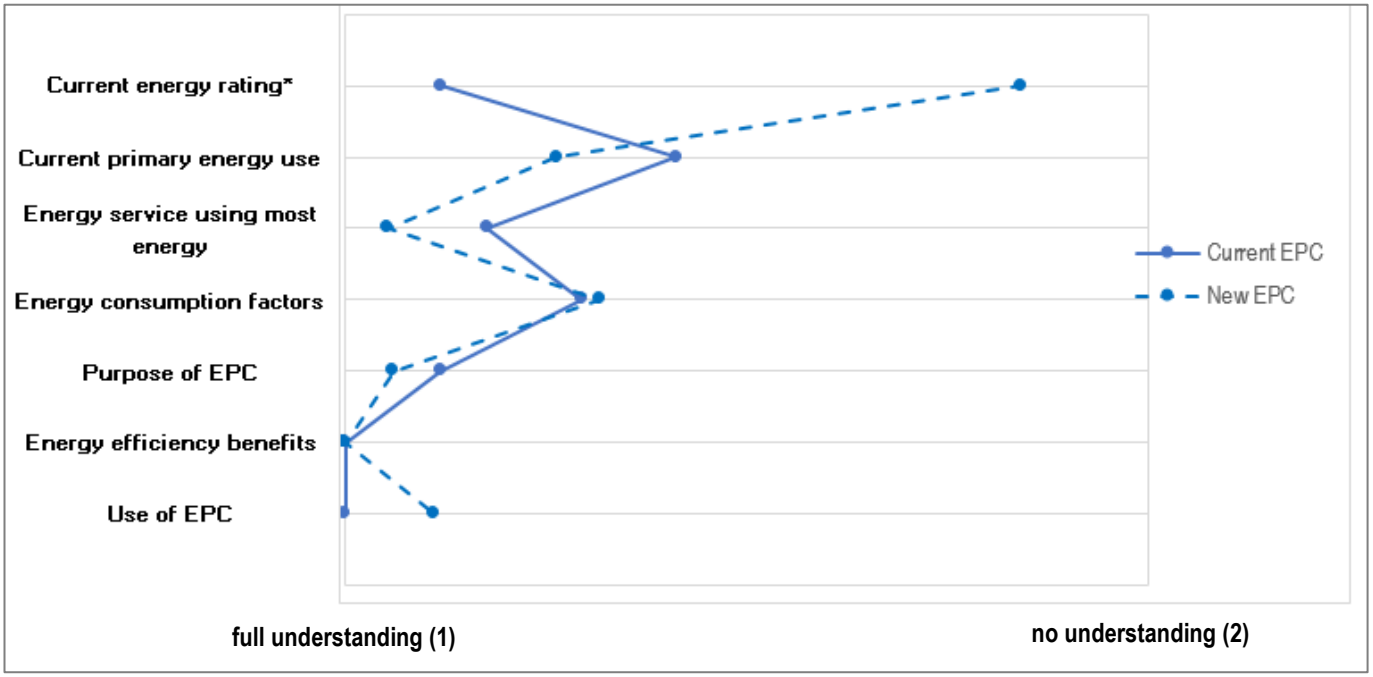

Figure 7: Understanding of EPC features in Austria

***Current energy rating:** The groups differ significantly, t(34)= -6.108, p < .001. The mean for the new EPC group (M = 1.842, SD = 0.375) is significantly higher than the current EPC group (M = 1.118, SD = 0.332), indicating that the current energy rating is better understood by the current EPC group than the new EPC group.

Mean-composite variable "understanding of EPC features": The groups do not differ significantly, t(32) = -1.604, p = .059. The composite mean for the new EPC group (M = 1.235, SD = 0.123) is not significantly higher than the current EPC group (M = 1.160 SD = 0.151).

4.2.1.4. *Understanding of new EPC features*

From Figure 8, it is noticeable that all new EPC features were understood by the majority (ranging from 68-95%). Based on this, the information on benchmarking of the final energy rating would most likely have to be improved. The intention of the benchmarking of the final energy use is to put the energy rating of the building in context to the energy performance of other buildings, i.e. to compare the energy performance to other similar buildings.

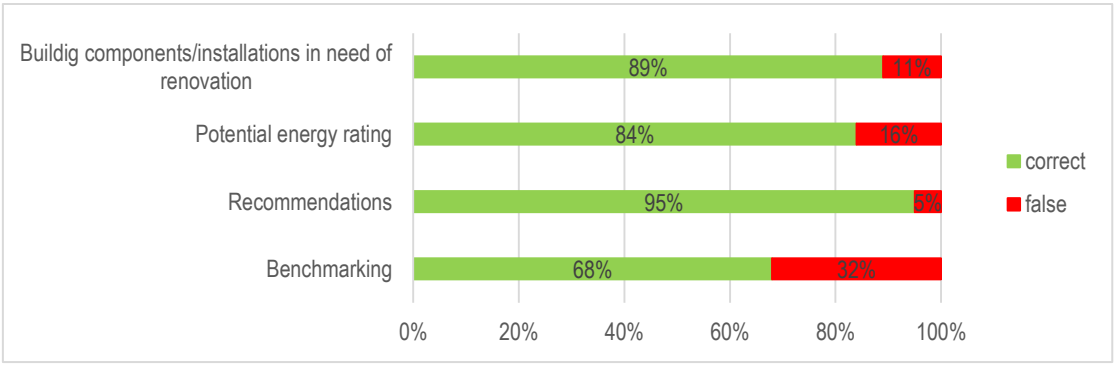

Figure 8: Understanding of new EPC features in Austria

4.2.1.5. *Perceived ease of use of presented EPC*

In contrast to the positive result of the comprehension test shown before, the majority of both groups does not find the presented EPC easy to understand. This means that most enquired elements of EPC were understood correctly, but the participants do not find it easy to understand the information, which could be interpreted to mean that they do not understand the information at first glance, have to concentrate a lot to understand or are not sure whether they understand the information correctly. Perceived ease of use was tested on a 5-point Likert scale. The groups do not differ significantly, t(33)= -0.04, p = .484. The mean of the new EPC group (M = 2.579, SD = 1.387) is not significantly higher than the current EPC group (M = 2.563, SD = 0.964). Noticeable is that many participants of the two groups did not find the presented EPC self-explanatory: 69% of the current EPC group answered negative, while still 50% of the new EPC group said so.

Table 4 specifies the parts which were not perceived as self-explanatory.

Table 4: Parts which are not self-explanatory regarding the presented EPCs in Austria

Current EPC	New EPC
• Display of final energy use	• Too technical for non-experts to understand
• Vocabulary is full of technical terms	• Additional indicators: • Living comfort • How is the air quality measured? • What does SRI mean? (Smart Readiness Indicator)
• Some abbreviations	• Primary energy use and primary energy use after renovation
• Energy classes	• Benchmark final energy use
• Energy use needs to be more comparable	• What exactly is the reference floor area?
	• Different values for heating energy use are confusing

In line with this, 94% of the current EPC group would appreciate assistance in understanding the EPC, while still 80% of the new EPC group expressed this. Figure 9 shows that on average, both groups find additional explanations in the EPC and online support important in understanding the EPC, while the current EPC group also evaluated an accompanying manual as important. Least important in both groups would be a hotline and a help desk on site.

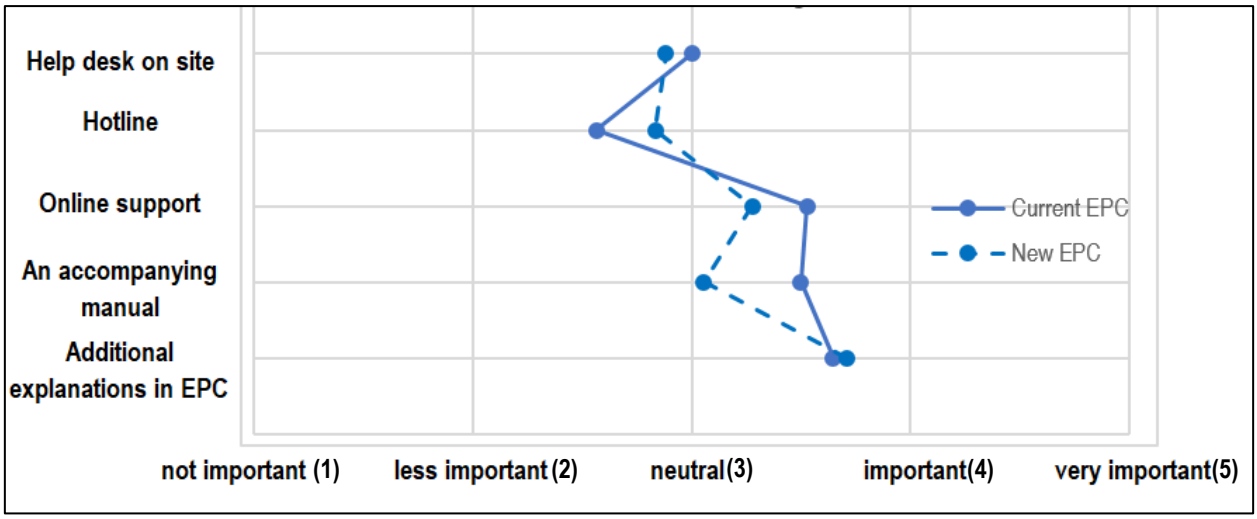

Figure 9: Importance of information in assisting in understanding the EPC in Austria

4.2.1.6. *Perceived usefulness of presented EPC*

Figure 10 shows the means for perceived usefulness of EPC information per group, on a 5-point Likert scale. Perceived usefulness was tested on a 5-point Likert scale. The course of the profile lines looks similar for both groups: both groups rated the usefulness of the EPC lowest for receiving information about the living comfort in a building. On average, both groups agree that the presented EPC is useful to receive information about the EPB, energy costs and the EPB in comparison to other buildings.

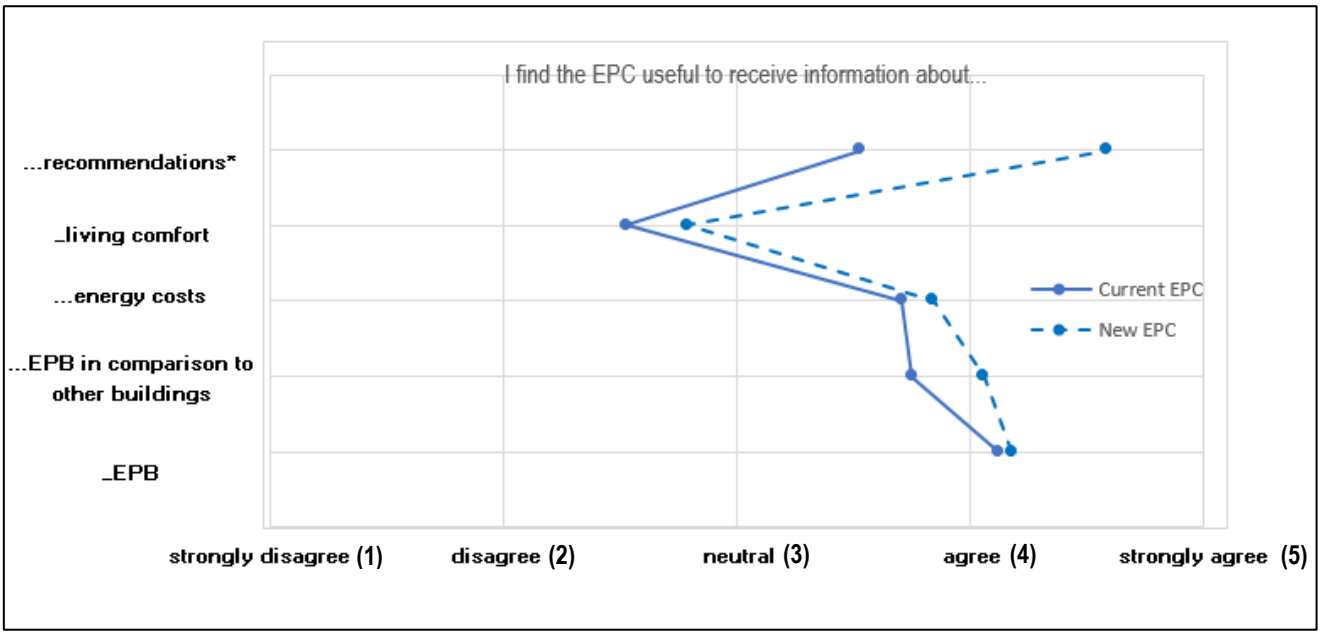

Figure 10: Perceived usefulness of EPC information in Austria

***Recommendation:** the groups differ significantly, t(32)= -3.402, p< .001. The mean for the new EPC group (M = 4.588, SD = 0.507) is significantly higher than the current EPC group (M = 3.529, SD = 1.179), indicating that the recommendations are perceived as significantly more useful by the new EPC group than by the current EPC group.

When comparing the perceived usefulness of the EPC to provide information about additional indicators (IAQ, thermal comfort, costs to run the building) the groups show a significant difference: t(34)= -2.035, p = .025. The mean of the new EPC group (M = 2.737, SD = 1.368) is significantly higher than the mean of the current EPC group (M = 1.941, SD= 0.899), indicating that the new EPC is more useful to learn about the air quality in the building than the current EPC.

Figure 11 shows participants' answers to their overall perceived usefulness of the presented EPC. The largest proportion of participants of the current EPC group (59%) agrees that they find the EPC useful, while the largest proportion of participants of the new EPC group (61%) strongly agrees with the statement.

Overall perceived usefulness: The groups do not differ significantly, t(33)= -1.52, p = .069. The mean of the new EPC group (M = 2.579, SD = 1.387) is not significantly higher than the current EPC group (M = 2.563, SD = 0.964).

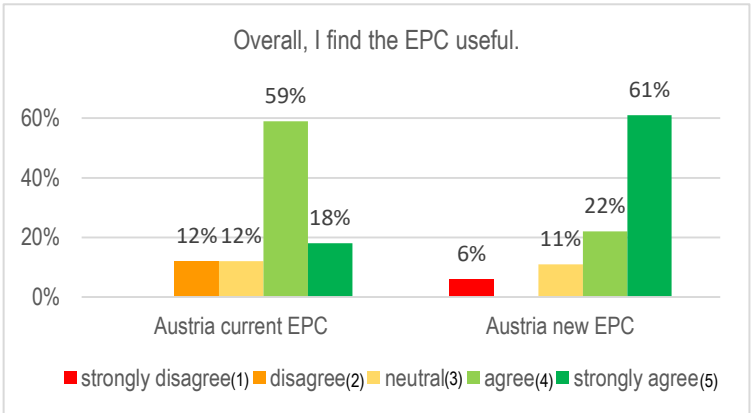

Figure 11: Overall perceived usefulness of EPC in Austria

4.2.1.7. *Evaluation of new EPC features*

Figure 12 indicates that the participants of the new EPC group are not satisfied with the division of pages yet. The suggestions for improvement indicate that the division between pages for target groups was not fully understood by the participants because they mentioned aspects which are already implemented. To include page numbers at the end of each pages was one suggestion that can still be taken into account.

From Figure 13 we can see that the majority (59% + 24%) perceives the information based on standard and actual conditions in the EPC as useful. Also, the majority perceives it as easy to understand; however; also 28% indicate to not find it easy to understand at all, demanding an improvement of the provision of information. Participants mentioned that they could not find difference between information based on standard or actual condition of use or did not understand question. They also asked about longer explanations about what is taken into account as standard/actual conditions.

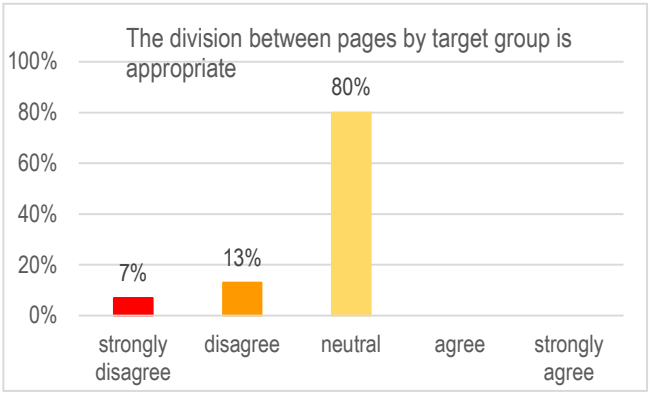

Figure 12: Perceived appropriateness of division between pages in Austria

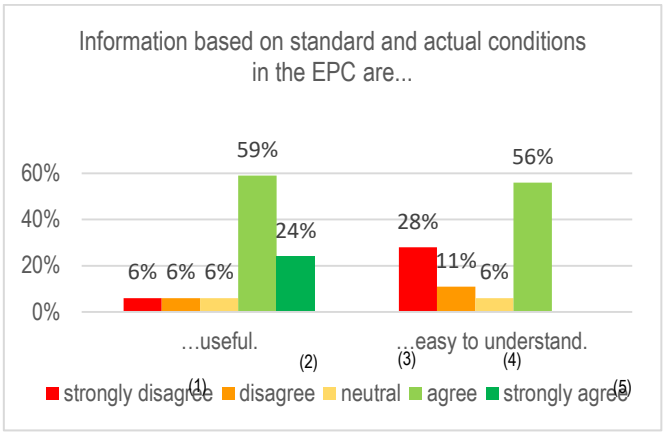

Figure 13: Evaluation of new EPC features in Austria

(1)

4.2.1.8. *Feelings about the EPC*

Figure 14 shows the means regarding the feelings regarding the presented EPC per group.

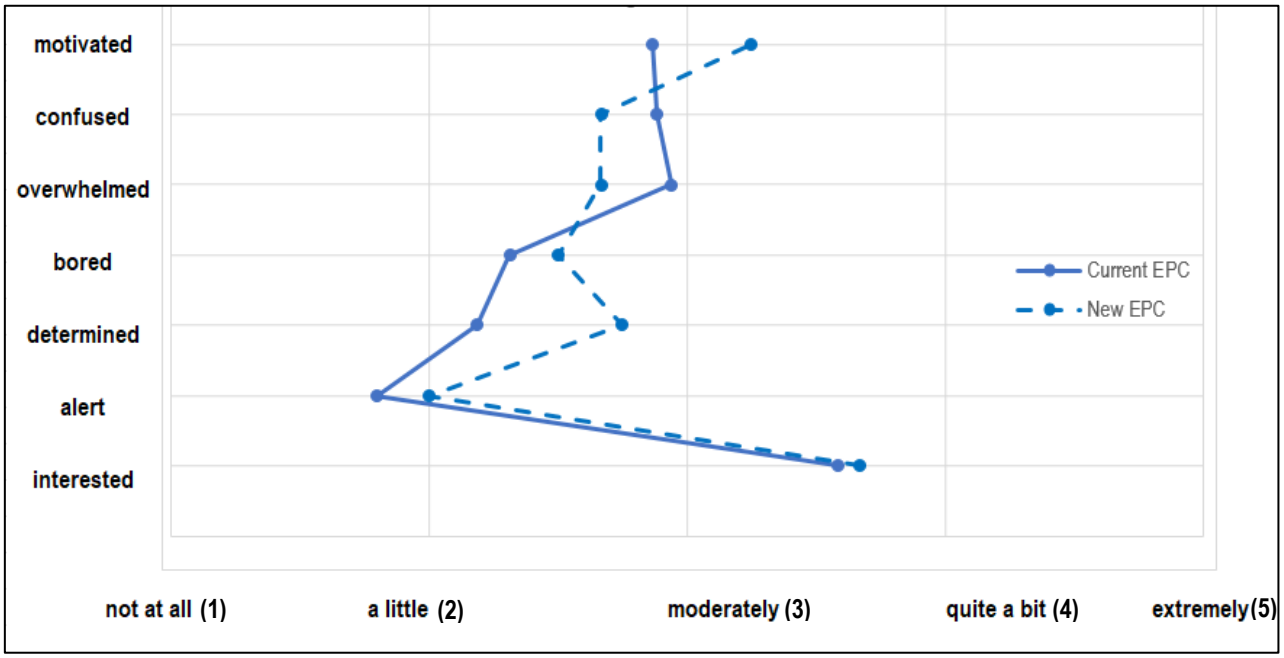

Figure 14: Feelings about the EPC in Austria

***Mean-composite variable "feelings about the EPC"**: the groups differ significantly, t(23) = -2.0960, p = .024. The composite mean for the new EPC group (M = 3.393, SD = 0.559) is significantly higher than the current EPC group (M = 2.901, SD = 0.610), indicating that the new EPC groups in general had more positive feelings that the current EPC group regarding the presented EPC. This interpretation is also supported by the diagram above.

Other feeling mentioned by the current EPC group: The positive answers hint at curiosity and interest to learn more about the EPC. Regarding negative comments, one participant complained of tiredness, whereas another participant reported his obligation to finish the questionnaire. Of the mixed feelings, one participant reported confusion about some parts of the current EPC alongside general interest, whereas the second participant reported that his experience with the EPC started out overwhelming, but ended with clarity.

Other feeling mentioned by the new EPC group: The negative anwers included anger about non-explained technical terms and overwhelmedness with bureaucracy and a wish for support in self-certification. The positive emotions included contendedness, curiosity, motivation, interest and feeling informed and sensitized.

4.2.1.9. *Overall perception of EPC*

Figure 15 shows the means for the characterization of EPC per group. We can see that mean for the new EPC group is higher regarding the individuality and the usefulness of the EPC, but lower regarding the organization and clearness of the EPC than the current EPC group.

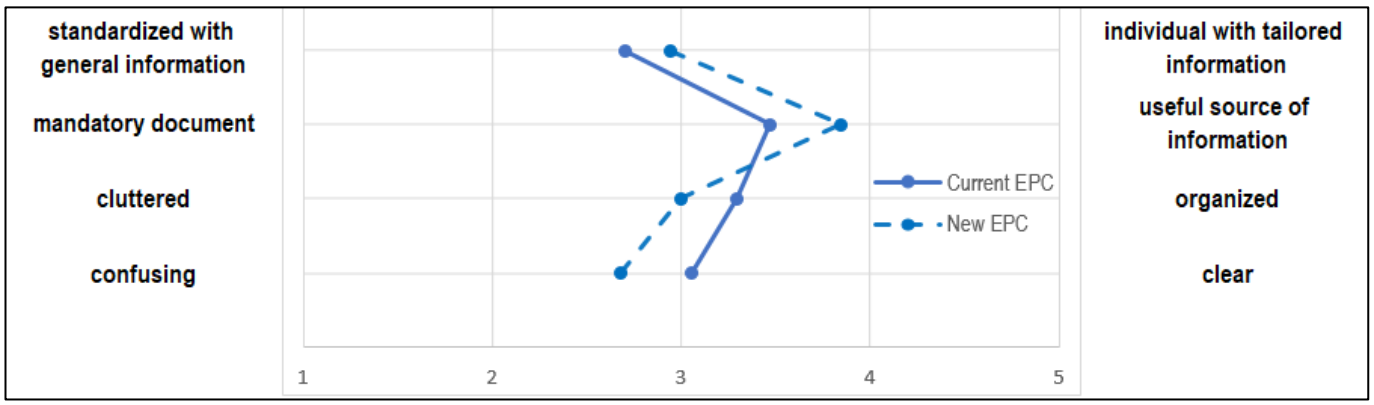

Figure 15: Characterization of EPC in Austria

Mean-composite variable "characterization of EPC": The groups do not differ significantly, t(34) = 0.046, p= .0518. The composite mean for the new EPC group (M = 3.118, SD = 0.944) is not significantly higher than the current EPC group (M = 3.132, SD = 0.853).

Regarding the fulfilment of expectations regarding EPC (i.e. Figure 16) the answers are mixed in both groups, with a tendency towards "neutral/expectations are met" in the current EPC group.

Fulfilment of expectations: the groups do not differ significantly (34) = 0.680, p = .749. The mean of the new EPC group (M = 3.053 SD = 1.224) is not significantly higher than the current EPC group (M = 3.294, SD = 0.849).

When asked about what is needed to meet participants' expectations they repeat that explanations for laymen are needed (e.g. as an online supplement), a clearer layout, less pages and less technical values. From Figure 17 we can see that the mean for the new EPC group and the current

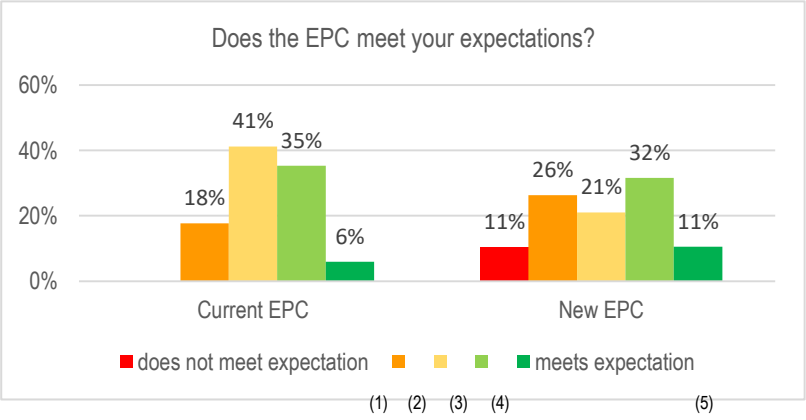

Figure 16: Fulfilment of expectations regarding EPC in Austria

EPC group regarding appropriateness of the length and the language of the EPC is very similar (both groups evaluating the presented EPC as rather appropriate).

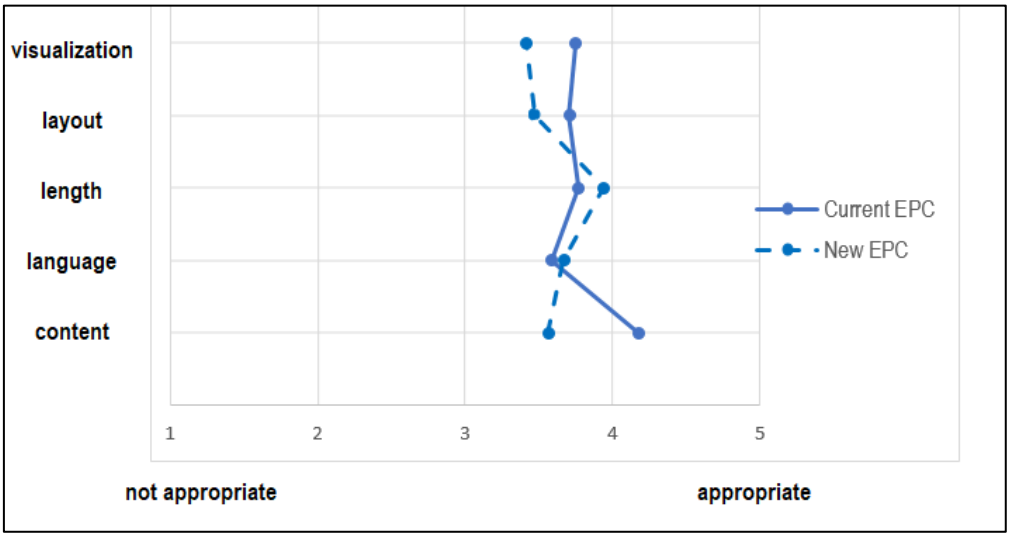

Figure 17: Perceived appropriateness of EPC in Austria

Mean-composite variable "appropriateness of EPC": The groups do not differ significantly regarding the evaluation of appropriateness of EPC, t(30) = 0.333, p = .629. The composite mean for the new EPC group (M = 3.737, SD = 0.894) is not significantly higher than the current EPC group (M = 3.837, SD = 0.804).

Table 5 summarizes the suggestions to improve the new EPC (content, language, length, layout and visualization).

Table 5: Suggestions for improvement of the new EPC in Austria, A

Content	Language
• Considering reality (monument conservation, costs) • Consider the impact of user behaviour • More detailed explanation of technical terms, perhaps in an appendix or online	• Reduce redundancies (e.g. "for buildings with regular inside temperatures", which is stated on the 1st page and repeated throughout the EPC) • Ok for a working expert • Use less technical terms and phrasings

Table 6: Suggestions for improvement for the new EPC in Austria, B

Layout	Visualization
• First page should be a concise summary, details should be in the back • Energy renovation recommendations should be further in the back • Clearer order	• "Great graphics" • Too many colours and graphics, I work better with numbers • Scales and their visualization are too different: arrows, column charts, pie charts, indicative scales • Use standardized colours for "final energy need and costs by category"

	• More graphics • Way too full

4.2.1.10. *Attitude towards EPC and energy efficiency*

Figure 18 shows that on average the attitude towards EPC is between neutral and positive in both groups.

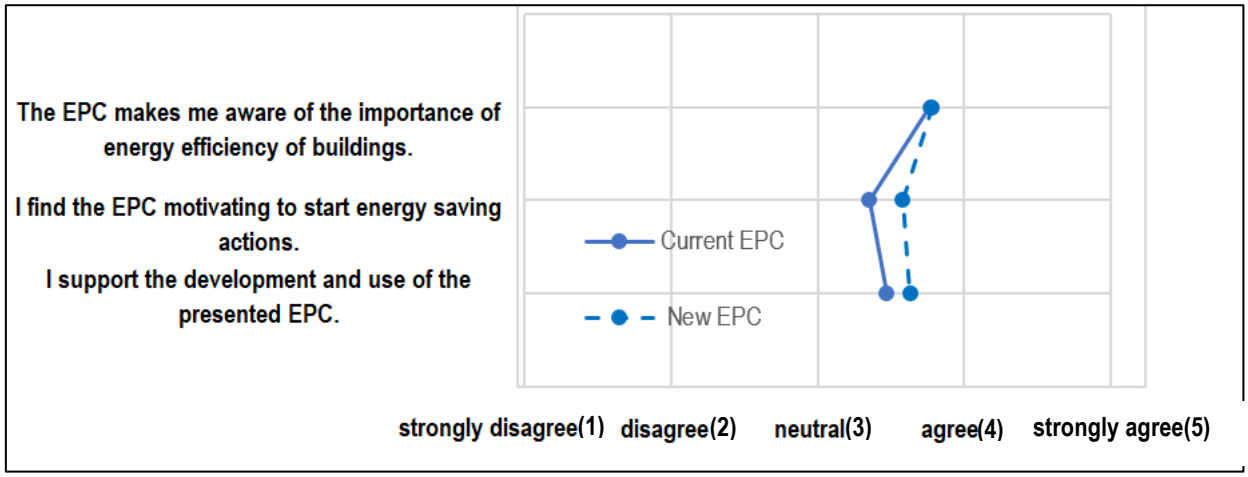

Figure 18: Attitude towards EPC in Austria

Mean-composite "attitude towards EPC": the groups do not differ significantly, t(33)=-0.44, p = .331. The mean of the new EPC group (M = 3.865, SD = 1.152) is not significantly higher than the current EPC group (M = 3.529, SD = 0.921).

4.2.1.11. *Behavioural intention to use EPC*

Figure 19 shows that the behavioral intention to use the EPC is between neutral and positive in both groups.

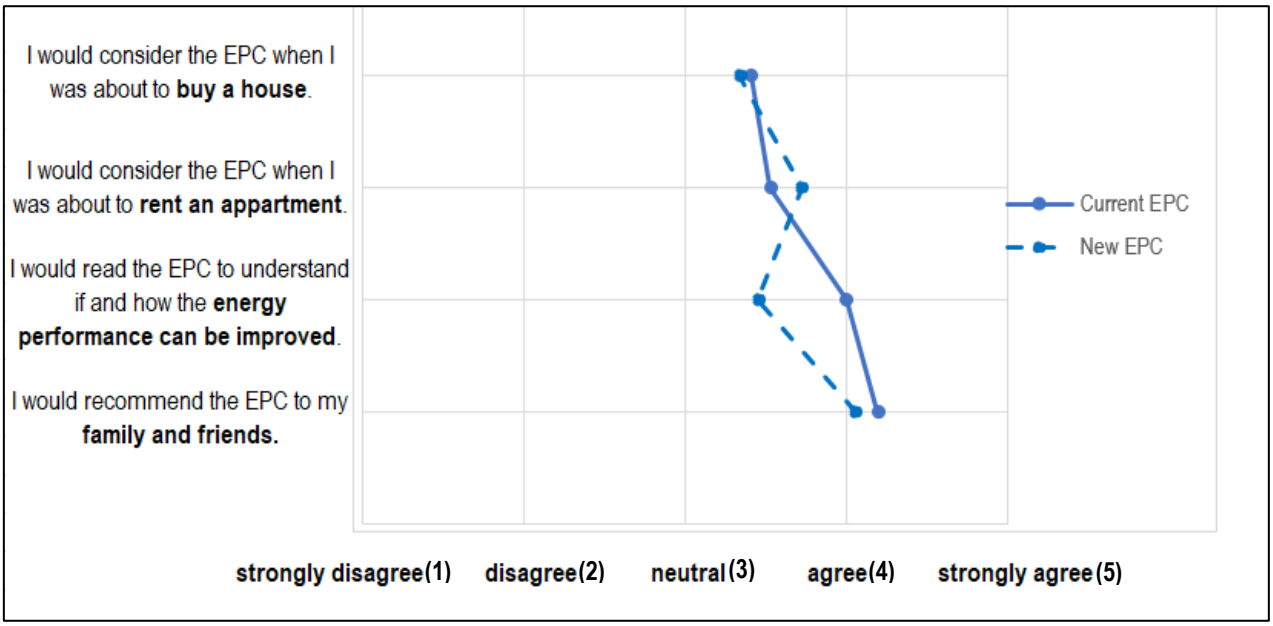

Figure 19: Behavioural intention to use the EPC in Austria

Mean-composite "behavioral intention to use EPC": The groups do not differ significantly regarding the behavioral intention to use the presented EPC, t(31) = 0.751, p = .771. The composite mean for the new EPC group (M = 3.639, SD = 1.228) is not significantly higher than the current EPC group (M = 3.917, SD = 0.805). A small fraction would not use the EPC voluntarily (12% of the current and 11% of the new EPC group).

All participants rated family/friends who are experts as most influential on the decision to renovate, followed by energy advisors. The EPC was assessed as influential by roughly 70%. Consumer associations, media information and family/friends who were experts were evaluated as least influential. Participants mentioned who/what else would play a role in the decision to renovate: personal research, in-situ visit and consultation by expert (e.g. energy advisor), architect, site engineer/builder with both theoretical *and* practical knowledge, online calculators and information provided by landlords.

Most of the enquired factors (location, price, energy performance and operational costs of a building and living comfort,) are important upon the decision to buy a house. Most important are the location and the price of the house, followed by the energy performance and operational costs. The aesthetics of the building were rated as important by about only 40%.

4.2.1.12. *Willingness to pay for EPC*

Figure 20 shows participants to pay for the two EPC versions. Currently, an EPC for a single home costs about 450€ (250€ basic fee + 3€/m²), while the costs for an EPC for larger residential buildings is calculated with 1 €/m² (+ 250€ basic fee). Hence, the prices for an EPC are comparatively high in Austria. The enquired price categories are all less expensive. Overall, participants' answers regarding their willingness to pay for the new EPC ranged from 30€ to 500€. On average the willingness to pay of the new EPC is higher than the willingness to pay of the current EPC group. About 30% of the new EPC group is willing to pay 300-350€; however; willingness to pay does not only depend on the presented EPC, but also on e.g. income and whether one needs an EPC or not (for funding, real estate transactions, new construction etc.).

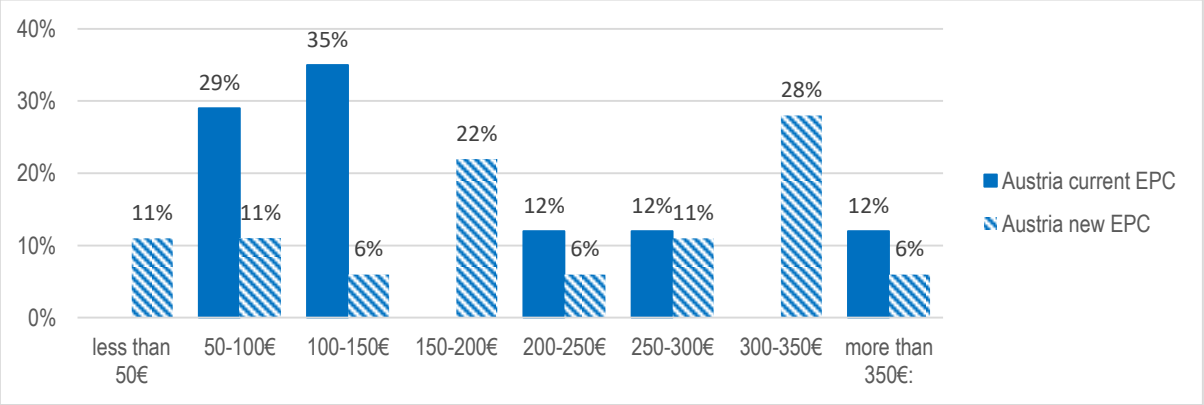

Figure 20: Willingness to pay for EPC in Austria

4.2.1.13. *Overview of open discussion during the workshop in Austria*

Table 7 summarizes the critiques (positive and negative) regarding the new EPC mentioned in the discussions in the Austrian workshop. The current EPC in Austria was not topic of discussion.

Table 7: Overview of the discussion in Austria

Positives	New EPC

	• Good visualization with the different colours • Simple titling • Renovation recommendation and savings potential very interesting and highly relevant • Benchmarking
Negatives	• Too much different information • Page 1 (especially top half) is overloaded with information and confusing • User-specific information is confusing and not accurate enough • Confusion about standardized and user-specific calculation • IAQ unclear: how is it measured? Air quality is also dependent on the location of the building • Values or units are too technical / jargons
Suggestions/Comments	• Location should be considered when measuring air quality (e.g., next to a highway vs. in the countryside) • Payback period of the refurbishments would be useful • Digital version to offer more information but still have it clearly arranged

4.2.1.14. *Conclusion of the third Austrian user workshop*

In the current EPC group the proportion of males was significantly larger with 71% of participants being male. A wide age range was represented in the two groups, ranging from 20-24 years to 65 years or older in the new EPC group and 15-19 years to 65 years or older in the current EPC group. The great majority of participants has a university degree (82% of the current EPC group and 74% of the new EPC group). The majority in both groups is owning the house they live in (63% of the new EPC group and 59% of the current EPC group). Different types of stakeholders were present in both groups: the largest stakeholder group is made of end-users (71% in the current EPC group and 68% in the new EPC group). The majority of participants in both groups had experience with the EPC before the workshop (88% of the current EPC group and 74% of the new EPC group indicated so). Participants were in contact with the EPC before in a professional context (during their job) and as end-users (apartment-hunting, during house building) in both groups.

Regarding participants' understanding of EPC features, the current EPC group significantly understood the current energy rating better than the new EPC group. Looking at the overall understanding no significant difference can be found. On average the purpose of EPC, energy efficiency benefits and use of EPC is understood better than the current primary energy use and energy consumption factors in both groups. All new EPC features were understood by the majority (80% or more have correctly understood the different features, except for benchmarking of the final energy rating, which was only correctly understood by 68%, indicating a need for improvement).

A high proportion of both groups did not find the presented EPC self-explanatory: 69% of the current EPC group answered negative, while 50% of the new EPC group said so. In line with this, 94% of the current EPC group would appreciate assistance in understanding the EPC, while still 80% of the new EPC group expressed this. On average, both groups find additional explanations in the EPC and online support important in understanding the EPC, while the current EPC group also evaluated an accompanying manual as important.

On average, both groups agree that the presented EPC is useful to receive information about the EPB, energy costs and the EPB in comparison to other buildings. Both groups rated the usefulness of the EPC lowest for receiving information about the living comfort in a building. Regarding the perceived usefulness of EPC, the new EPC group significantly perceives the EPC more useful to receive information about recommendations and air quality. However, comparing the overall perceived usefulness no significant difference can be found between the groups.

Regarding new EPC features participants are not satisfied with the division of pages yet. From the responses it appears that participants did not understand that the first two pages are targeted towards all and that the last two pages are targeted towards

end-users, while everyone can access all pages. The majority (59% + 24%) perceives the information based on standard and actual conditions in the EPC as useful and easy to understand; however; also 28% indicate to not find it easy to understand at all, demanding an improvement of the provision of information. Some admitted to not see the difference between calculations based on standard and actual conditions; longer explanations about how standard and actual conditions are taken into account were requested.

On average, both groups are moderately to quite a bit interested in the presented EPC. On average, the new EPC group had significantly more positive feelings towards the presented EPC.

On average, both groups evaluated the presented EPC as rather appropriate regarding content, language, length, layout and visualization. In order to further improve the new EPC participants suggested to use less technical terms and to provide more detailed explanations, perhaps in an appendix or online. Regarding visualization the opinions diverge from “great graphics” to the critique that scales and visualizations are too different (arrows, column charts, pie charts) which could cause confusion. Also contradictory answers were received regarding the amount of graphics that should be included.

On average, the attitude towards EPC and behavioural intention to use EPC is between neutral and positive in both groups with no significant difference. High percentages of both groups would use the EPC voluntarily, e.g. in order to receive information before renovation (78% of the new EPC group and 60% of the current EPC group) and in order to learn about the energy efficiency of the building (47% of the current EPC group, 41% of the new EPC group). From all participants family/friends who are experts were rated as most influential on the decision to renovate, followed by energy advisors. Most of the enquired factors are important upon the decision to buy a house. Most important are the location and the price of the house, followed by the energy performance and operational costs.

The willingness to pay for an EPC is significantly higher in the new EPC group. However, the prices for an EPC are comparatively high in Austria (about 450€ for a singly home) and the enquired price categories are all lower. Participants’ answers regarding their willingness to pay for the new EPC ranged from 30€ to 500€.

The mood in both discussion and questionnaire leaned towards slightly favouring the new EPC over the current Austrian EPC. In particular participants appreciated the graphic representations and the clearer structure. As for the content, the energy improvement recommendations were repeatedly praised as well as the improved benchmarking. Others criticized that the information, especially on the upper half of the first page, is too cluttered. Regarding language, participants wished for a simpler less technical language. Critique from the questionnaire and the discussion included that user-specific information is confusing as well as the calculation of standardized and user-specific calculation. Another suggestion made both in the questionnaire and discussion was to add additional information and explanations to an appendix or via additional online content. Some suggested adding time frames for payback rates.

4.2.2. Belgium

This subchapter presents the results of the third user workshop in Belgium (Flanders). From the Flemish region 30 persons filled in a questionnaire, with 14 responses regarding the current EPC and 16 responses regarding the new EPC.

4.2.2.1. *Socio-demographics*

Figure 21 shows the gender distribution and housing situation of participants in the two groups. The larger proportion of participants are male, with gender roughly equally distributed between the two groups. The vast majority of participants is owning the house they are living in (in both groups more than 90%). The ratio of tenants to owners is about the same for the two groups.

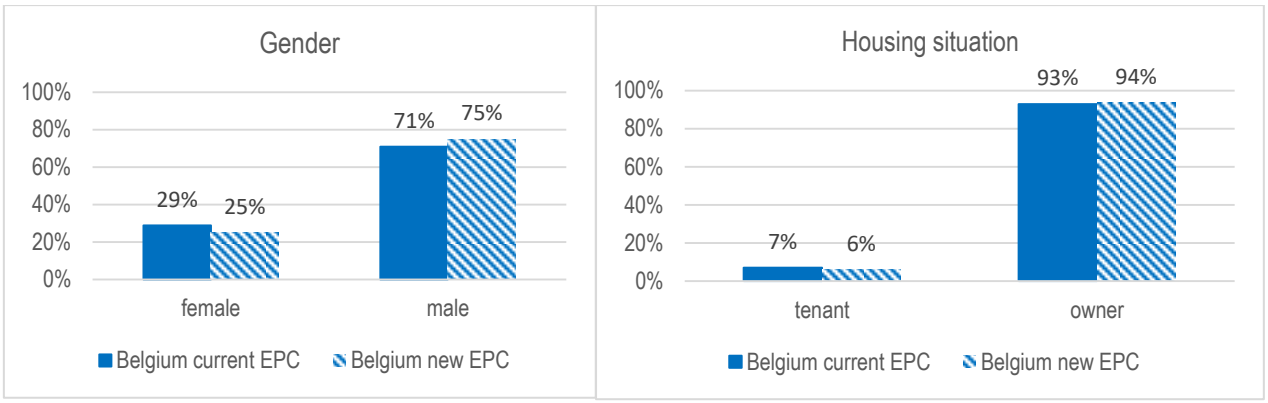

Figure 21: Gender and housing situation of Flemish participants

The largest fraction of participants lives in a detached house (min 50% in both groups), followed by the second largest group living in a semi-detached house in both groups (44% of participants of the new EPC group and 29% of participants of the current EPC group).

Age is spread relatively even in both groups, representing different age groups of the working society. The majority of participants in both groups has a university degree (75% of the new EPC group and 93% of the current EPC group).

4.2.2.2. *Relation to EPC and experiences with EPC*

Figure 22 shows the stakeholder types which were present in the two groups. The largest group in both groups present end-users (71% in both groups), while different other stakeholders are also present (except for craftsmen). In addition, participants in the new EPC group described themselves as technical consultant, working in renovation supervision, researcher with experience in EPB and EPC and renovation coach.

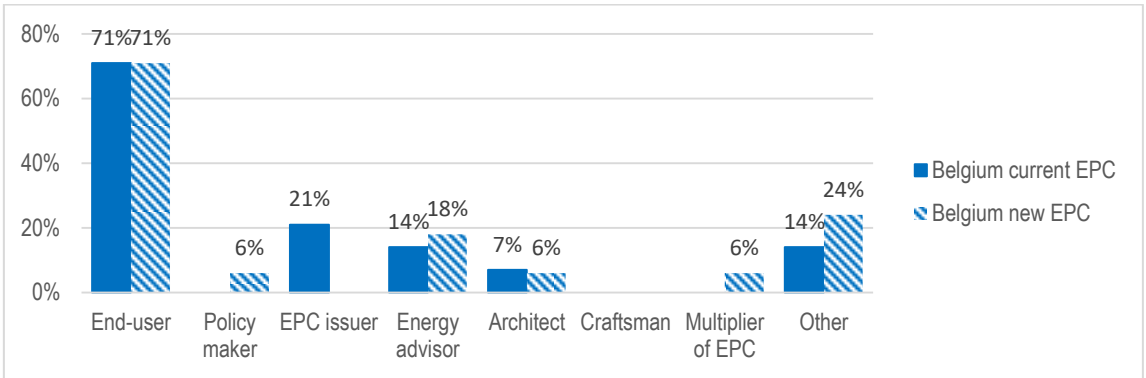

Figure 22: Stakeholder types in Belgium (Flanders)

The greatest proportion of participants had experience with the EPC before (79% of the current EPC group and 94% of the new EPC group). Participants were in professional contact with the EPC (e.g. renovation supervision) and/or as end-user (e.g. buying/renting an apartment). Table 8 specifies participant's experience with EPC.

Table 8: Description of experience with EPC in Belgium

Current EPC group	New EPC group
• In university (filling out EPCs) • Work-related, e.g. renovation supervision • Buying/renting/selling a home • As a reporter • Energy participation project • Environmental policies	• Buying/renting home/apartment • As building owner • Energy/renovation consulting • Previous EPC project

4.2.2.3. *Understanding of EPC elements*

The answers are coded as 1 for a correct and 2 for a wrong answer. The means per group (current and new EPC) for each item of understanding of EPC elements are shown in Figure 23. There are significant differences in understanding of several features. Also the understanding regarding the current energy rating differs significantly: 100% of the current EPC group understood the information, while only 20% of the new EPC group understood the information correctly. The t-test could not be calculated for the single item as the variance in the new EPC group equals 0.

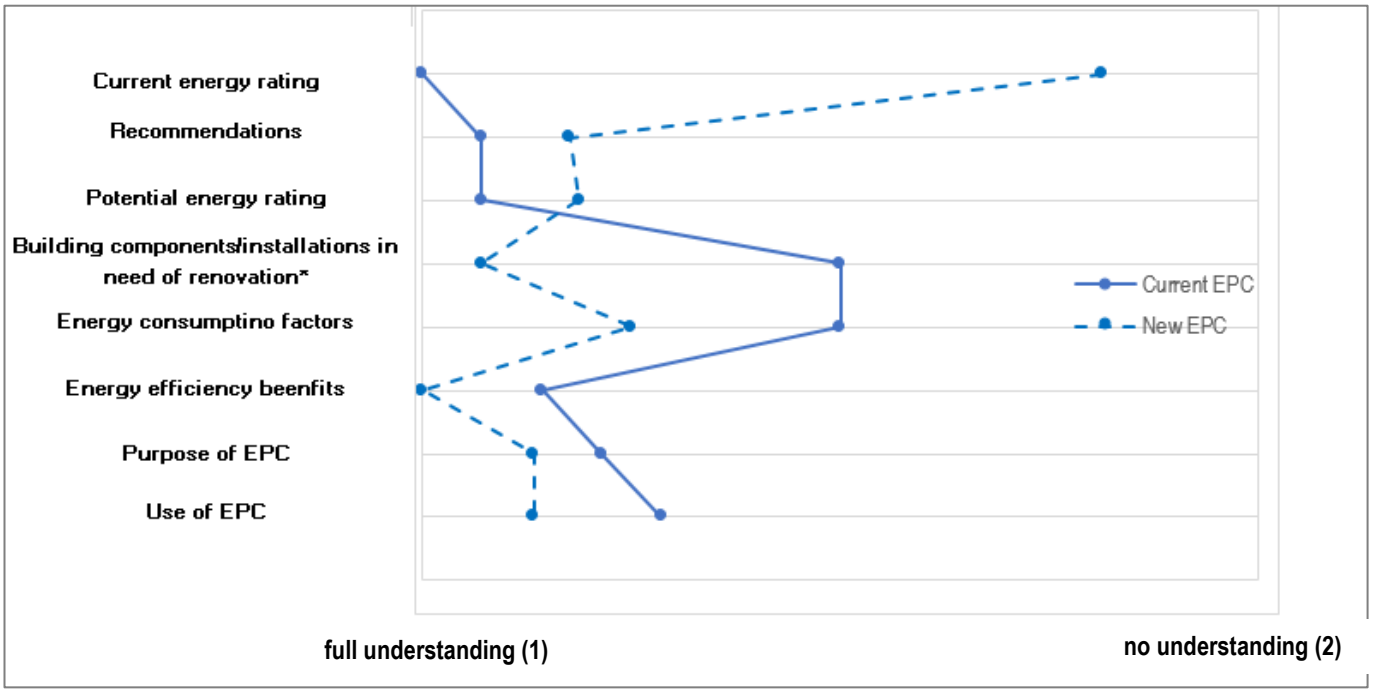

Figure 23: Understanding of EPC elements in Belgium (Flanders)

***Building components/installations in need of renovation:** The groups differ significantly, t(26) = 2.747, p= .995. The mean for the new EPC group (M = 1.071, SD = 0.267) is significantly lower than current EPC group (M= 1.5, SD= 0.519), indicating that the new EPC group understood the information regarding building components/installations in need of renovation significantly better than the current group.

Mean-composite "understanding of EPC features": The groups do not differ significantly, t(25) = -0,748, p = .231. The composite mean for the new EPC group (M = 1.221, SD = 0.104) is not significantly higher than the current EPC group (M = 1.188 SD = 0.127).

4.2.2.4. *Understanding of new EPC elements*

The tested new EPC features were correctly understood by the majority of participants, indicating that the information is well presented. The benchmarking was correctly understood by 75%, while the energy service using most energy was correctly identified by 93%.

4.2.2.5. *Perceived ease of use of presented EPC*

Figure 24 shows participants' overall perceived ease of use of the presented EPC.

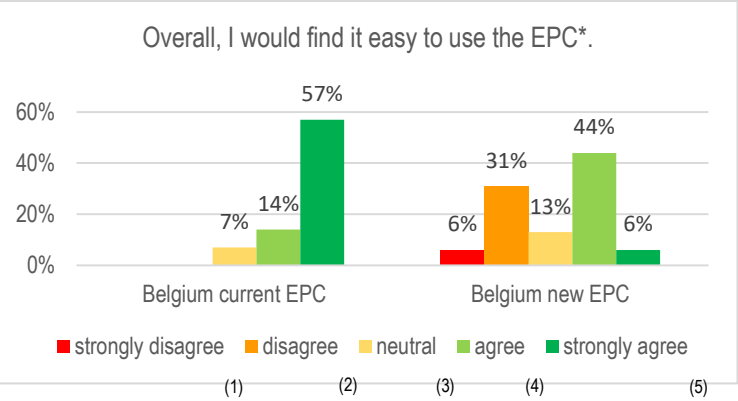

Figure 24: Overall perceived ease of use of EPC in Belgium

***Overall perceived ease of use**: the groups differ significantly, t(28) = 1.830, p = .961. The mean of the new EPC group (M= 3.125, SD = 1.147) is significantly lower than the current EPC group (M = 3.857, SD= 1.027), indicating that the overall the current EPC group perceives it easier to use the presented EPC than the new EPC group. But, about half of the participants in both groups do not find the EPC self-explanatory, and would appreciate assistance in understanding the EPC.

Parts which are not self-explanatory regarding the new EPC:

- The label/energy efficiency class
- Boxplots regarding thermal comfort and air quality, e.g. it is not explained that regarding the Fanger model, '0' is considered average comfortable, while values higher than 0 are considered "warmer" and values lower 0 are considered "colder").
- End-users might have never heard of the Fanger model. The danger is that it becomes too technical and consequently too complicated for the average person.
- Too much jargon: primary energy, different units, Fanger model …
- SRI
- The sequence of numbers/subjects is illogical, structure is too chaotic.
- Difference between standard and actual conditions
- Difference between current situation and situation after implementation of energy saving measures

From Figure 25 we can see that an accompanying manual is perceived as most important source of additional information in both groups, while additional explanations are evaluated as secondly most important by both groups. A hotline is the least wanted form of assistance in both groups.

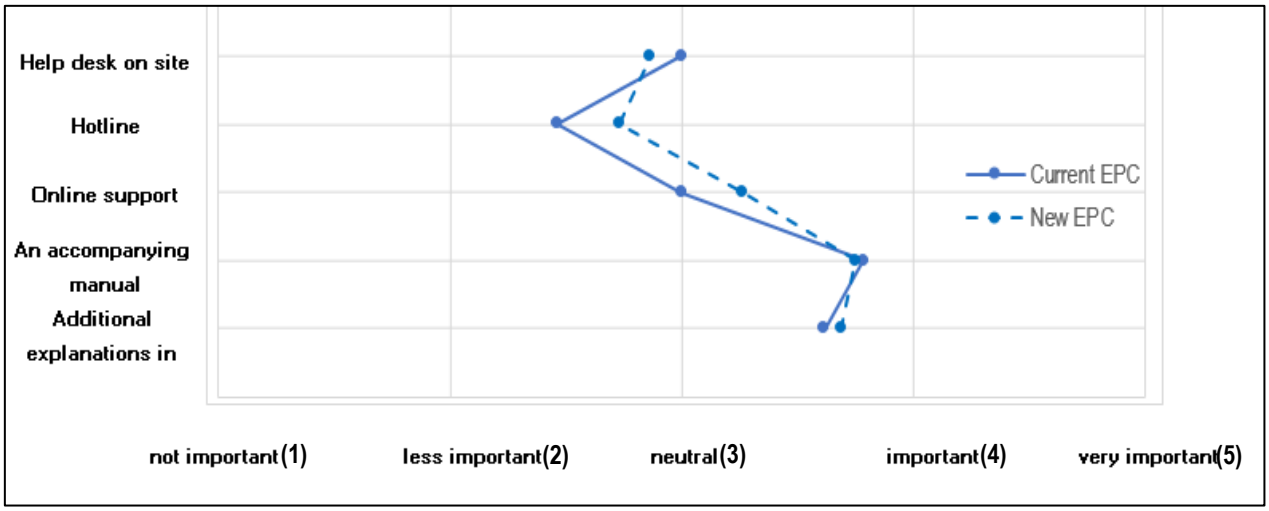

Figure 25: Importance of information in assisting in understanding the EPC in Belgium (Flanders)

4.2.2.6. *Perceived usefulness of presented EPC*

Figure 26 shows the average perceived usefulness of the EPC to receive different kinds of information for both groups.

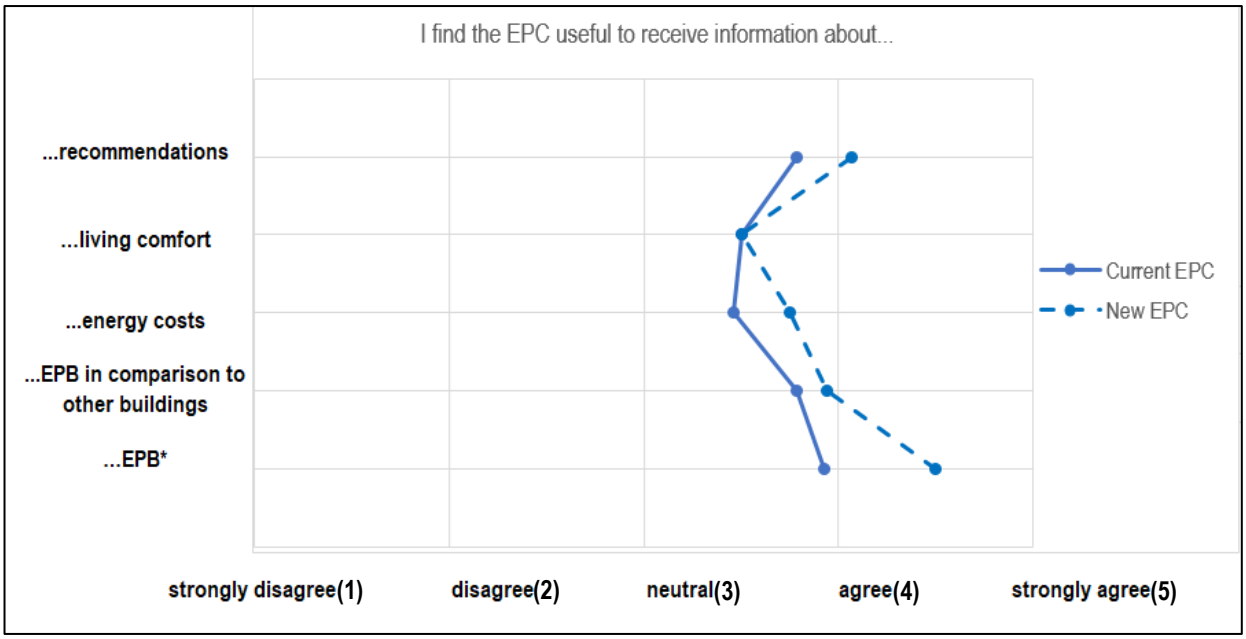

Figure 26: Perceived usefulness of EPC elements in Belgium (Flanders)

***EPB:** There is a significant difference between the two groups, t(28)= -1.806, p= .041. The mean of the new EPC group (M= 4.5, SD= 0.516) is significantly higher than the mean of the current EPC group (M= 3.929, SD=1.141), indicating that the new EPC is perceived as more useful in order to receive information about the EPB.

When comparing the perceived usefulness of the EPC to receive information about additional indicators (comfort, IAQ and costs for operating the building) it appears that the new EPC group can better get an idea of the air quality and the expected costs for heating than the current EPC group; while the current EPC group can better get an idea of the comfort of living in a building. The differences are not different.

Overall, the perceived usefulness is high in both groups, as shown in Figure 27.

***Overall perceived usefulness**: the groups differ significantly, t(28)= 1.830, p = .961. The mean of the new EPC group (M = 3.125, SD = 1.147) is significantly lower than the current EPC group (M= 3.857, SD = 1.027), indicating that the current EPC group perceives the presented EPC as more useful than the new EPC group.

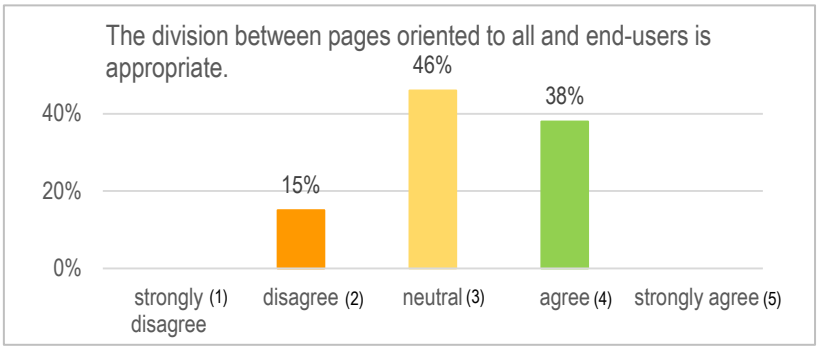

Figure 27: Overall perceived usefulness of EPC in Belgium

4.2.2.7. *Evaluation of new EPC features*

Most participants are neutral regarding the appropriateness of division of pages (cf. Figure 28). Some didn't realize the division of pages which indicates that this should be better highlighted.

In order to improve the disvion of pages participants suggested to:

- Break it down more clearly
- Page 3 is most cluttered + boxplots are not readable by most people
- For end users, a little more background on issues described on p. 3 and 4 should be added.
- Better division into overview and detail info.
- I didn't realize there was a difference between the target group of the pages
- More clearly distinguish headings visually and textually

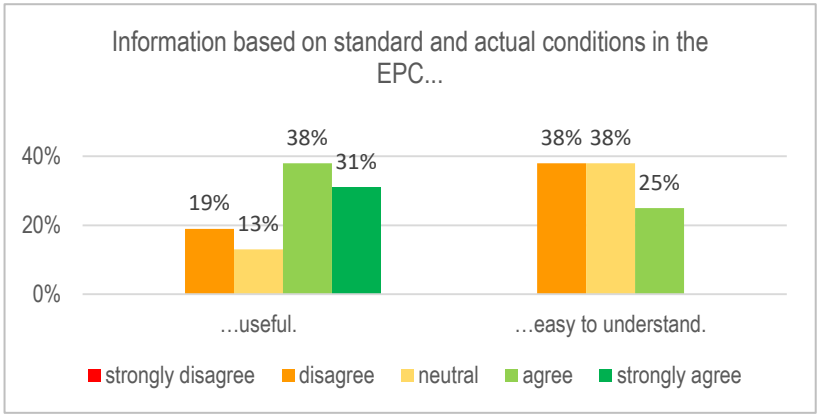

Figure 28: Perceived appropriateness of division of pages in Austria.

The provision of information based on standard and actual conditions is perceived as useful by 69% and as easy to understand by only 25% (cf. Figure 29).

In order to improve the provision of standard and actual conditions participants suggested to:

- Explain what the difference is and what the point is
- Show how the actual conditions are taken into account
- Emphasize a little more on page 1 what the difference is between dotted line (actual) and full (standard) - make legend bigger & more prominent"
- Clearly indicated the energy label of the house. If the legal parameter are the standardized values, then the actual values should not be on the first page. For example, we are in the situation of a borderline case between label D (standardized) and C (actual).

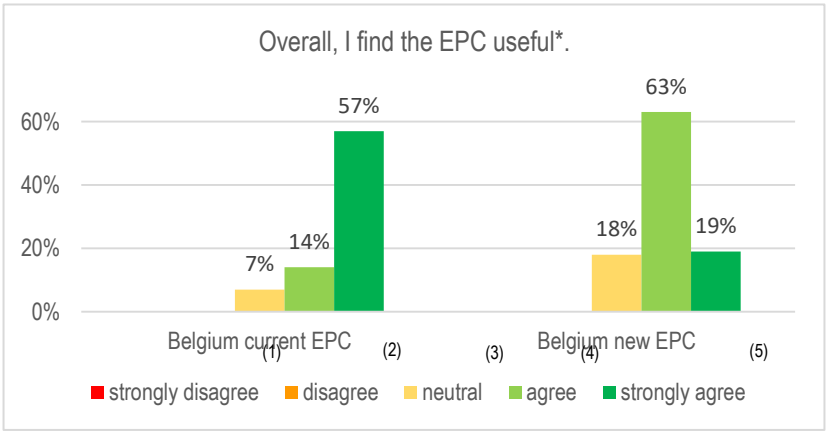

Figure 29: Evaluation of new EPC features in Austria

4.2.2.8. *Feelings about the EPC*

Figure 30 shows the average feelings towards EPC by the two groups. The new EPC group felt more confused, bored and overwhelmed.

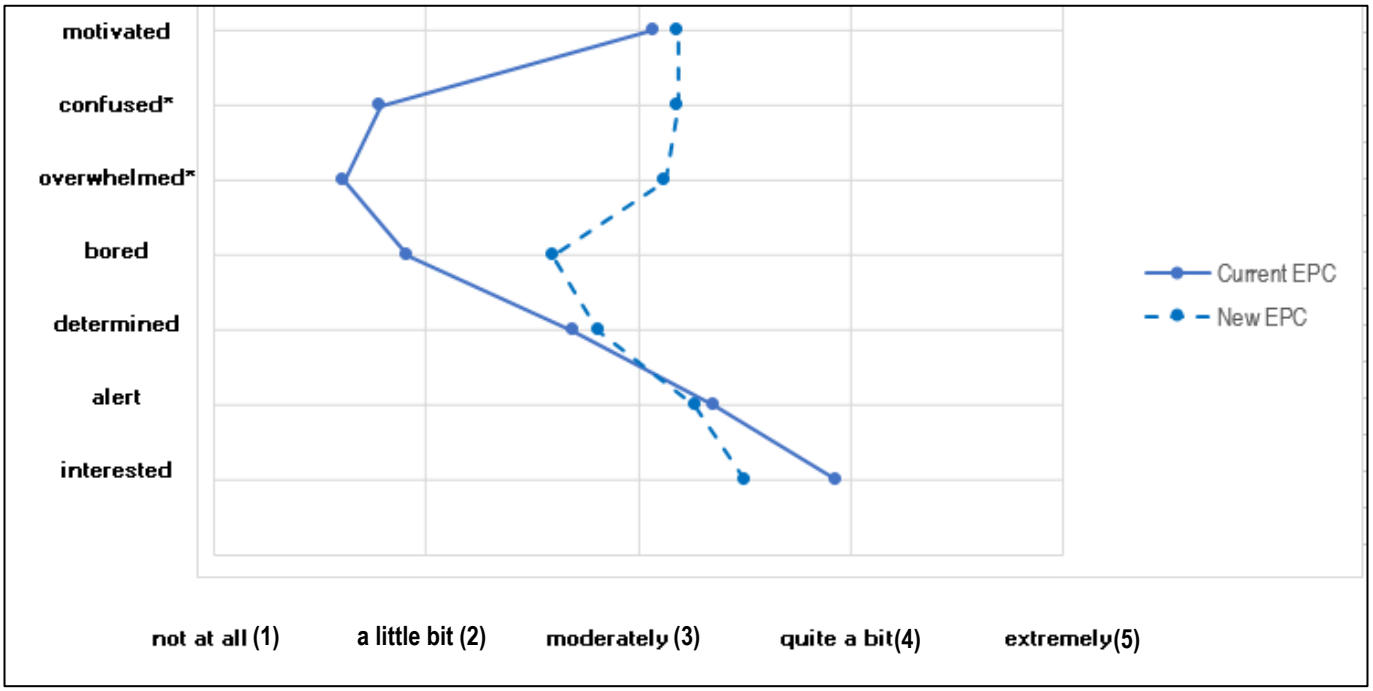

Figure 30: Feelings about EPC in Belgium (Flanders)

***Overwhelmed:** the groups differ significantly, t(-3.138), p= .002. The mean of the current EPC (M= 1.615, SD= 0.961) is significantly higher than the new EPC group (M = 3.125, SD= 1.5), indicating that the current EPC groups significantly feels less overwhelmed than the new EPC group. On average the new EPC group feels moderately overwhelmed.

***Confused:** the groups differ significantly, t(-3.341), p = .001. The mean of the current EPC group (M = 1.786, SD= 0.975) is significantly lower than the new EPC group (M = 3.188, SD= 1.276), indicating that the current EPC significantly feels less confused than the new EPC group. On average the new EPC group feels moderately confused.

***Mean-composite variable "feelings about the EPC:** The groups differ significantly, t(23) = 2.313, p = .985. The composite mean for the new EPC group (M = 3.122, SD = 0.76) is significantly lower than the current EPC group (M = 3.727, SD = 0.467).

Besides that, participants of the current EPC group mentioned to feel disappointed, stressed, frustrated and even mislead. Overall feelings were purely negativ. In the new EPC group partiipants additionally mentioned to feel uninformed. Somebody could not make out any relationship between different figures, while another could not make sense of the SRI and air quality index-

4.2.2.9. *Overall perception of EPC*

From Figure 31 we can see that the mean for the new EPC group is higher regarding the individuality and the usefulness of the EPC, but lower regarding the organization and clearness of the EPC than the current EPC group

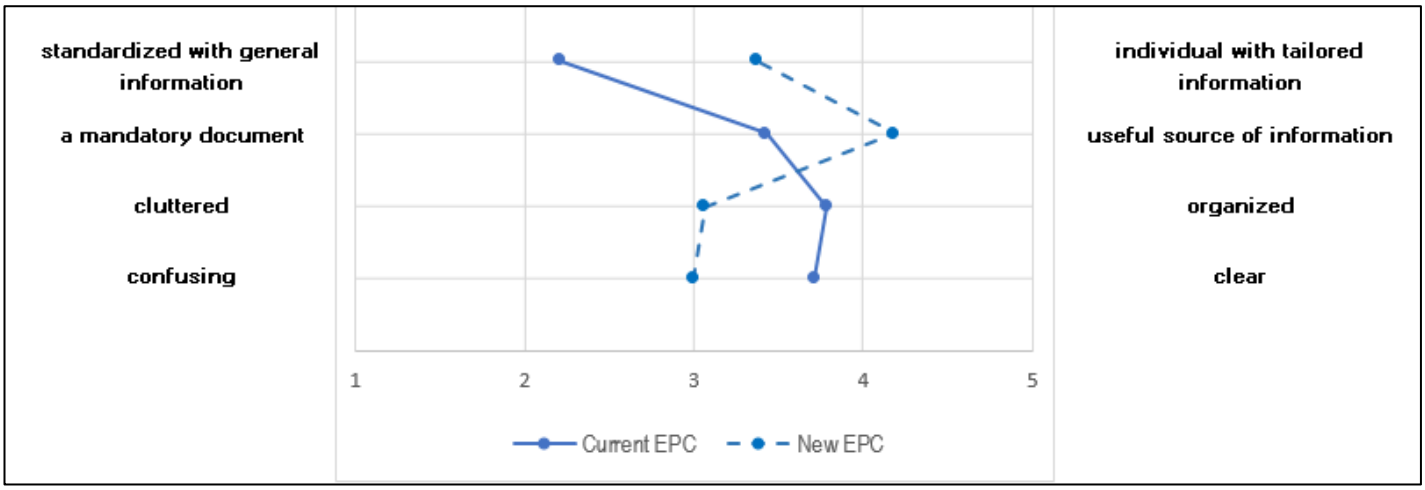

Figure 31: Characterization of EPC in Belgium (Flanders)

Mean-composite variable "characterization of EPC": The groups do not differ significantly, t(27) = 0.009, p = .504. The composite mean for the new EPC group (M = 3.344, SD = 0.73) is not significantly higher than the current EPC group (M = 3.346, SD = 0.673).

Figure 32 shows that more than 50% of the new EPC group said that their expectation towards EPC were met.

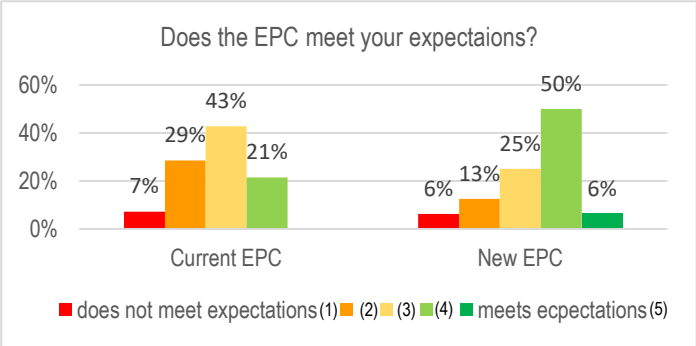

Figure 32: Fulfilment of expectation towards EPC in Belgium (Flanders)

Fulfilment of expectations for EPC: The groups do not differ significantly t(28) = -1.668, p = .053. The mean of the new EPC group is not significantly higher (M = 4.5, SD= 0.516) than the current EPC group (M = 3.929, SD = 1.141); however, 56% of the new EPC groups said that their expectations are fulfilled while only 21% of the current EPC group say so.

In order to better meet participants' expectations participants of the new EPC group said:

- Make it easier to understand, currently it contains too many difficult words
- Simpler: less data, self-explanatory information
- Some parts are quickly out of date (due to changing costs or new technologies) and need to be adjusted
- Should be organized better
- Recommendations should be based on actual conditions of use so that they are more tailored.

Figure 33 presents how on average participants of the two groups perceived the appropriateness of the presented EPC.

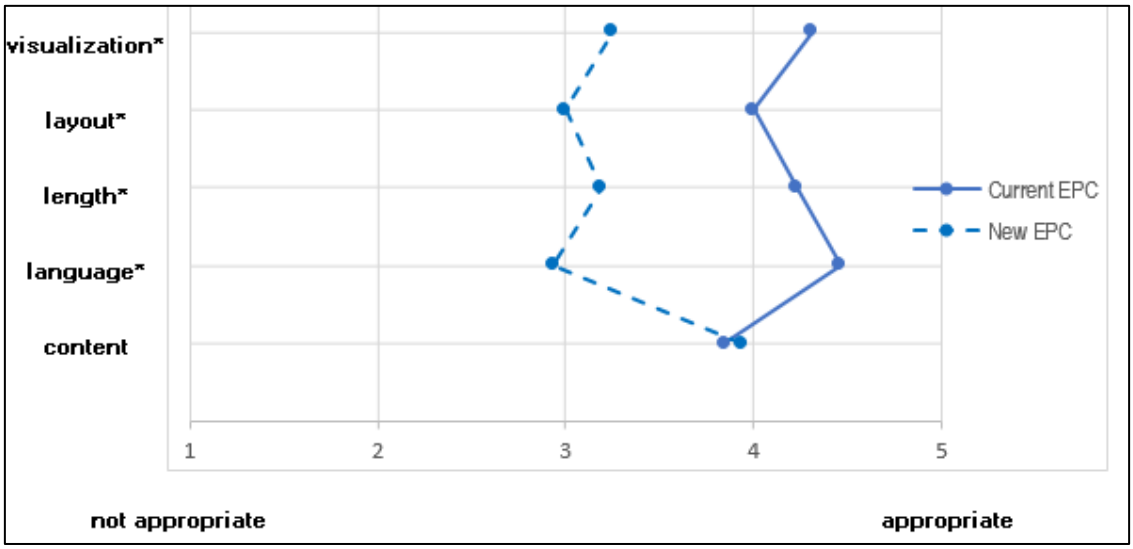

Figure 33: Perceived appropriateness of EPC in Belgium (Flanders)

***Language:** the groups differ significantly, t(26) = 4.183, p = 1. The mean of the new EPC group (M = 2.933, SD= 1.223) is significantly lower than the current EPC group (M = 4.462, SD = 0.519), indicating that the language of the current EPC is perceived more appropriate.

***Length:** the groups differ significantly, t(27)= 2.618, p = .993. The mean of the new EPC group (M = 3.188, SD= 1.223) is significantly lower than the current EPC group (M = 4.231, SD= 0.832), indicating that the length of the current EPC is perceived more appropriate.

***Layout:** the groups differ significantly, t(27) = 2.2, p = .982. The mean of the current EPC group (M = 3.0, SD = 1.211) is significantly lower than the new EPC group (M = 4.0, SD = 1.225), indicating that the layout of the current EPC is perceived more appropriate.

***Visualization:** the groups differ significantly, t (27) = 2.9, p = .996. The mean of the current EPC group (M = 3.250, SD = 1.125) is significantly lower than the new EPC group (M = 4.308, SD= 0.751).

***Mean-composite variable "appropriateness of EPC":** The groups differ significantly regarding the evaluation of appropriateness of EPC, t(26) = 3.872, p = 1.0. The composite mean for the new EPC group (M = 2.667, SD = 0.645) is significantly lower than the current EPC group (M = 3.474, SD = 0.413). From the diagram we can see that the means for the new EPC are lower for visualization, layout, length and language.

Table 9 and Table 10 present the suggestions for improvement of the new EPC as mentioned by participants.

Table 9: Suggestions for improvement of the new EPC in Belgium, A

Content	Language	Length
• Should be shortened • More explanation of renovation work needed to meet targets. • More clarification • Focus on the most important information.	• Should be less technical and easier to understand • Easier language • Far too few explanations of the terms used. • SRI: does not immediately give an idea of what exactly is meant by this	• Should be shorter • Not long enough to discuss everything in detail. • Too long for end-users

Table 10: Suggestions for improvement of the new EPC in Belgium, B

Layout	Visualization
• Boxes at comfort and air quality should not be clear • More structured (clearer titles) • Too much info in a too little space • Too busy/full • Very unclear layout, it is extremely difficult to find anything. • Layout is beautiful	• Too busy/full • More images • Add clear figures with facades and energy saving potential • Visualization in itself is clear but too much

4.2.2.10. *Attitude towards EPC*

Figure 34 shows participants' attitude towards EPC on average in the two groups, tested with three different items.

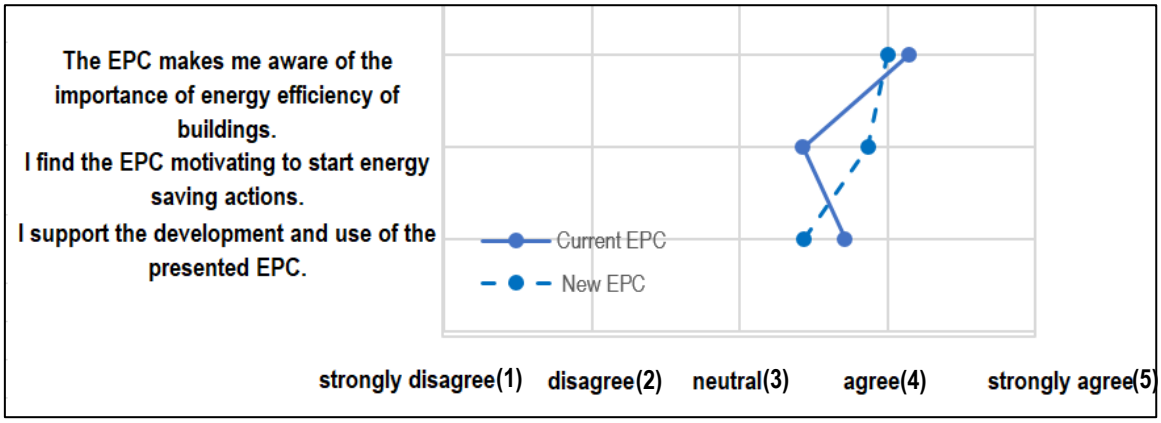

Figure 34: Attitude towards EPC in Belgium (Flanders)

Mean-composite variable "attitude towards EPC": The groups do not differ significantly, t(27)=-0.487. The composite mean for the new EPC group (4.022, SD = 0.781) is not significantly higher than the current EPC group (M = 3.857, SD= 1.035).

4.2.2.11. *Behavioural intention to use EPC*

From Figure 35 one can see that on average the behavioral intention of the new EPC group is slightly higher or equal to the current EPC group for three tested items.

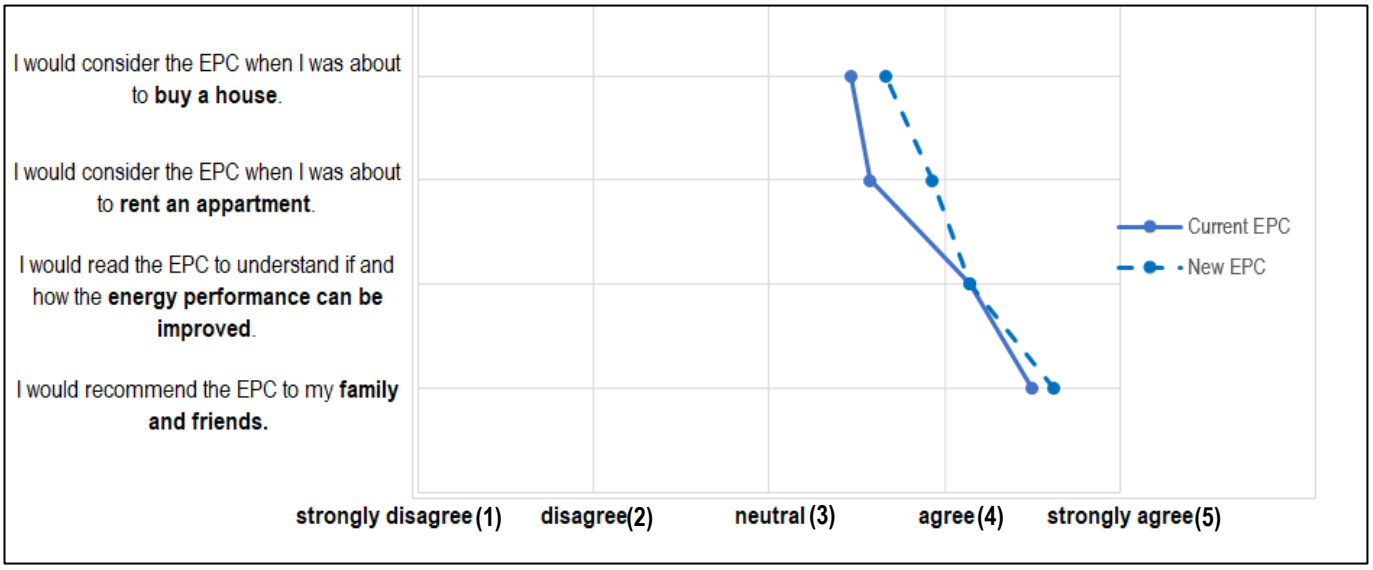

Figure 35: Behavioral intention to use EPC in Belgium (Flanders)

Mean-composite variable "behavioral intention to use EPC": The groups do not differ significantly, t(25) = -0.449, p = .329. The composite mean for the new EPC group (M = 4.071, SD = 0.616) is not significantly higher than the current EPC group (M = 3.942, SD = 0.867).

Approximately one third in each group said to be not willing to voluntarily use the EPC, while in the current EPC group participants mentioned to be willing to voluntarily use the EPC to e.g. compare the energy performance of the building before and after renovation and to possibly qualify for the EPC label premium.

Among all participants the energy advisor is the most influential actor on decision making regarding renovating, followed by family/friends who are experts. About 75% of the participants find the EPC important for decision making, as well. Media information and consumer associations as well as neighbours who have renovated their building are least important.

Most requested factors (energy performance, price, location, living comfort and operational costs) are perceived as important to very important by the majority of participants regarding their influence on buying a house. It is remarkable that none of the participants evaluated the energy performance as unimportant. Aesthetics of the building are only considered as important by 80%.

4.2.2.12. *Willingness to pay for EPC*

Figure 36 shows the willingness to pay for EPC in the two groups. One can see from the diagram that few participants from the new EPC group are willing to pay very high prices (more than 350€). In contrast to this, other participants of the new EPC group are only willing to pay 0€, 1€ or 40€. But, overall there is no significant difference between the two groups. On average participants of both groups are willing to pay about 100€ for an EPC. Hence, the majority of participants in both groups is not willing to pay the price (220€ for a single house) that existing EPCs cost in Belgium (Flemish region).

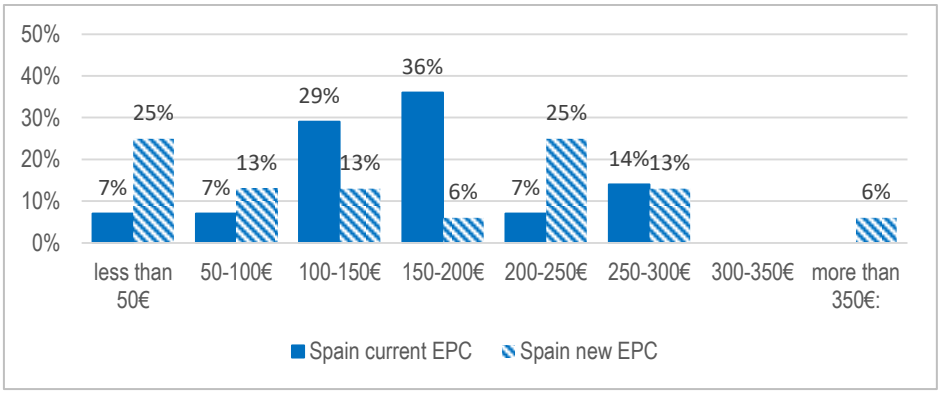

Figure 36: Willingness to pay for EPC in Belgium (Flanders)

4.2.2.13. *Overview of open discussion during the workshop in Belgium (Flemish region)*

Table 11 summarizes the critiques (positive and negative) regarding the new EPC and current EPC as mentioned in the discussions in the Belgian (Flemish) workshop.

Table 11: Overview of discussion in Belgium (Flanders)

Belgium

Positives	**New EPC**	**Current EPC**
	• Attention for thermal comfort and IAQ, • Mentioning of cost in Euros • Investment cost useful for owners and buyers, • Shows necessary investments to reach A Label, • Good to have more installations included	• Clearer than new EPC • Easier to read than New EPC
Negatives	• More confusing, • Difference between primary and final energy is unclear, • Explanation on p. 3 is not clear, • Boxplot on indoor environmental quality is not clear • Confusing, not accessible to all, • Dimensions are hard to find, front page is overloaded with information, • Unclear whether passive or active cooling is considered	• Dimensions are hard to find
Suggestions/Comments	• Add indications about what is important and what is not • What about changes in prices?	

4.2.2.14. *Conclusion of the third Belgian (Flemish) user workshop*

The larger proportion of participants are male (min. 70%), with gender roughly equally distributed between the two groups. In both groups age is spread relatively even, representing different age groups of the working society. The majority of participants in both groups has a university degree (min. 75%). The vast majority of participants is owning the house they are living in (in both groups more than 90%). The ratio of tenants to owners is about the same for the two groups. The largest fraction of participants lives in a detached house (min 50%), followed by the second largest group living in a semi-detached house in both groups. The largest group in both groups present end-users (71% in both groups), while different other stakeholders are also present (except for craftsmen).

The current energy rating was better understood by the current EPC group, while other features such as building services using most energy, energy consumption factors and the purpose and use of EPC were understood better in the new EPC group. Overall, there is no significance difference in understanding between the two groups. But, the current EPC group significantly perceives the EPC as more easy to understand. But, about 50% of both groups do not find the EPC self-explanatory, and would appreciate assistance in understanding the EPC. An accompanying manual is perceived as most important format for assisting in understanding, while additional explanations are evaluated as secondly most important by both groups.

Parts which are not considered as self-explanatory are the label/energy score as there are too many different ones. Too many jargons are used such as primary energy, different units and the Fanger model. Also, the boxplots regarding thermal comfort and air quality were mentioned as well as the SRI, the difference between standard and actual conditions. Also, the current EPC group perceives the EPC as significantly more useful than the new EPC group.

Most participants are neutral regarding the appropriateness of division of pages. One participant did not realize that there was a difference between the target groups of the pages, indicating that this should be better communicated. The provision of information based on standard and actual conditions is perceived as useful by 69% and as easy to understand by only 25%. This information could be improved by better explaining what the difference is and what the point is and by making the legend more prominent.

The groups differ significantly regarding the feelings they have regarding the presented EPC. The current EPC group has less negative feelings regarding the EPC than the new EPC group (more confused, overwhelmed and bored). However, the current EPC group participants mentioned to feel disappointed, stressed, frustrated and even mislead.

The groups also differ significantly regarding the evaluation of appropriateness of the EPC: language, length, layout and visualization are significantly perceived as more appropriate by the current EPC group. Suggestions for improving the content include on the one hand, shortening the content by focusing on the most important information, and on the other hand, by giving more explanations. The language should be less technical. The length is described as quite long for end-users but not long enough to discuss everything in detail which sums up the dilemma of creating an EPC that is appropriate for all target groups. Regarding the layout the boxplots are not clear, there is too much information in too little space, it is difficult to find information, while it is also stated that the layout is beautiful. Visualizations are okay for most participants. There is a difference in the preference about the number of images.

In contradiction to this, the new EPC seems to better fulfil participants' expectations towards EPC, though with no significant difference. Participants repeated that the EPC should be shorter and clearer and focused on the main information to meet their expectations. In addition, it was mentioned that some parts will be quickly outdated due to changing costs or new technologies.

There is not signfiicant difference in the attitude towards the EPC and regarding the behavioural intention to use the EPC between the groups. However, on average the behavioral intention of the new EPC group is slightly higher which is ambivalent to the results on understanding, perceived ease of use and usefulness of the EPC.

About 25% of the participants in both groups indicates to not be willing to voluntary use the EPC. The voluntary use intention in order to learn about the energy performance of the building is slightly higher by the new EPC group (50% versus 36%), which is also contradictory in regard to the aforementioned evaluation of the new EPC.

Among all participants the energy advisor is the most influential actor on decision making regarding renovating, followed by family/friends who are experts. All requested factors are perceived as important or very important by the majority of participants regarding their influence on decision making when buying a house.

The willingness to pay does not differ significantly between the two groups. However, one can notice a tendency that the new EPC groups is willing to pay higher prices. But, the majority of participants in both groups is only willing to pay less than what current EPCs cost in Belgium (Flemish region) - (220€ for a single house).

In the discussion during the workshop some participants had negative feelings about the new EPC and stated that they liked the old Belgian EPC more because it is easier to understand than the new EPC. Other critiques included that the complexity was too high for end-users, information density and that the difference between primary and final energy was not explained. Positive for some was the addition of air quality and thermal comfort. The general ambivalent mood in the discussion matches the answers given in the questionnaire. Scores for the new and current EPC do not differ much from each other.

4.2.3. Finland

The following subchapter presents the results of the third user workshop in Finland. In this context, 17 questionnaires were filled in, with 9 responses regarding the current EPC and 8 responses regarding the new EPC.

4.2.3.1. *Socio-demographics*

Figure 37 shows that in Finland in both groups, the gender split is skewed towards male majority with a ratio around 2 to 1. Most attendees own the home they live in, with only a minority being tenants.

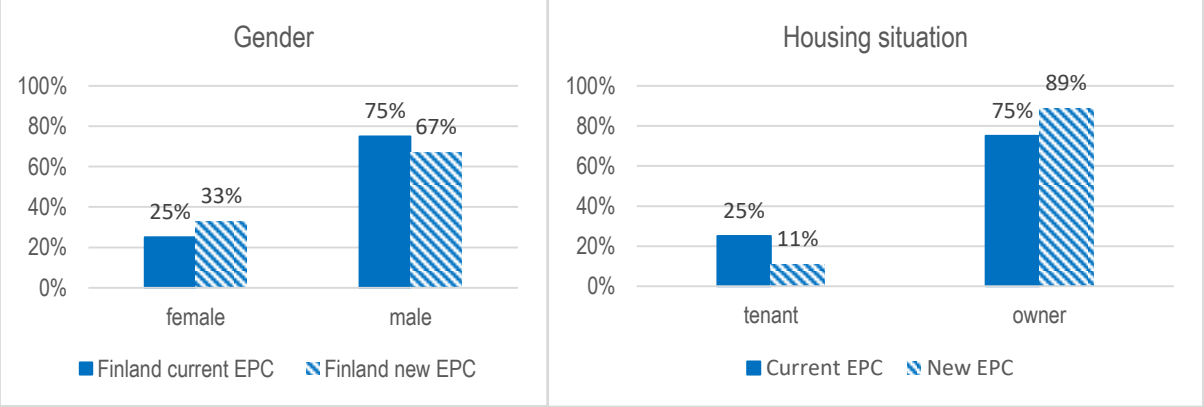

Figure 37: Gender and housing situation of Finish participants

Most participants in both groups (50% of the current EPC group and 67% of the new EPC group) live in an apartment, followed by 25% of the current EPC group and 22% of the new EPC group living in a detached house. Age is spread relatively evenly, representing a full spectrum of the working population. In the new EPC group all indicated to have university degree, while 87% of the current EPC group said so, with 13% having other school-leaving certificate.

4.2.3.2. *Relation to EPC and experiences with EPC*

Figure 38 presents the stakeholder types which were present in the two groups. Participants in both groups regard themselves almost entirely as end-users although there are some who worked with the EPC as energy advisor, policy maker or researcher. In the current EPC groups 43% said they had previous experience with the EPC while in the new EPC group 78% answered positive. This represents a noteworthy difference. In the current EPC group others identified themselves as researcher, while also in the new EPC group participants indicated to work in R&D or as researcher in energy efficiency.

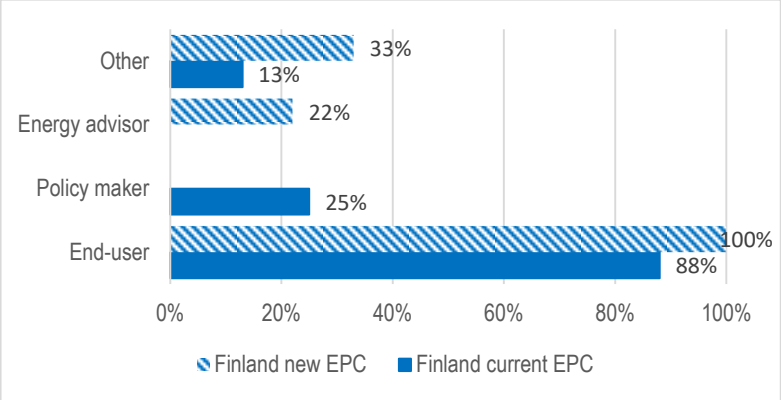

Figure 38: Stakeholder types in the Finish workshop

In the current EPC groups 43% said they had previous experience with the EPC while in the new EPC group 78% answered positive. This represents a noteworthy difference. Participants in the current EPC group described their experience as an end-user with EPC (as house owner), while participants from the new EPC group mentioned their experience as house owner and researcher.

4.2.3.3. *Understanding of EPC elements*

The answers are coded as 1 for a correct and 2 for a wrong answer. The means per group (current and new EPC) for each item of understanding of EPC elements are shown in Figure 39

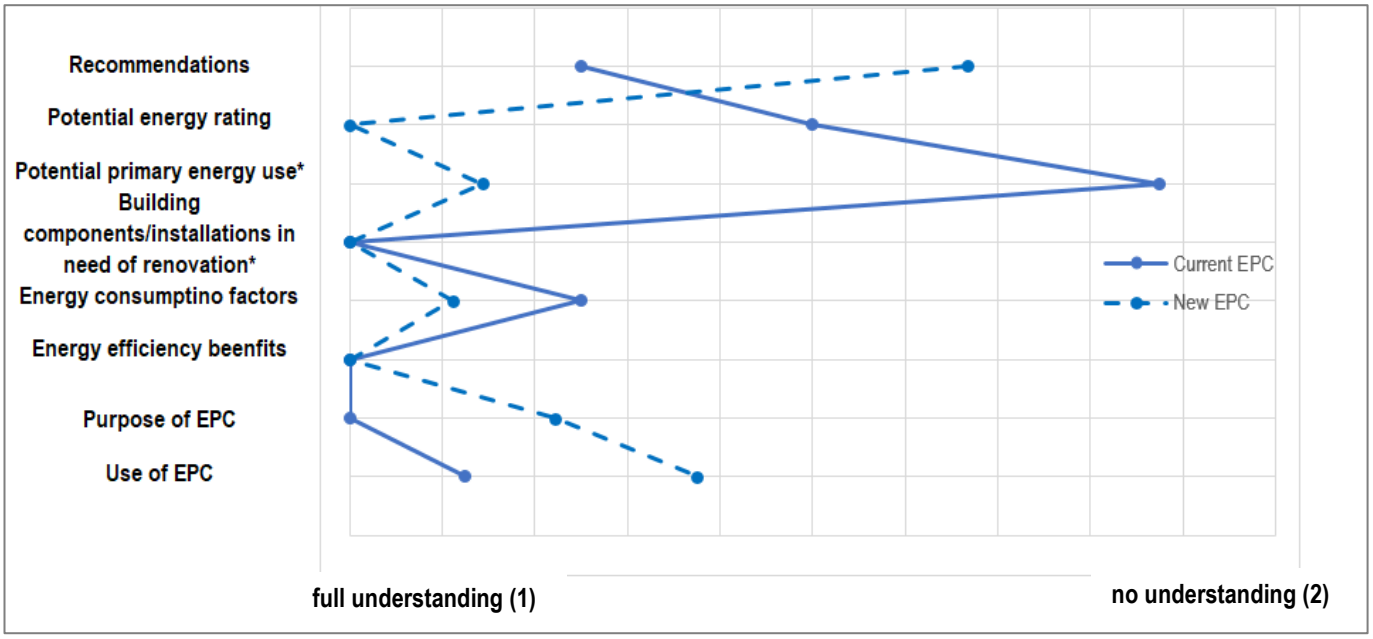

Figure 39: Understanding of EPC elements in Finland

***Current energy rating:** The groups differ significantly, t(15)= -1.775 p = .048. The mean for the new EPC group (M = 1.667, SD = 0.5) is significantly higher than the current EPC group (M =1.25, SD=0.463), indicating lower comprehension by the current energy rating by the new EPC group.

***Components/installation in need of renovation:** The groups differ significantly, t(13)=3,875. The mean for the new EPC group (M=1,143, SD=0,378) is significantly lower than the current EPC group (M=1,875, SD= 0,354), indicating higher comprehension by the new EPC group than by the current EPC group.

Recommendations: The variance in recommendations is equal to 0 after grouping on new/current EPC group. Therefore, the t-test could not be applied, but from the diagram we can see than the difference between new EPC and current EPC group is considerable.

Mean-composite variable "understanding of EPC features": The groups do not differ significantly, t(13) = 0.806, p = .786. The composite mean for the new EPC group (M = 1.196, SD = 0.098) is not significantly higher than the current EPC group (M = 1.25 SD = 0.149).

4.2.3.4. *Understanding of new EPC elements*

Figure 40 shows how well the participants understood new EPC aspects. Overall the new aspects were well understood, with an exception for the current energy rating, which was not understood by 67%. Also, the potential energy rating was not understood by 41% demanding for an easier presentation of the information. The understanding of the potential energy rating can be disregarded as it was not

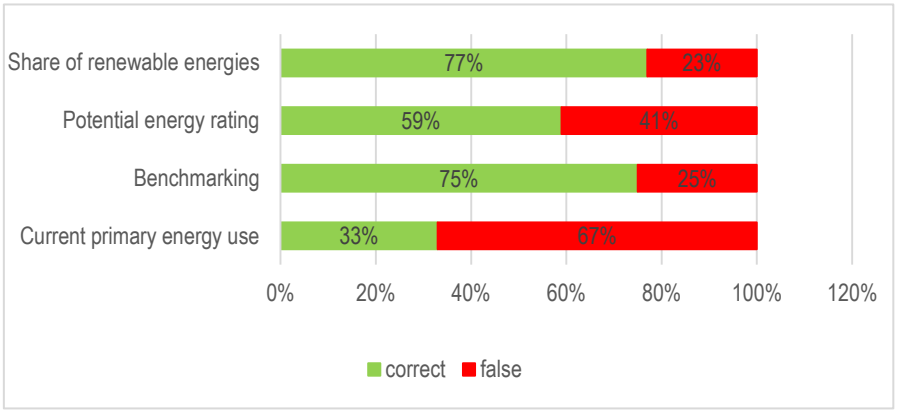

Figure 40: Understanding of new EPC features in Finland

4.2.3.5. *Perceived ease of use of the presented EPC*

Overall perceived ease of use was assessed in a similar positive way with no significant difference between the groups as it can be seen in Figure 41.

Overall perceived ease of use: The groups do not differ significantly, t(14) = 0.986, p = .830. The mean of the new EPC group (new EPC: M = 3.667, SD= 1.118) is not significantly higher than the current EPC group (current EPC: M = 4.143, SD= 0.69). Interestingly, 86% of the current EPC group find the presented EPC self-explanatory, while 100% of the new EPC answered so.

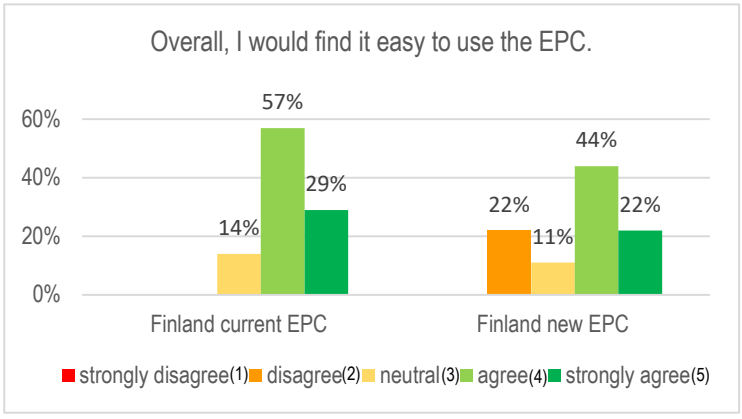

Figure 41: Overall perceived ease of use of the EPC in Finland

In the new EPC the "difference between total primary energy use and final energy use" and the "difference between standard and actual conditions" were aspects which were mentioned as not self-explanatory and therefore should be examined again. More participants of the current EPC group indicated to appreciate assistance in understanding the EPC (88%) than in the new EPC group (63%). An accompanying manual and additional explanations were most requested in both groups, as shown in Figure 42.

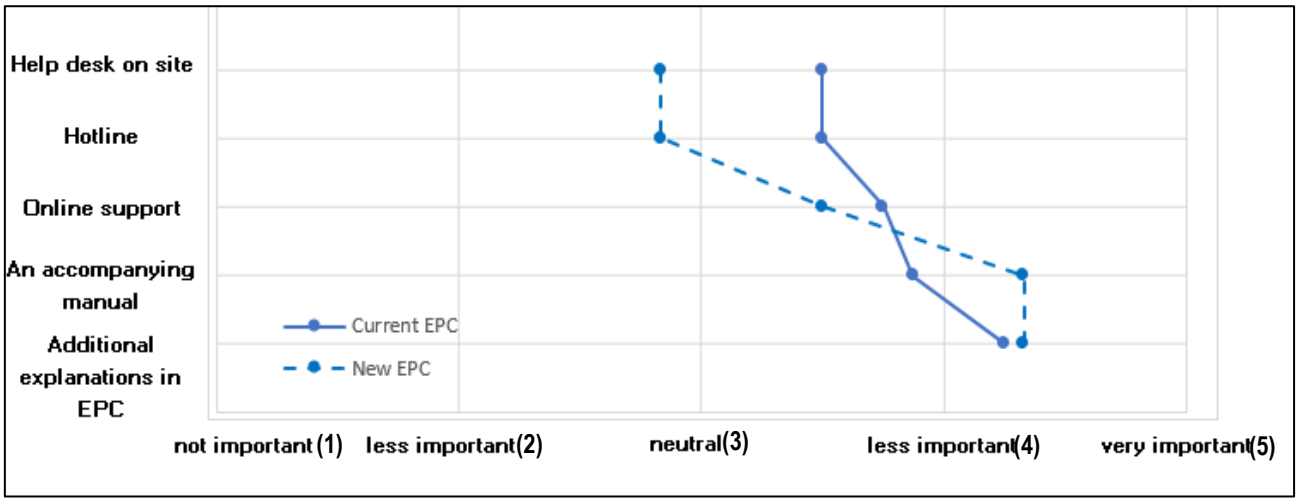

Figure 42: Importance of information in assisting in understanding the EPC in Finland

4.2.3.6. *Perceived usefulness of presented EPC*

Figure 43 shows how useful the two groups on average perceive the EPC to deliver different information. There was no significant difference found between the two groups. The new EPC was rated slightly better in order to receive information about the living comfort.

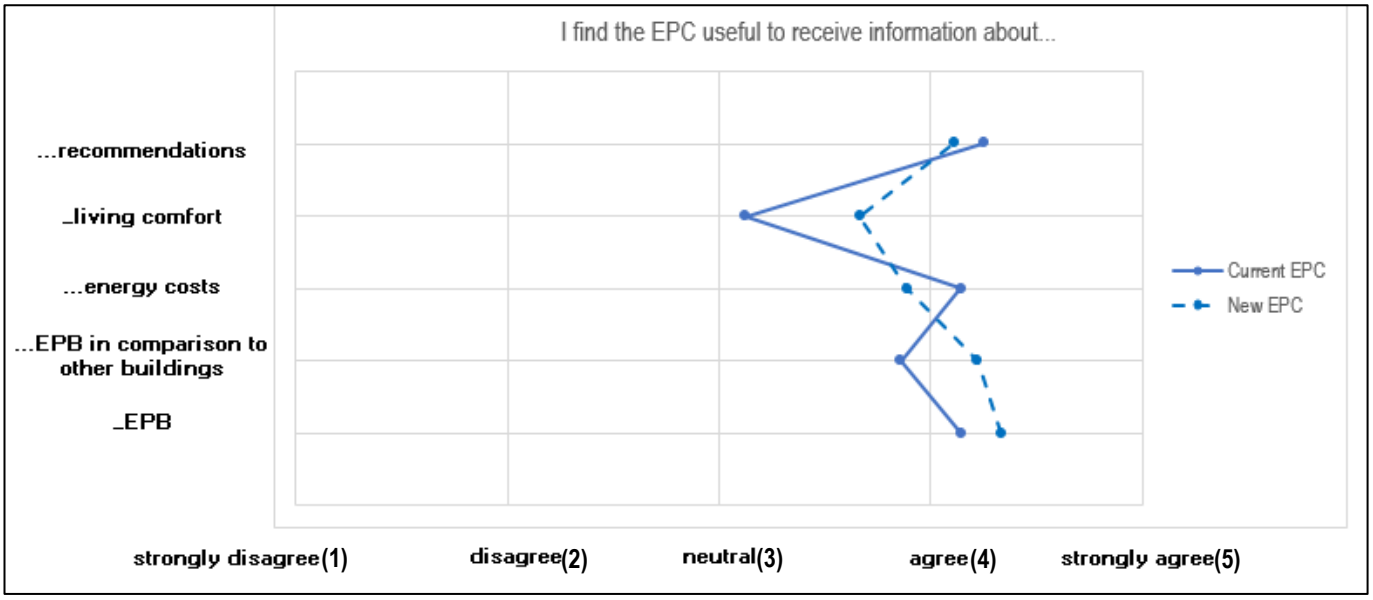

Figure 43: Perceived usefulness of EPC information in Finland

Figure 44 shows that overall the usefulness of EPC was rated slightly better for the current EPC than for the new EPC.

The groups do not differ significantly, t(15)= 0.645, p= .632. The mean of the new EPC group (M = 3.778, SD= 1.481) is not significantly higher than the current EPC group (M=4.125, SD= 0.354).

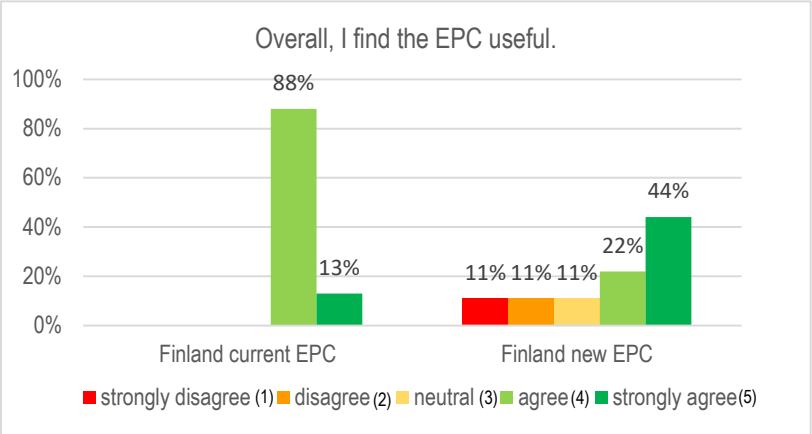

Figure 44: Overall perceived usefulness of EPC in Finland

4.2.3.7. *Evaluation of new EPC features*

The division of pages oriented towards different target groups was assessed as appropriate by about 50% of the participants, as visualized in Figure 46. Nothing was mentioned in order to improve the division of pages.

Information based on standard and actual conditions were perceived as useful and easy to understand by a majority, which is shown in Figure 45. It was suggested that the difference between actual and standard conditions should be explained sooner, as the conditions are already stated on the first page but not explained.

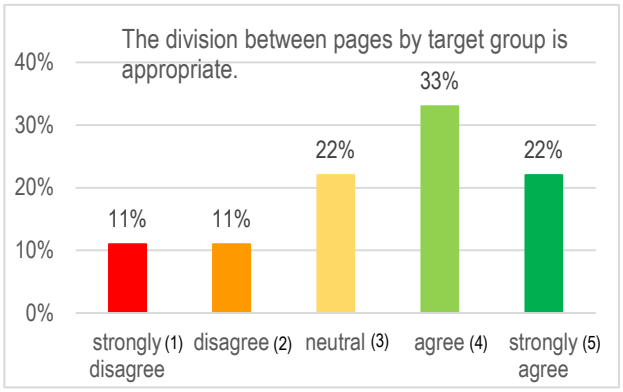

Figure 46: Perceived appropriateness of division between pages in Finland

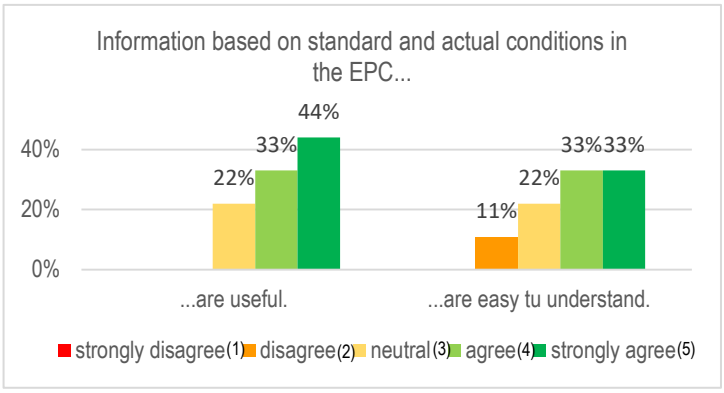

Figure 45: Evaluation of information based on standard and actual conditions

4.2.3.8. *Feelings about the EPC*

Figure 47 shows how on avergae participants of the two groups feel about the presented EPC. Both groups on average indicated to feel quite a bit motivatedand interested.

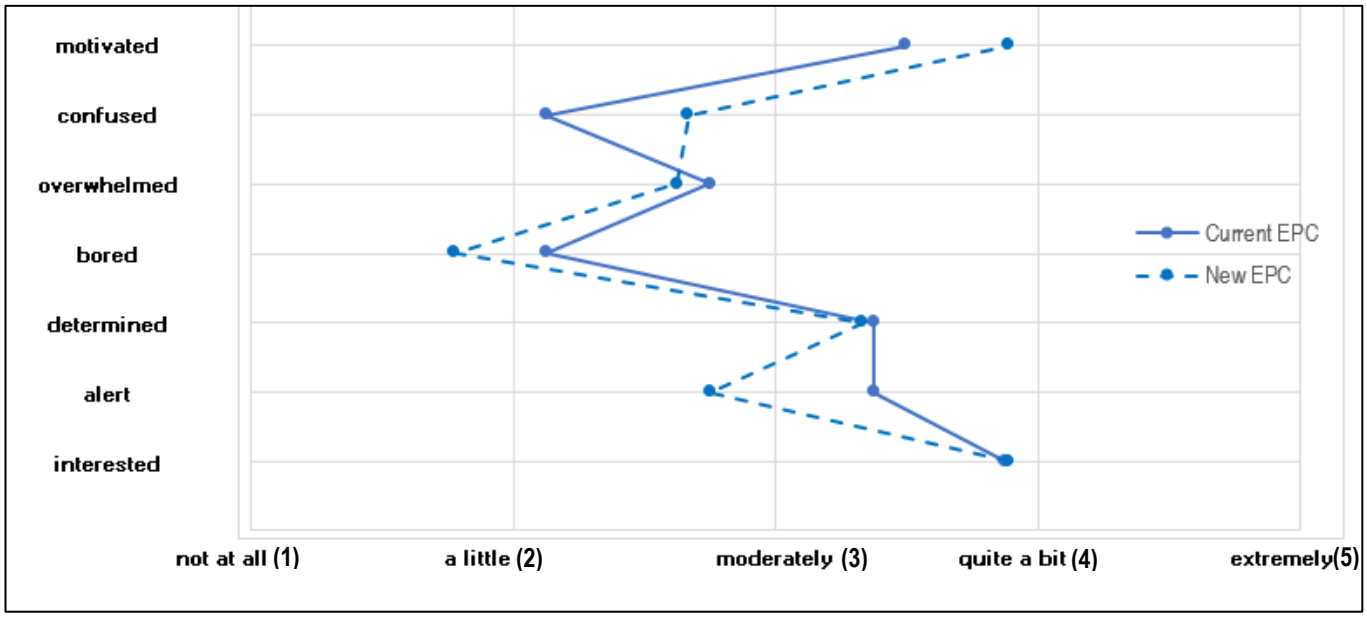

Figure 47: Feelings about the EPC in Finland

Mean-composite variable "feelings about the EPC": The groups do not differ significantly, t(14) = 0.218 p = .585. The composite mean for the new EPC group (M = 3.5, SD = 0,926) is not significantly higher than the current EPC group (M = 3.589, SD = 0.698). However, the diagram shows that the new EPC group felt more confused but less bored and more motivated than the current EPC group. Other mentioned feelings by the current EPC group were mixed, criticizing that information about RES and missing comparability between different options for EEMs. Additional feelings by the new EPC group were positive, with users stating to feel good about the more detailed and better information and to be curious and willing to learn more.

4.2.3.9. *Overall perception of EPC*

Figure 48 visualizes how the EPC was characterized by the two groups. It is obvious that the new EPC was on average perceived as more cluttered and confusing.

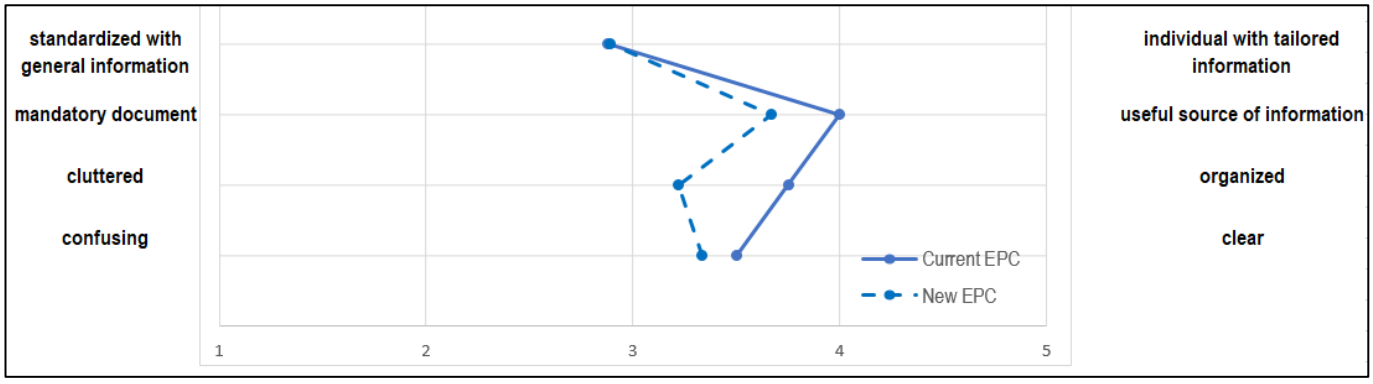

Figure 48: Characterization of EPC in Finland

Mean-composite variable "characterization of EPC": The groups do not differ significantly, t(15) = 0.587, p = .717. The composite mean for the new EPC group (M = 3.278, SD = 0.996) is not significantly higher than the current EPC group (M = 3.531, SD = 0.749).

Figure 49 shows that appropriateness of the EPC was rated slightly better in the new EPC group. From the diagram we can see that the means for the new EPC are higher for all tested aspects regarding EPC; especially visualization was rated higher. Scores in both groups are between 3 - 5 leaning towards appropriate rather than not appropriate.

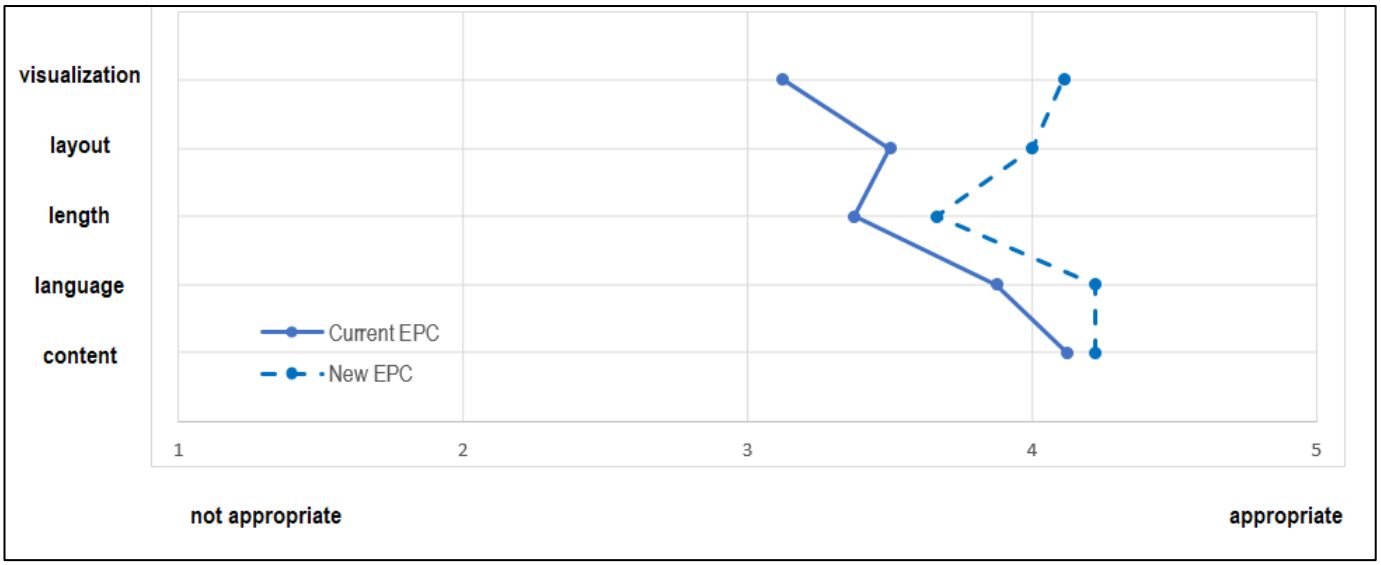

Figure 49: Perceived appropriateness of EPC in Finland

Mean-composite variable "appropriateness of EPC": The groups do not differ significantly regarding the evaluation of appropriateness of EPC, t(15) = -1.079, p = .149. The composite mean for the new EPC group (M = 4.044, SD = 0.78) is not significantly higher than the current EPC group (M = 3.6, SD = 0.92). Suggestions to improve the new EPC included to shorten and simplify it, while adding more explanations for laypeople (e.g. in an appendix or online supplement).

Both groups scored expectations as mostly met on average (cf. Figure 50). However, a minority (11%) scored expectations as not met. The groups do not differ significantly, t(15)= 0.704, p = .754. The mean of the new EPC group (M = 3.556, SD= 1.130) is not significantly higher than the current EPC group (M = 3.875, SD= 0.641). When asked what is needed such that expectations are met in terms of new EPC participants repeated clear, comparable, understandable information for laypeople and measured numbers.

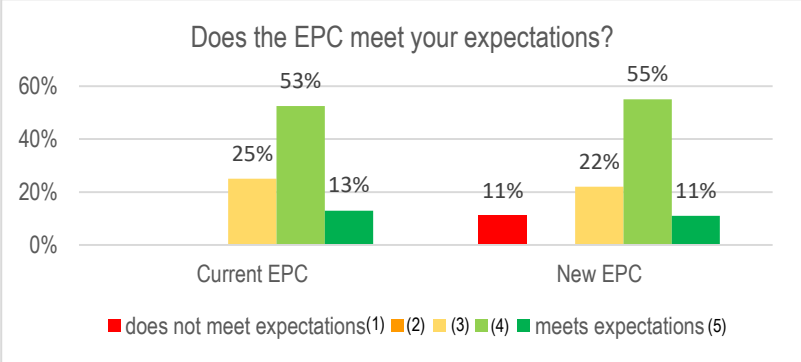

Figure 50: Fulfilment of expectations regarding EPC in Finland

4.2.3.10. *Attitude towards EPC*

Figure 51 shows that on average the attitude towards EPC is positive in both groups, with the current EPC being slightly better evauated than the new EPC.

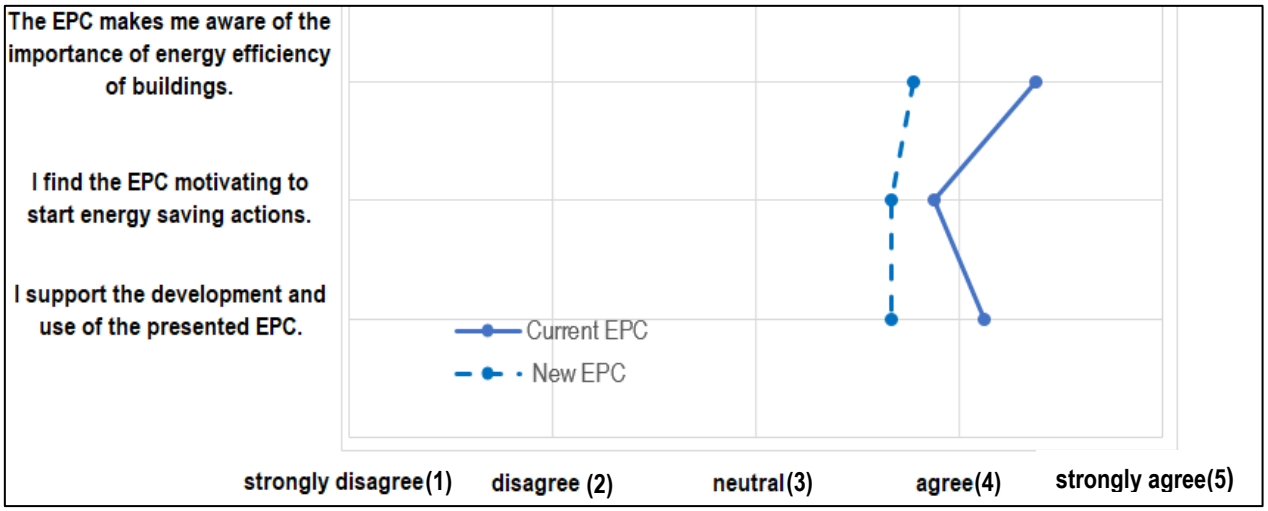

Figure 51: Attitude towards EPC in Finland

Mean-composite variable attitude towards EPC: The groups do not differ significantly, t(15)= 0.795, p = .780. The mean of the new EPC group (M= 3.704, SD= 1.379) is not significantly higher than the current EPC group (M = 4.125, SD= 0.616).

4.2.3.11. *Behavioural intention to use EPC*

Figure 52 shows the behavioural intention to use the EPC. On averge, the current EPC was rated better than the new EPC with no significant difference. Overall, the behavioural intention to use the EPC is positive.

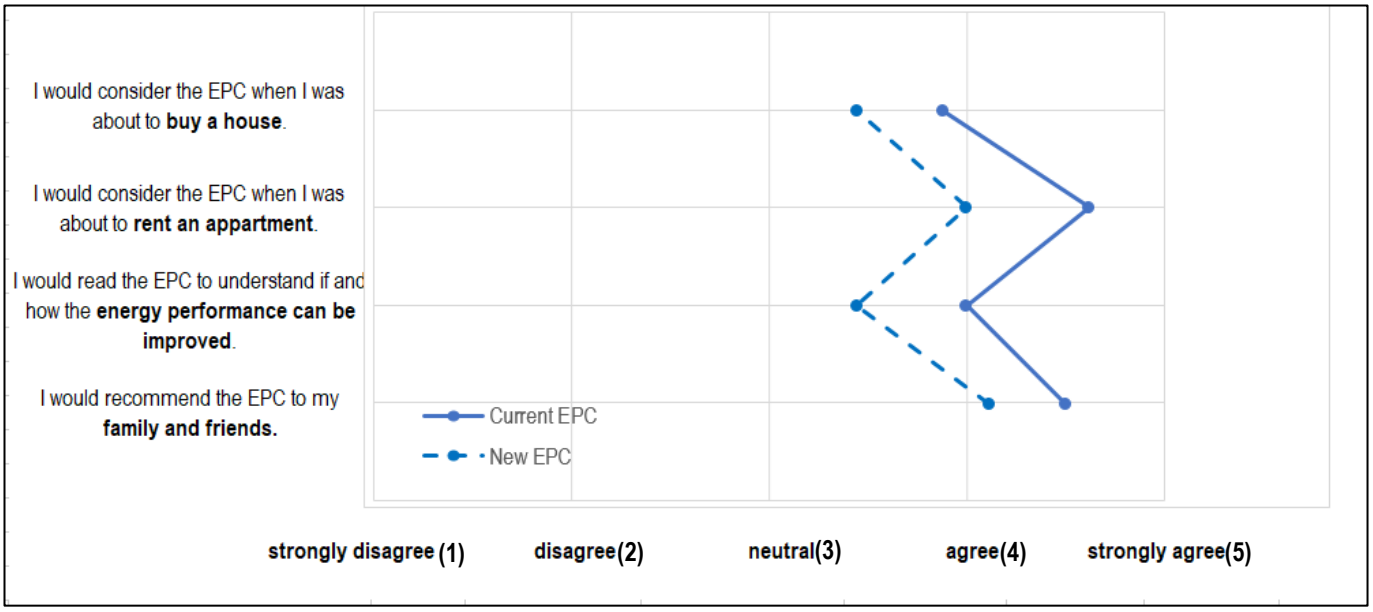

Figure 52: Behavioural intention to use the EPC in Finland

Mean-composite variable "behavioural intention to use EPC": The groups do not differ significantly regarding the behavioral intention to use the presented EPC, t(15) = 1.07, p = .849. The composite mean for the new EPC group (M = 3.75, SD = 1.218) is not significantly higher than the current EPC group (M = 4.25, SD = 0.535). No participant of the current EPC group said to not be willing to use the EPC voluntarily, while 44% of the new EPC group answered so. Other participants in the new EPC group mentioned to be willing to voluntarily use the EPC as support in planning selection of new buildings.

When asked about the sources/actors of information participants would use when renovating, the three highest rated sources/actors were “family/friends who are experts”, “neighbours who renovated their building” and “the EPC”. This displays overall trust in the EPC as a source of reliable information. Participants mentioned what/who else would play a role upon the decision to renovate: phone app, video tutorials, and renovation examples.

When asked about what factors influence the decision when buying a house participants rated most of the given factors as important or very important (i.e. location, price, living comfort the energy performance and operational costs). All participants rated the energy performance at least as “important”. Aesthetics of the building were rated as less important.

4.2.3.12. *Willingness to pay for EPC*

Figure 53 shows the willingness to pay for the presented EPCs. There is no significant difference between the groups, with the mean of the current EPC willing to pay 50-100€ and the mean of the new EPC group willing to pay less than 50€. Current prices for EPC in Finland range from 300 to 400€ for existing one-family-houses, from 150 to 200€ for new one-family houses, 670€ for existing apartment buildings and 850€ for new apartment buildings. Hence, prices for EPCs for existing family houses and apartment buildings as well as new apartment buildings are currently higher than the enquired price categories. The responses show that no one is willing to pay the current price for these buildings. 28% of the current EPC group and 22% of the new EPC group are willing to pay the current price or more for an EPC for a new one-family house.

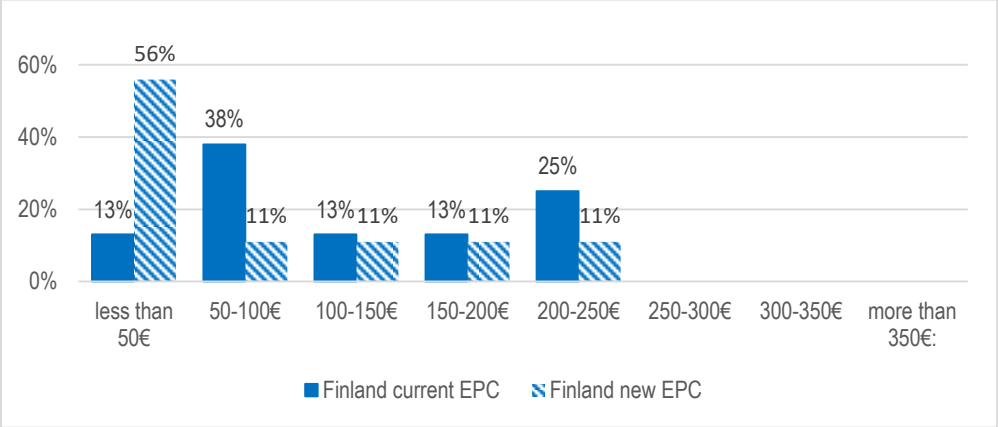

Figure 53: Willingness to pay for EPC in Finland

4.2.3.13. *Overview of open discussion during the workshop in Finland*

Table 12 summarizes the critiques (positive and negative) regarding the new EPC and current EPC as mentioned in the discussions in the Finnish workshop.

Table 12: Overview of discussion in Finland

Finland

Positives	New EPC	Current EPC
	• (Some) favoured the new EPC • Looks aesthetic • Good visualization -> makes it easier to understand the information • Focus more on the energy improvements • Easier to understand for end-users	

Negatives	• Overloaded with information • Primary energy is not a good criteria • Could not understand what the energy cost for the whole year for the building is • Does not show the calculations or how they are done	• It Is easier to find the information in the old version
Suggestions/Comments	• Better overview, less information • „2 summary pages maximum“ • Summary page and other information in the annex	• Include the detailed calculations • Pay attention to country-specific differences e.g. in Finland three glazing are a standard, so double glazing would be a step back

4.2.3.14. *Conclusion of the third Finnish user workshop*

In both groups, the gender split is skewed towards male majority with a ratio around 2 to 1. Age is spread relatively evenly, representing a full spectrum of the working population. Most attendees own the home they live in, with only a minority being tenants. Stakeholders in both groups regarded themselves almost entirely as end-users although there were some who worked with the EPC as energy advisor, policy maker or researcher. In the current EPC groups 43% said they had previous experience with the EPC while in the new EPC group 78% answered positive. This represents a noteworthy difference.

A significant difference between the two groups in understanding of the EPC features was found in two aspects. Understanding of the “components/installations in need of renovation” was significantly higher by the new EPC group. The other significant difference was found in the “current energy rating”. Here, the current EPC group showed a significant better understanding. While no significant difference was found the understanding of the “recommendations” improved from around 50% of participants giving a correct answer in the current EPC to 100% correct answers in the new EPC. Understanding of all other features was high in both current and new EPC with no significant difference between them.

Features which were introduced in the new EPC gave a mixed picture in terms of understandability. The “current primary energy rating” was not understood by 67% which however should not be a worrying result, as the info was not included. The “Potential energy rating” and “benchmarking” with 75% and 59% correct answers were understood better although still requiring improvements.

Overall perceived ease of use was assessed in a similar way with no significant difference between the groups. When rating whether the EPC is self-explanatory a clear majority in the current EPC (86%) and the new EPC (100%) gave “yes” as an answer. In the new EPC the “difference between total primary energy use and final energy use” and the “difference between standard and actual conditions” were elements which were rated as not self-explanatory and therefore should be examined again. For the current EPC (88%) and the new EPC (63%) of participants said they would appreciate assistance in understanding the EPC. An accompanying manual and additional explanations were most requested.

When rating the perceived usefulness of presented EPC no item was rated significantly different between the two groups. On average participants agreed with each statement. Overall usefulness was rated slightly better for the current EPC than for the new EPC however there was no statistical significance.

The division of pages was judged ambiguously with some finding it to be appropriate, others not. Information based on standard and actual conditions were perceived as useful and easy to understand by a majority. It was suggested that the difference between actual and standard conditions should be explained sooner.

Feelings about the EPC were mixed. On average participants felt moderate for most of the queried feelings. No significant difference between current and new EPC was found. Mentions under “other feelings” in the current EPC included dissatisfaction with certain details of the current EPC. For the new EPC answers included appreciation and curiosity.

Appropriateness of the EPC was rated similar with no significant difference between the two versions. Scores in both groups are between 3 - 5 leaning towards appropriate rather than not appropriate. Participants suggested that for the new EPC more explanations for laypeople are needed and that information should be simplified and reduced. Length should be reduced. Visualization was largely praised. As far as the fulfilment of expectations is concerned there is no significant difference between the current and new EPC group. Both groups scored expectations as mostly met on average. However, a minority of the new EPC group (11%) scored expectations as not met. When asked what to improve such that expectations are met, answers repeated improving understandability for laypeople and the inclusion of measured numbers.

Attitude towards both EPCs was between neutral and slightly positive for each of the three items. There was no significant difference. On average participants agreed that they intended to use the EPC in each of the displayed scenarios. There was no significant difference between the groups. When asked about the sources/actors of information participants would use when renovating the three highest rated sources/actors were “family/friends who are experts”, “neighbours who renovated their building” and “the EPC”. This displays overall trust in the EPC as a source of reliable information. When asked about what factors influence the decision when buying a house participants rated most of the given factors as important or very important.

On average participants in the new EPC group were willing to pay significantly more for the EPC. However, a majority (56%) were only willing to spend less than 50€. This is less than the average of the current EPC price for a one family home (around 150€ - 400€). The responses show that no one is willing to pay the current price for existing and new apartment buildings and existing one-family houses which residential buildings and new

A majority in the Finish discussion groups liked the visual presentation of the new EPC stating that it improves understandability, a view that is also supported by the results of the questionnaire. Still many found the new EPC to be overloaded with information and suggested adding a one or two page summary. Others however, in particular energy experts, noted that they missed the detailed calculations of the old finish version and that it was easier for experts to find the detailed information in the current EPC. Overall the mood between the new EPC and the current EPC was split.

4.2.4. Greece

The following subchapter presents the results of the third user workshop in Greece. In this context, 39 questionnaires were filled in, with 17 responses regarding the current EPC and 22 responses regarding the new EPC.

4.2.4.1. *Socio-demographics*

Figure 54 shows the gender distribution and housing situation of the participants in both groups. Both sexes are represented by about 50% in both groups, with more females in the new EPC group and more males in the current EPC group. The vast majority of participants in both groups owns the building they live in (min. 78%).

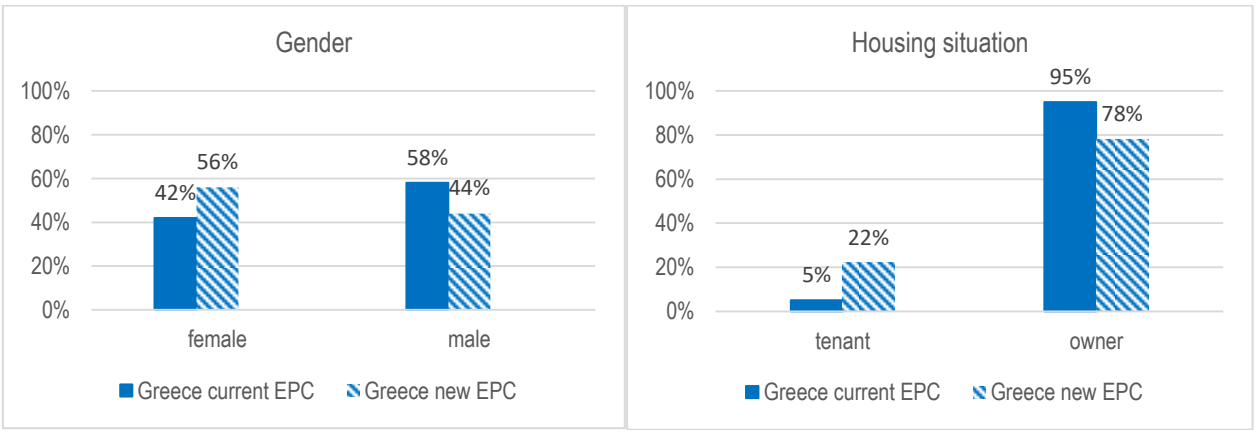

Figure 54: Gender and housing situation of Greek participants

The type of building participants live in is relatively mixed, with most living in a terraced house (47% of the current EPC group and 67% of the new EPC group).It is noticeable that only 6% of the new EPC group are younger than 40 years. Most participants of the current EPC group are between 40 and 45, while the largest fraction of the new EPC group is between 45 and 49 years old. The participants of the new EPC group have a higher level of completed education than the current EPC group (all of the new EPC group have a university degree or other school-leaving qualification).

4.2.4.2. *Relation to EPC and experiences with EPC*

Figure 55 shows the stakeholder types that were present in both groups. Most participants in both groups assign themselves as end-users, while energy advisors is the group that is second most represented. Participants in the new EPC groups indicated to be participants in a sister project of ePANACEA.

Most participants of both groups had experience with the EPC before the workshop (74% of the current EPC group and 76% of the new EPC group). Participants were in professional contact with the EPC (e.g. as energy consultant) and/or as end-user (e.g. as owner/tenant) in both groups as further specified in Table 13.

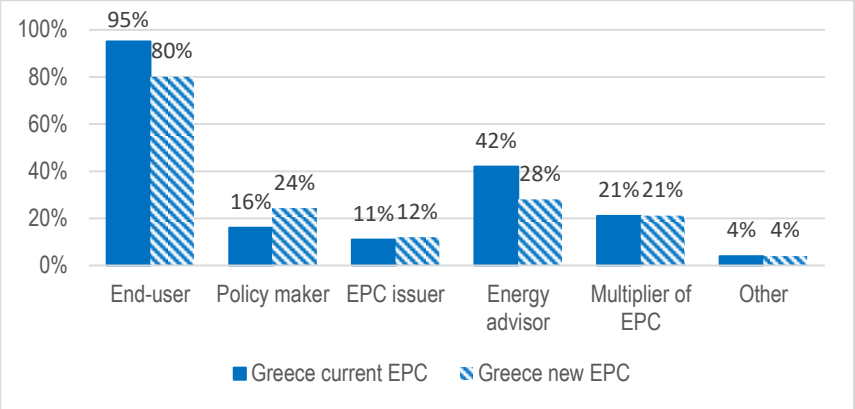

Figure 55: Stakeholder types in the Greek workshop

Table 13: Description of experience with the EPC in Greece

Current EPC group	New EPC group
• as energy consultant • as owner/tenant • in the ePANACEA Web workshop • in multiple roles	• as energy consultant • as owner/ tenant 3x • in multiple roles • in other projects

4.2.4.3. *Understanding of EPC elements*

The answers are coded as 1 for a correct and 2 for a wrong answer. The means per group (current and new EPC) for each item of understanding of EPC elements are shown in Figure 56

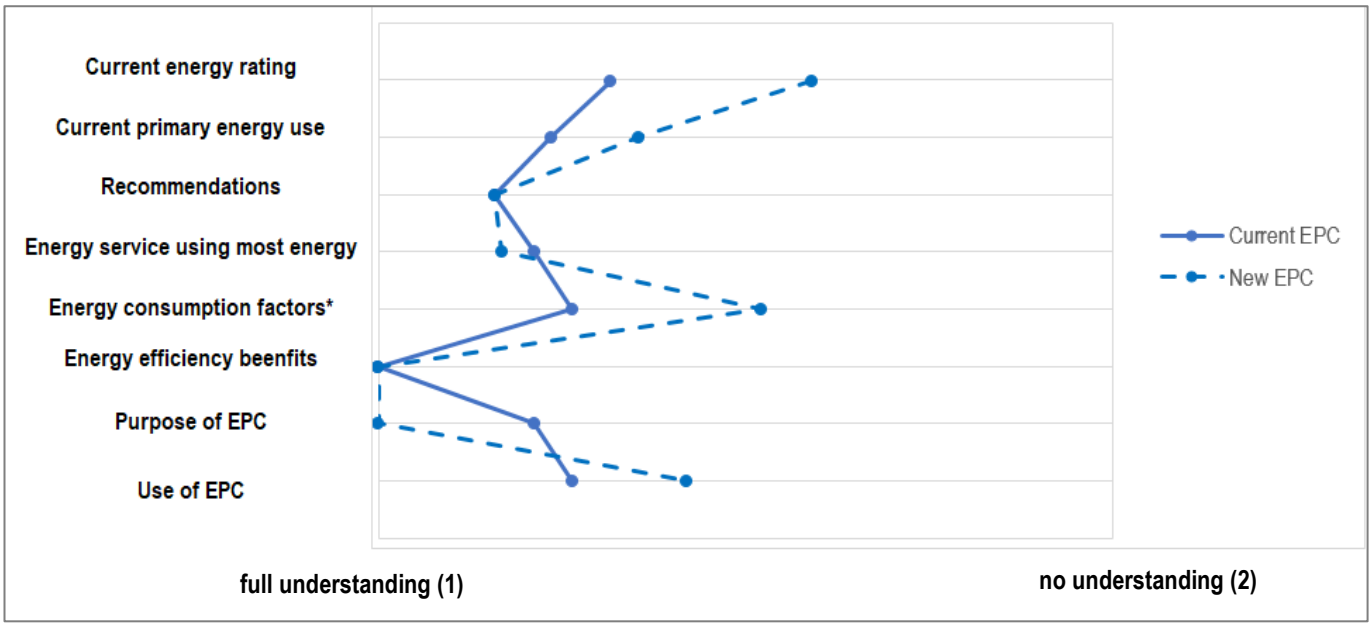

Figure 56: Understanding of EPC features in Greece

***Energy consumption factors:** The groups differ significantly, t(38)= -1.736, p = .045. The mean of the new EPC group (M = 1.421, SD = 0.507) is significantly higher than the current EPC group (M = 1.263, SD= 0.452), indicating that the current EPC is better understood than the new EPC.

Mean-composite "understanding of EPC": The groups do not differ significantly, t(23) = 0.806, p = .786. The composite mean for the new EPC group (M = 1.198, SD = 0.125) is not significantly higher than the current EPC group (M = 1.26 SD = 0.236).

4.2.4.4. *Understanding of new EPC elements*

he potential energy rating was correctly understood by the majority of participants (94%), while the benchmarking and building components/installation in need of renovation are not correctly understood by 50% and 33%, respectively, indicating need for improving the presentation of information.

4.2.4.5. *Perceived ease of use of EPC*

Figure 57 shows that overall, both groups evaluated the presented EPC to be easy to understand.

The groups do not differ significantly, t(37)= 0.381, p = .647. The mean of the new EPC group (M = 3.85, SD= 0.813) is not significantly higher than the current EPC group (M = 3.947, SD=0.78). The majority perceives the EPC self-explanatory (89% of the current and 100% of the new EPC group). Still, there are a couple of aspects mentioned to be not self-explanatory in both groups (cf.

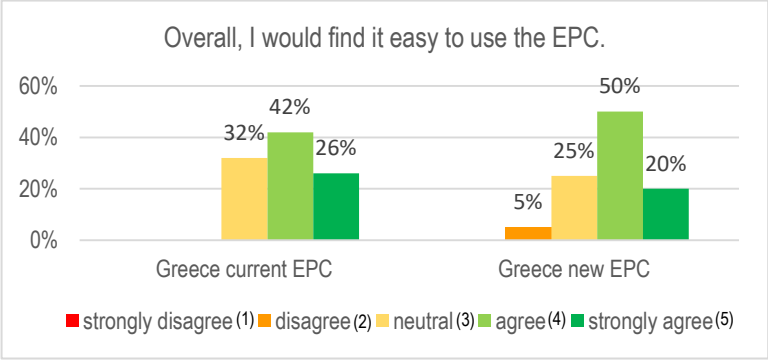

Figure 57: Overall perceived ease of use of the EPC in Greece

Table 14).

Table 14: Parts which are not self-explanatory regarding the presented EPCs in Greece

Current EPC	New EPC
• Insufficient information about the category the building will be assigned to after the energy saving measure	• Primary energy consumption after implementation of the recommendations
• Saving scenario	• Thermal comfort & IAQ graphs are not clear
• The meaning of reference building	• Energy identity of the building
• The concept of primary energy	• The current situation is not directly comparable with the implementation of the measures (except on the last page)

In both groups 79% would appreciate assistance in understanding the EPC, while 21% indicate to not need assistance. Figure 58 shows that online support is perceived as rather important source of additional information in both groups, while the new EPC group on average would appreciate a hotline and the current EPC group additional explanations in the EPC, as well.

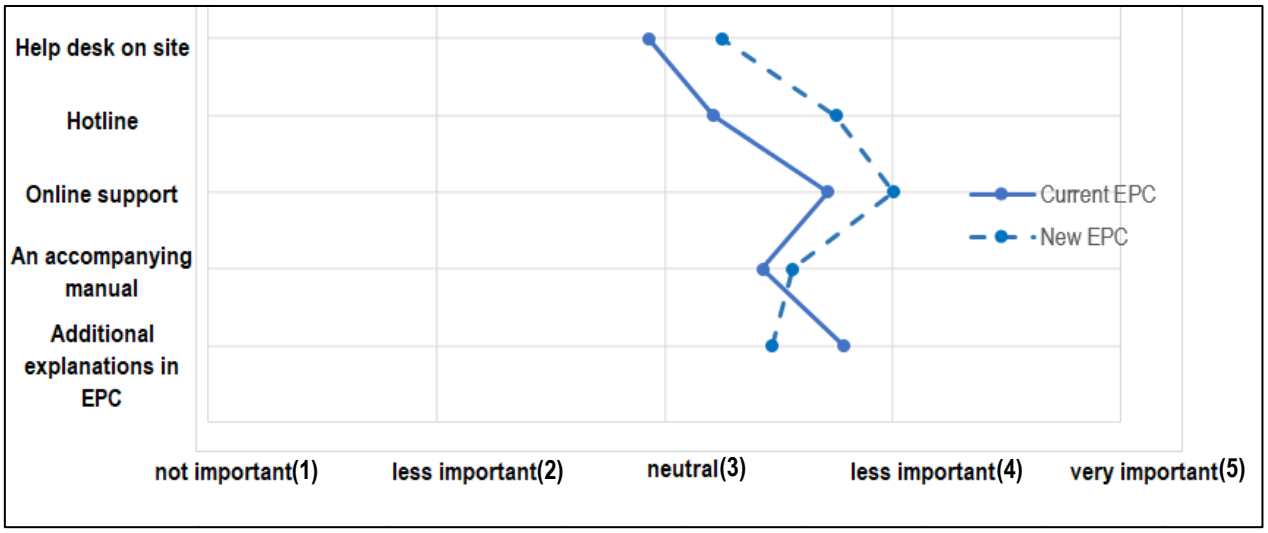

Figure 58: Importance of information in assisting in understanding the EPC in Greece

4.2.4.6. *Perceived usefulness of presented EPC*

Figure 59 shows how on average the EPC was perceived as useful to receive information regarding different aspects.

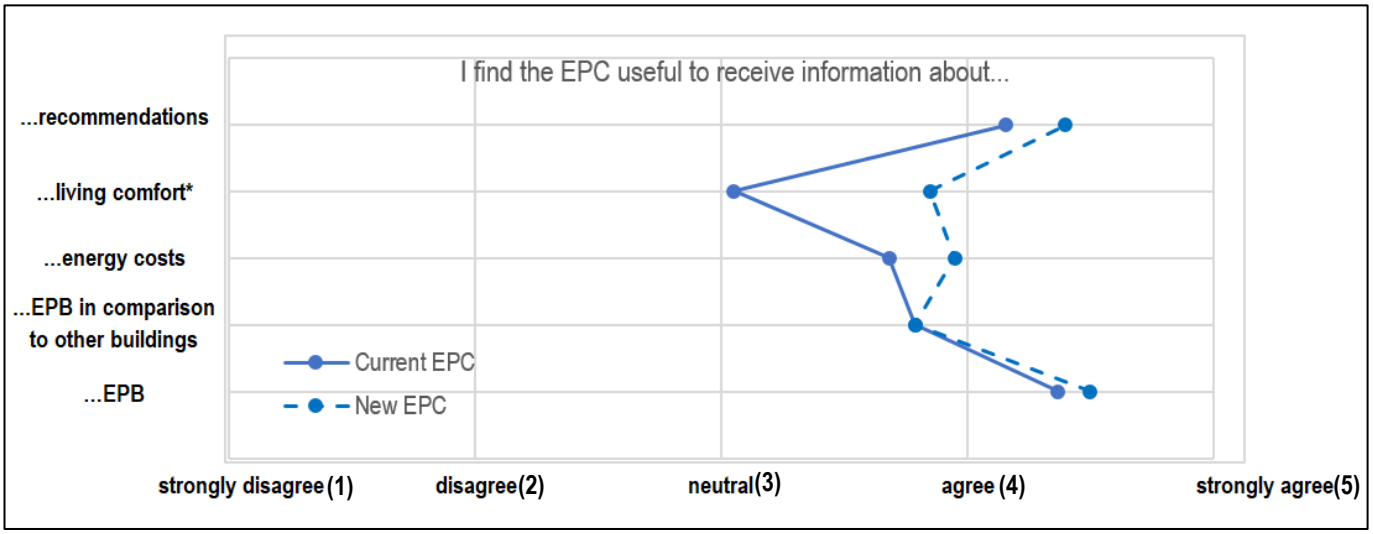

Figure 59: Perceived usefulness of EPC information in Greece

***Living comfort**: The groups differ significantly, t(37) = -2.541, p = .008. The mean of the new EPC group (M = 3.85, SD = 0.988) is significantly higher than the current EPC group (M = 3.053, SD = 0.970), indicating that the new EPC is more useful to receive information about the living comfort than the current EPC.

Figure 60 shows that the new EPC is significantly perceived as more useful in order to receive information about additional indicators (costs for running the building, IAQ and comfort).

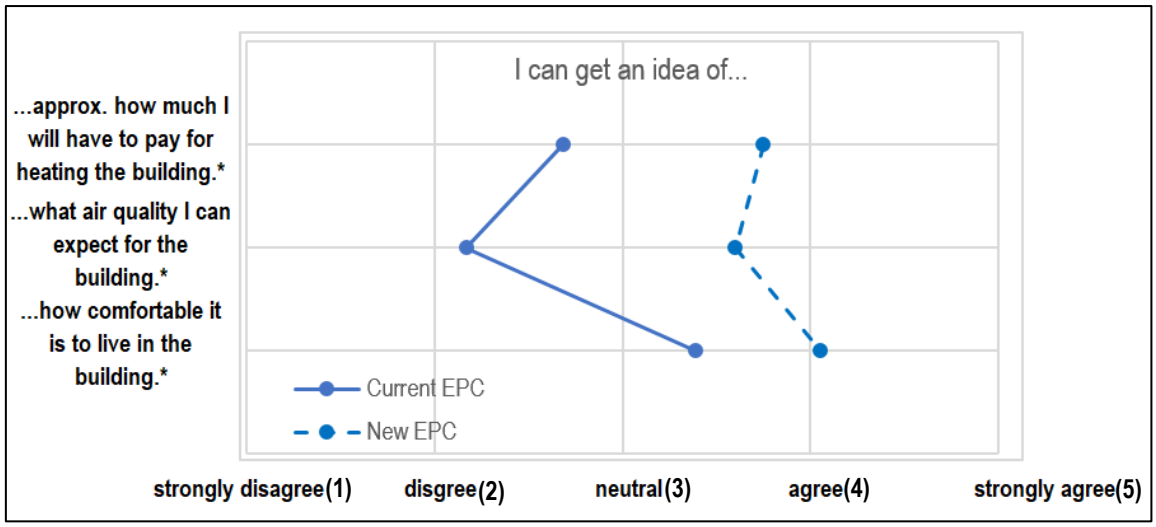

Figure 60: Perceived usefulness of EPC to receive information about additional indicators in Greece

***Costs for heating:** The groups differ significantly, t(37)=-4.143, p = <.001. The mean of the new EPC group (M = 3.75, SD= 0.55) is significantly higher than the current EPC group (M = 2.684, SD= 1.003), indicating that the new EPC is more useful in order to learn about the costs for heating the building.

***Air quality:** The groups differ significantly, t(36)= -5.066, p = <.001. The mean of the new EPC group (M= 3.6, SD= 0.94) is significantly higher than the current EPC group (M = 2.167, SD= 0.786), indicating that the new EPC is more useful in order to learn about the air quality that can be expected in the building.

***Comfort:** The groups differ significantly, t(35)=-2.377, p= .0012. The mean of the new EPC group (M = 4.053, SD = 0.848) is significantly higher than the current EPC group (M = 3.389, SD= 0.85), indicating that the new EPC is more useful in order to learn about the comfort in a building.

Overall, both EPC versions are perceived as useful, as shown in Figure 61. Overall, the groups do not differ significantly, t(37) =0.923, p= .343. The mean of the new EPC group (M = 4.3, SD = 0.657) is not significantly higher than the current EPC group (M = 4.263, SD = 0.562), indicating that overall the two EPC versions are perceived as equally useful, which is in contrast to the significantly higher perceived usefulness of the EPC in providing information on costs, air quality and comfort by the new EPC group.

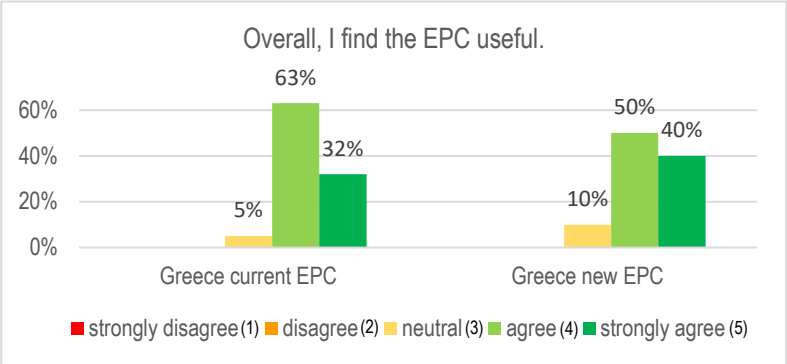

Figure 61: Overall perceived usefulness of EPC in Greece

4.2.4.7. *Evaluation of new EPC features*

Figure 62 shows that participants have a mixed opinion regarding the appropriateness of the division between pages by target group. Participants suggest to improve the division between pages by target group by dedicating one page for the building envelope, one page for the systems, one page for energy data and keeping more space for hints. Others suggested bright different colours and boxes to make information easier to understand and to better structure and clearer separate the information. Besides, that other participants commented to not understand the need for separation.

Figure 63 shows how useful and easy to understand participants find the information based on standard and actual conditions in the EPC. Almost all (95%) perceive it as useful, while only 61% perceive it as easy to understand.

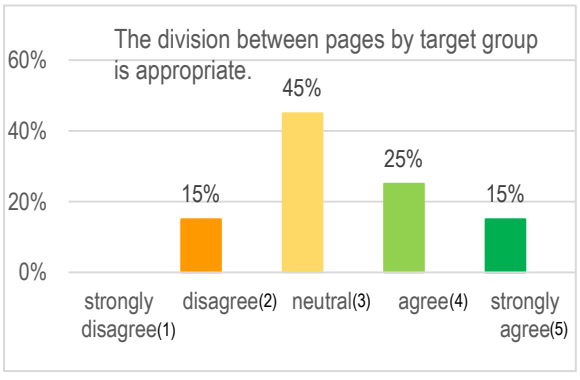

Figure 62: Perceived appropriateness of division between pages in Greece

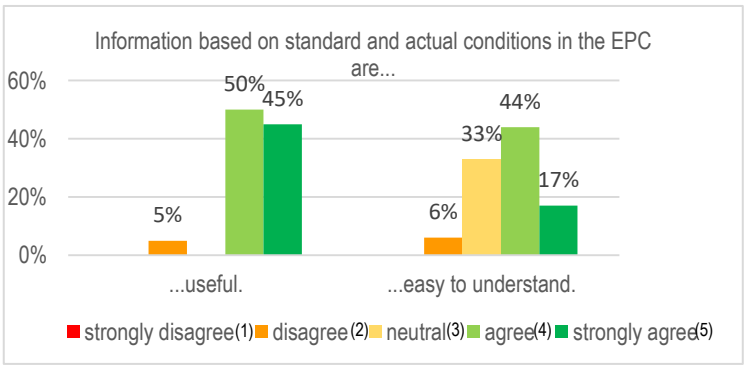

Figure 63: Evaluation of new EPC features in Greece

Improvement of standard and actual conditions of new EPC:

- Values should be are all based on standard conditions so that a comparison can be made between buildings. The information based on actual conditions should be reported elsewhere, e.g. where the proposed interventions are mentioned (i.e. as proposed interventions related to the change in user behaviour).
- It should be stated that the standard phrases refer to a comparison with an ideal reference building. This should be clearly separated from the actual conditions.
- Clearly present the final classification of the energy performance of the building. Which is typical or actual?

4.2.4.8. *Feelings about the EPC*

Figure 64 shows how participants of the two groups feel on average regarding the presented EPC. The diagram shows that the on average the new EPC group feels more interested and motivated, but also more overwhelmed.

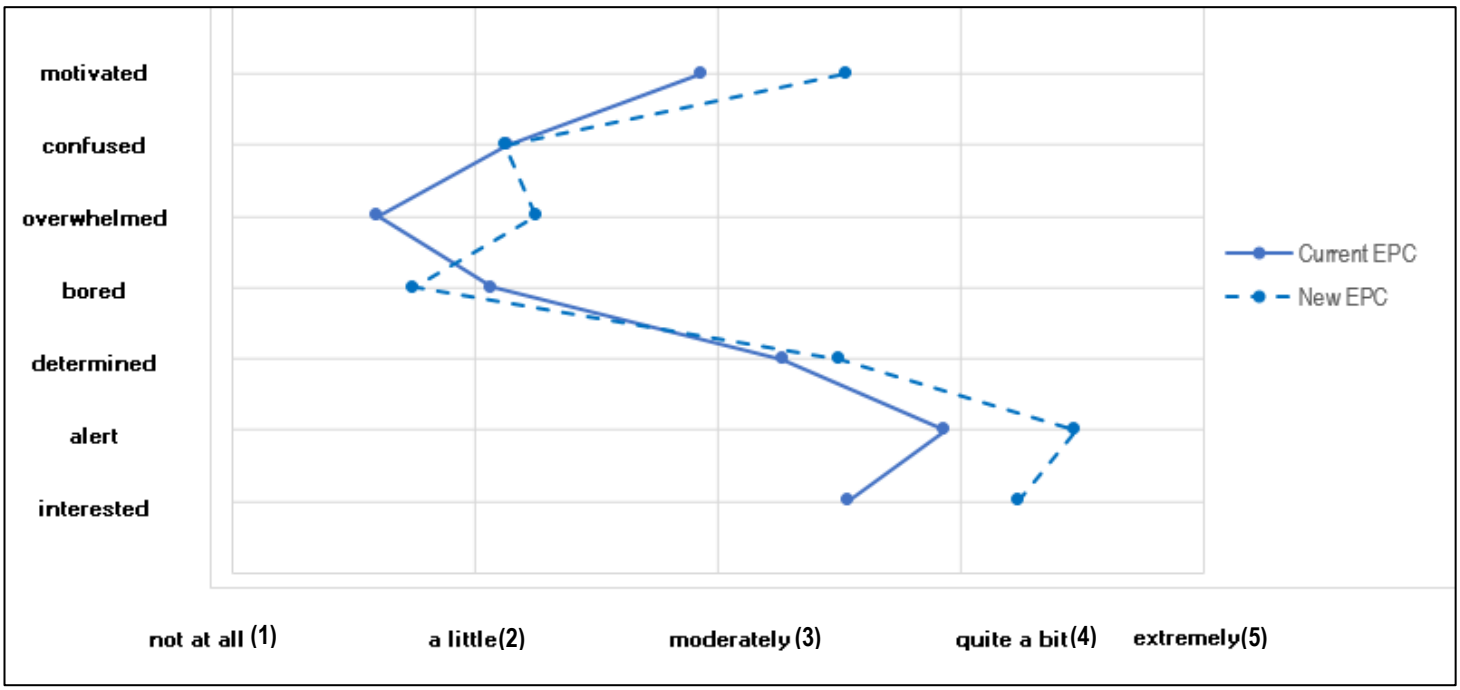

Figure 64: Feelings about the EPC in Greece

Mean-composite variable "feelings about EPC": The groups do not differ significantly, t(28) = 0.010 p = .922. The composite mean for the new EPC group (M = 3.905, SD = 0.588) is not significantly higher than the current EPC group (M = 3.695, SD = 0.596).

Mentions under "other feelings" in the current EPC group: one participant mentioned that the EPC should be simpler qhile another said to need more time to study. It was demanded that there should be one uniform EPC for the whole EU. There was the request for information about air quality and more graphics as well as energy classification after introducing the measures, which is already included in the new EPC proposal.

Mentions under "other feelings" in the new EPC group: three participants found the new EPC helpful and interesting although a little confusing. There were complaints about comfort of use, aesthetics and that the information was cramped together.

4.2.4.9. *Overall perception of EPC*

From Figure 65 we can see that the mean for the new EPC group is higher regarding the individuality and the usefulness of the EPC, whereas the rating is the same regarding the organization and clearness of the EPC.

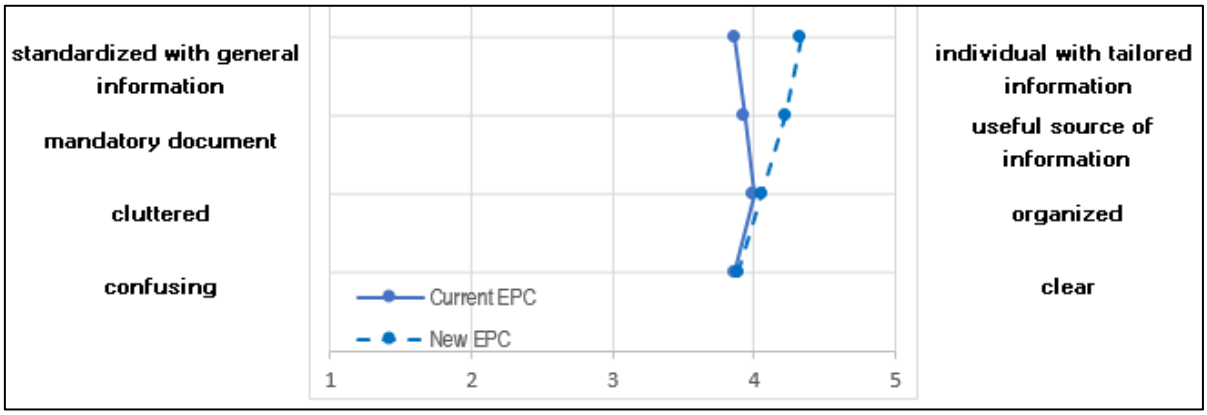

Figure 65: Characterization of EPC in Greece

Mean-composite variable "characterization of EPC": The groups do not differ significantly, t(36) = -0.995, p = .164. The composite mean for the new EPC group (M = 4.125, SD = 0.487) is not significantly higher than the current EPC group (M = 3.917, SD = 0.711).

Figure 66 shows to what extent participants' expectations were met in the two groups.

Fulfilment of expectations for EPC: The groups do not differ significantly, t(37)= -1.421, p = .082. The mean of the new EPC group (M = 3.85, SD = 0.813) is not significantly higher than the current EPC group (M = 3.474, SD = 0.841).

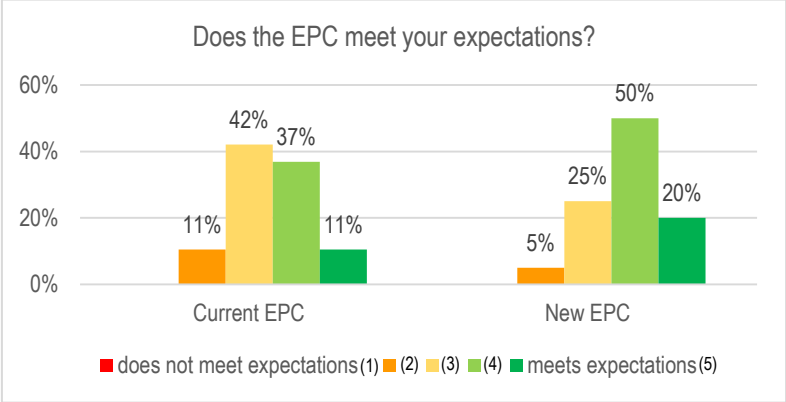

Figure 66: Fulfilment of expectations regarding EPC in Greece

What is needed such that expectations are met in terms of new EPC:

- Primary and final energy use before and after the proposed interventions
- Set up in such a way that the current situation is clear.
- Improved in terms of the proposed interventions mainly, improved in terms of economic benefits.
- Perhaps a few more and more detailed explanations
- Simpler, more understandable to the end user (structured with more useful information without chatter)
- Detailed data on the consumption of the building and the quality of visual, acoustic, thermal comfort and air quality, as well as information on renewable energy sources

From Figure 67 we can see that the rating of appropriateness of the new EPC is higher in regard to all tested aspects (visualization, layout, length, language and content).

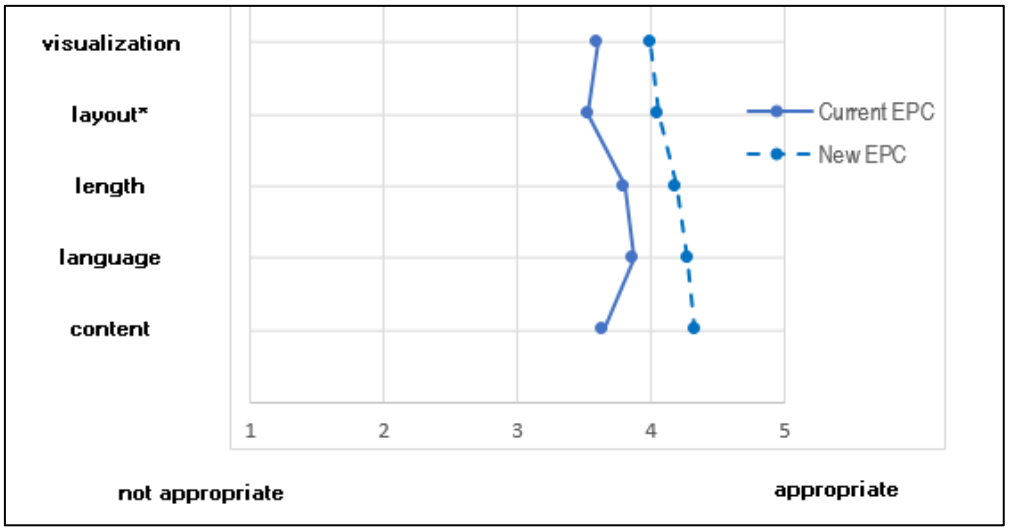

Figure 67: Perceived appropriateness of EPC in Greece

***Layout:** the groups differ significantly, t(37)= -1.925, p = .031. The mean of the current EPC group (M = 3.579, SD=0.769) is significantly lower than the new EPC group (M=4.05, SD = 0.759), indicating that the new EPC groups significantly finds the layout more appropriate than the current EPC group.

Mean-composite variable "appropriateness of EPC"*: The groups differ significantly regarding the evaluation of appropriateness of EPC, t(28)= -2.694, p = .0006. The composite mean for the new EPC group (M = 4.225, SD = 0.61) is significantly higher than the current EPC group (M = 3.614, SD = 0.63).

Participants have suggestions for improvement, as listed in Table 15.

Table 15: Suggestions for improvement of the new EPC in Greece

Content	Language	Visualization
• Building classification after the proposed interventions✓ • More analysis on the proposed interventions, add primary energy consumption • Financial gains, payback time • More clearly • Less text • Information on consumption per installation ✓ • Only in electricity sum of final energy	• Make it less specialised	• Make the information less confusing • Make it visually more appealing • Add illustrations

4.2.4.10. *Attitude towards EPC and energy efficiency*

Figure 68 shows that on average the attitude is positive in both groups, with significant higher scores in the new EPC group.

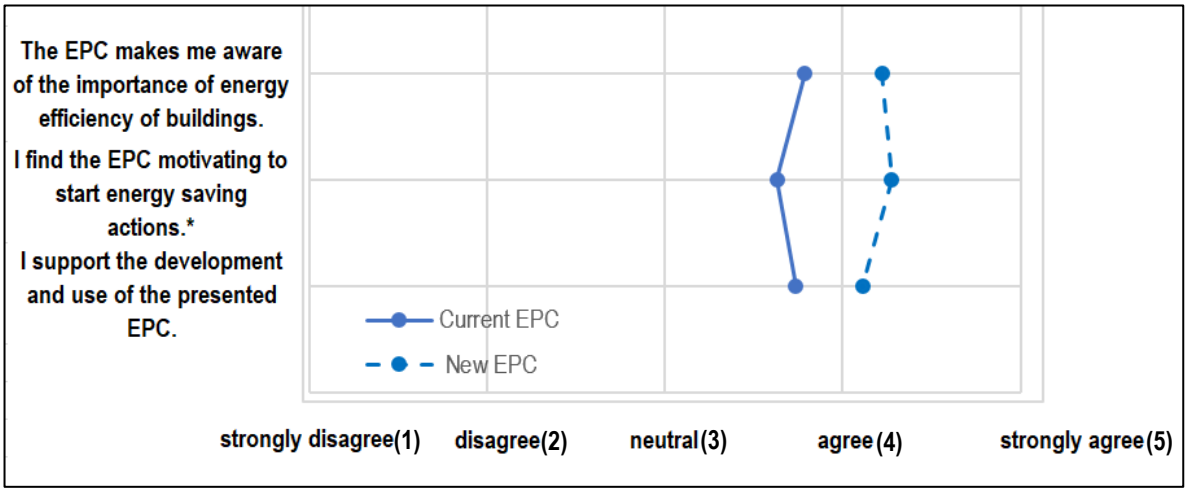

Figure 68: Attitude towards EPC in Greece

***I find the EPC motivating to start energy saving actions:** the groups differ significantly, t(35)=-1.936, p = .03. The mean of the new EPC (M= 4.278, SD= 0.958) is significantly higher than the current EPC group (M = 3.632, SD= 1.065).

***Mean-composite "attitude towards EPC"**: the groups differ significantly, t(35)=-1.988, p = .027. The mean of the new EPC group (M = 4.204, SD= 0.733) is significantly higher than the current EPC group (M= 3.719, SD= 0.848).

4.2.4.11. *Behavioral intention to use EPC*

Figure 69 shows the average behavioural intention to use the presented EPC per group.

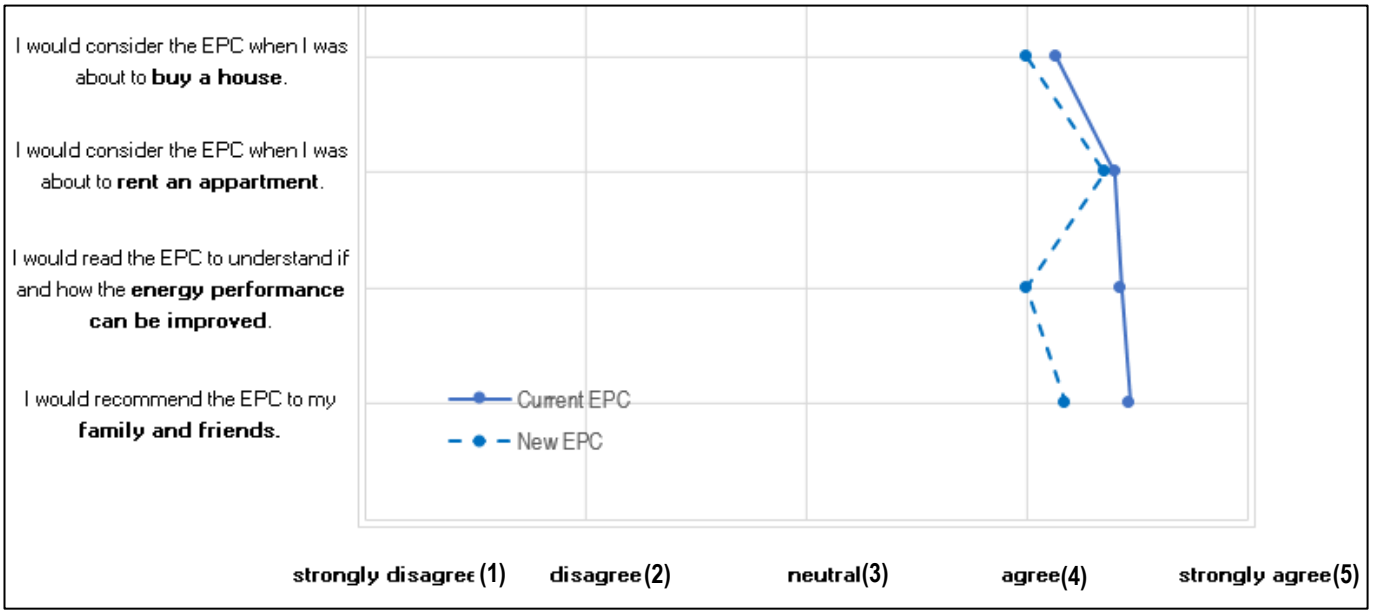

Figure 69: Behavioural intention to use the EPC in Greece

Mean-composite variable "behavioral intention to use EPC": The groups do not differ significantly, t(29) = 0.003, p = .955. The composite mean for the new EPC group (M = 4.393, SD = 0.587) is not significantly higher than the current EPC group (M = 4.393, SD = 0.552). However, from the diagram one can see that the behavioral intention of the new EPC group is lower for all items. Only 6% of the new EPC group said to not be willing to voluntarily use the EPC, while 16% of the current EPC group

said so. Currently an EPC costs 80€ to 150€ for an average household in Greece. Only few participants (26% of the current EC group and 18% of the new EPC group) is willing to pay more.

4.2.4.12. *Willingness to pay for EPC*

Figure 70 shows the willingness to pay per group. There is no significant difference between current and new EPC. In the current EPC group 58% are only willing to spend less than 100%, while in the new EPC group the fraction willing to pay only 100€ is 39%. Currently an EPC costs 80€ to 150€ for an average household in Greece. Only few participants (26% of the current EC group and 18% of the new EPC group) is willing to pay more.

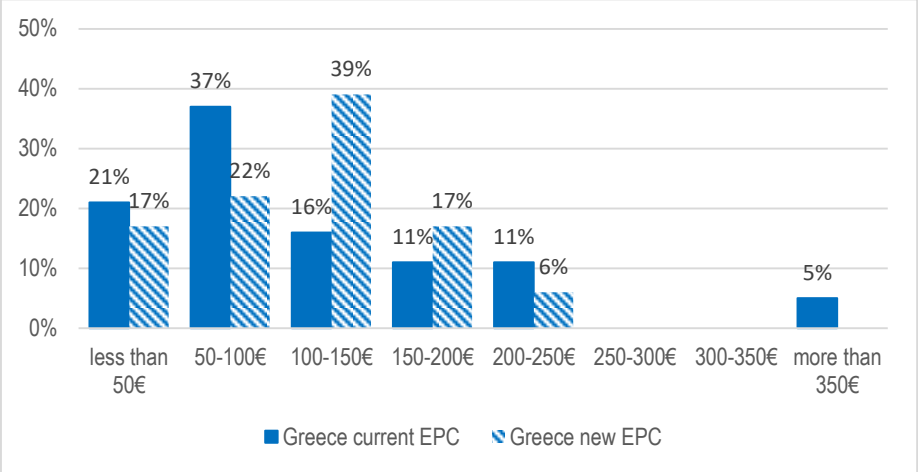

Figure 70: Willingness to pay for EPC in Greece

4.2.4.13. *Any other feedback from new EPC group*

- "I would like the home page to contain only some basic information that is of reasonable interest to the end user (especially one who is not familiar with these topics). I would like this home page to contain the current situation (class with typical conditions, total energy consumption, energy costs), savings proposals, and future situation based on the proposed interventions (plus investment costs and payback time)"
- "Guidelines for subsidies"
- "This EPC is much better than the existing one, gives enough information for the end user, but it confuses the standard situation with the actual situation and has some specialized information that needs additional explanation for a typical end user (maybe more links would be useful)"

4.2.4.14. *Overview of open discussion during the workshop in Greece*

Table 16 gives a summary of the discussion during the workshop in Greece. Only the new EPC was referred to by participants.

Table 16: Overview of discussion in Greece

Positives	New EPC
	• "Recommendations and energy efficiency potential" section: graphical representation is helpful especially for non-experts • "Energy performance of building components and installations" section: colour differentiation of components and installations helps to understand the energy performance • "Potential of renewable primary energy, generated on-site or nearby from different renewable energy sources" section: detailed presentation of the RES is useful
Negatives	• Current rating of your building section: Position of coloured boxes is confusing, it is not clear which energy class is related with the boxes • Recommendations and energy efficiency potential: primary energy consumption after recommendations is not displayed There are too many frames which may confuse the reader
Suggestions/Comments	• "Total primary energy standard share of renewables systems" section: Non-renewable primary energy should be indicated first, Colour of the bar indicating renewable/non-renewable energy mix should match proportion and the energy rating in the "current rating of your building" section • Some detailed Information should be moved to the annex

4.2.4.15. *Conclusion of the third Greek user workshop*

Both sexes are represented by about 50% in both groups, with more females in the new EPC group and more males in the current EPC group. It is noticeable that only 6% of the new EPC group are younger than 40 years. Most participants of the current EPC group are between 40 and 45, while the largest fraction of the new EPC group is between 45 and 49 years old. The participants of the new EPC group have a higher level of completed education than the current EPC group (all of the new EPC group have a university degree or other school-leaving qualification). The vast majority of participants in both groups owns the building they live in (min. 78%). The type of building participants live in is relatively mixed, with most living in a terraced house (47% of the current EPC group and 67% of the new EPC group).

Overall there was no significant difference tested regarding the understanding of EPC features between the two groups. Only the energy consumption factors were significantly better understood by the current EPC group. Among the new EPC features, the benchmarking, potential primary energy use and building components/installation in need of renovation are not correctly understood by 50%, 75% and 33%, respectively, indicating need for improving the presentation of information.

There is no significant difference regarding the perceived ease of use of the EPCs. Overall, both groups evaluated the presented EPC to be easy to understand. The majority perceives the EPC self-explanatory (89% of the current and 100% of the new EPC group!). Parts which are not self-explanatory in the current EPC is the meaning of the reference building, the concept of primary energy and the potential energy rating after the implementation of energy efficiency measures. In terms of the new EPC the thermal comfort and IAQ graphs are not clear. In both groups 79% would appreciate assistance in understanding the EPC (preferably by online support).

Overall the two EPC versions are perceived as equally useful, which is in contrast to the significantly higher perceived usefulness of the EPC in providing information on costs, air quality and comfort by the new EPC group.

The new EPC is slightly perceived more as individual with tailored information and as a useful source of information than the current EPC; however, the difference is not significant. The groups differ significantly regarding the evaluation of appropriateness of the EPC. Content, language, length, layout and visualization were all perceived as more appropriate by the new EPC group. In order to still improve the new EPC, participants suggested to provide more information on the proposed interventions (e.g. financial gains, payback times), to add primary energy consumption of the building but to also reduce the content and make it more clear as it currently contains a lot of potentially confusing information. The language was described as too specialised by one participant. There were also 5 participants who only stated that the new EPC is satisfactory as it is.

The new EPC slightly fulfils the expectations towards EPC better than the current EPC; but, the difference is not significant. 70% of the new EPC group indicated that they agree or strongly agree with the statement that the presented EPC fulfils expectations. 58% did so from the current EPC group. In order to fulfil their expectations participants indicated that primary and final energy use, before and after the proposed interventions, should be provided. Also, more detailed explanations should be included, which goes together with the hint that the EPC should become simpler for the end user (structured with more useful information without chatter). Also, the economic benefit of proposed interventions could be stated more clearly.

The majority of participants agrees (45%) or is neutral (40%) regarding the statement that the division of pages by target group is appropriate. But, there are 3 participants who mention that they see no need for the separation of pages. Others indicate that they did not understand the division of pages and that the pages should be better structured and have a clearer separation of the information.

The provision of information based on standard and actual conditions is perceived as useful by 95% of participants; but only 61% say that they are easy to understand. I would prefer that the values are all based on standard conditions so that a comparison can be made between buildings. As for the actual conditions, I would suggest that they should be reported elsewhere, e.g. where the proposed interventions are mentioned (i.e. as proposed interventions related to the change in user behaviour). In this regard a participant mentioned that it should be presented more clearly what the final classification of the energy performance of the building is – whether it is based on actual or on standard conditions of use.

The feelings towards the EPC versions are not significantly different. Both groups on average do not feel bored regarding the EPC and only a little confused. On average the new EPC group feels slightly more interested and motivated, but also more overwhelmed. The current EPC group mentioned suggestions for improvement which are already considered in the new EPC proposal, such as that there should be one uniform EPC for the whole EU, information about air quality, as well as energy classification after introducing the measures.

The attitude towards EPC is significantly more positive in terms of the new EPC group. The new EPC groups especially finds the EPC more motivating to start energy saving actions than the current EPC group.

In contrast to this the behavioural intention to use EPC is slightly higher by the current EPC group, but with no significant difference. The willingness to pay does not differ significantly between the two groups. Only a minority in both groups is willing to pay more than what the EPC currently costs in Greece (80€ - 150€).

In the discussion, participants appreciated the introduction of energy improvement recommendations. However, one point which comes up multiple times in the discussion as well as in the questionnaire is that after the introduction of the recommendations, the primary energy consumption should be displayed (which however could easily be calculated as the primary energy savings are indicated). The improved graphic representations are praised as being helpful for non-experts but participants suggested removing some information or moving it to a separate annex in order to improve understandability further. Overall the positive mood in the discussion matches that of the questionnaire.

4.2.5. Spain

The following subchapter presents the results of the third user workshop in Greece. In this context, 38 questionnaires were filled in, with 19 responses regarding the current EPC and 19 responses regarding the new EPC.

4.2.5.1. *Socio-demographics*

Figure 71 informs about the gender distribution and the housing situation of participants in the two groups. The genders are about equally represented in the groups, with a higher proportion of females in the new EPC group (58%) and a higher proportion of male in the current EPC group (56%). The vast majority in both groups is owning the building they live in (84% in the current EPC group and 79% in the new EPC group), others indicated to be landlords.

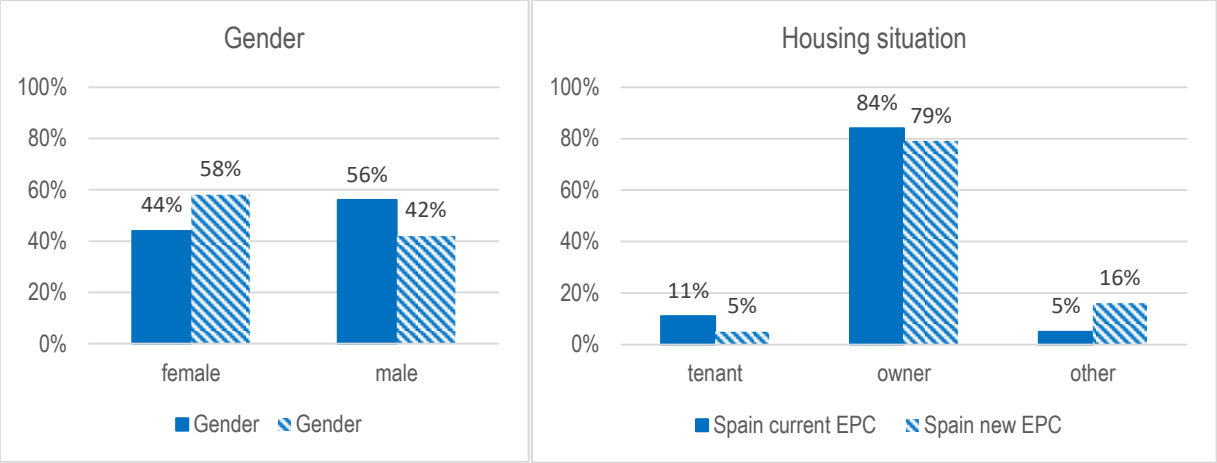

Figure 71: Gender and housing situation of Spanish participants

The majority of participants in both groups live in an apartment (68% of the current EPC group and 58% of the new EPC group), few participants of both groups indicated to live in an apartment block. Most participants in both groups are at least 35 years old and younger than 60. It is noticeable that 42 % of the new EPC group is older than 50 years, while only 10% is older than 50 years old in the current EPC group. The education level of both groups is very high with most participants having a university degree.

4.2.5.2. *Relation to EPC and experiences with EPC*

Figure 72 shows the stakeholder types that were present in the Spanish workshop in the two groups. A large fraction (79% in the current EPC group and 68% in the new EPC group) can identify themselves as end-user. In both groups about 60% can assign themselves to other stakeholder types. Additionally, in the new EPC group participants indicated to be professor and software entrepreneur.

In both groups the proportion of participants who already had experience with EPC was bigger than the fraction who had never been in contact with EPC before (of the new EPC group 74% were in contact before and of the current EPC group 63% were in contact before). Participants were in contact with the

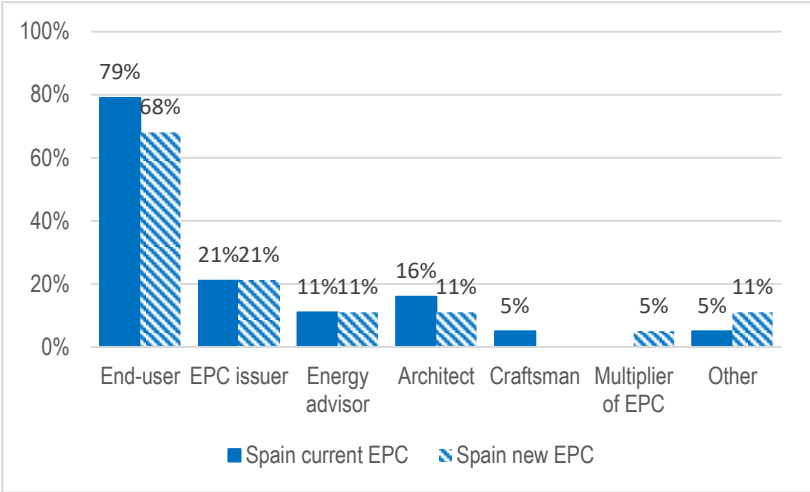

Figure 72: Stakeholder types in the Spanish workshop

EPC in a professional context (issuing EPC, training of technicians) and have experiences as end-user (renting/buying or selling a flat or house) as further presented in Table 17.

Table 17: Description of experience with EPC in Spain

Current EPC group	New EPC group
• Issuing EPC; working in the energy sector • Buying/selling a house/apartment • In a previous workshop in this project	• Renting/buying/selling a flat/house • Training of technicians and issuing of EPC • "I saw it before but didn't use it yet". • Developing software to produce EPC

4.2.5.3. *Understanding of EPC elements*

The answers are coded as 1 for a correct and 2 for a wrong answer. The means per group (current and new EPC) for each item of understanding of EPC elements are shown in Figure 73.

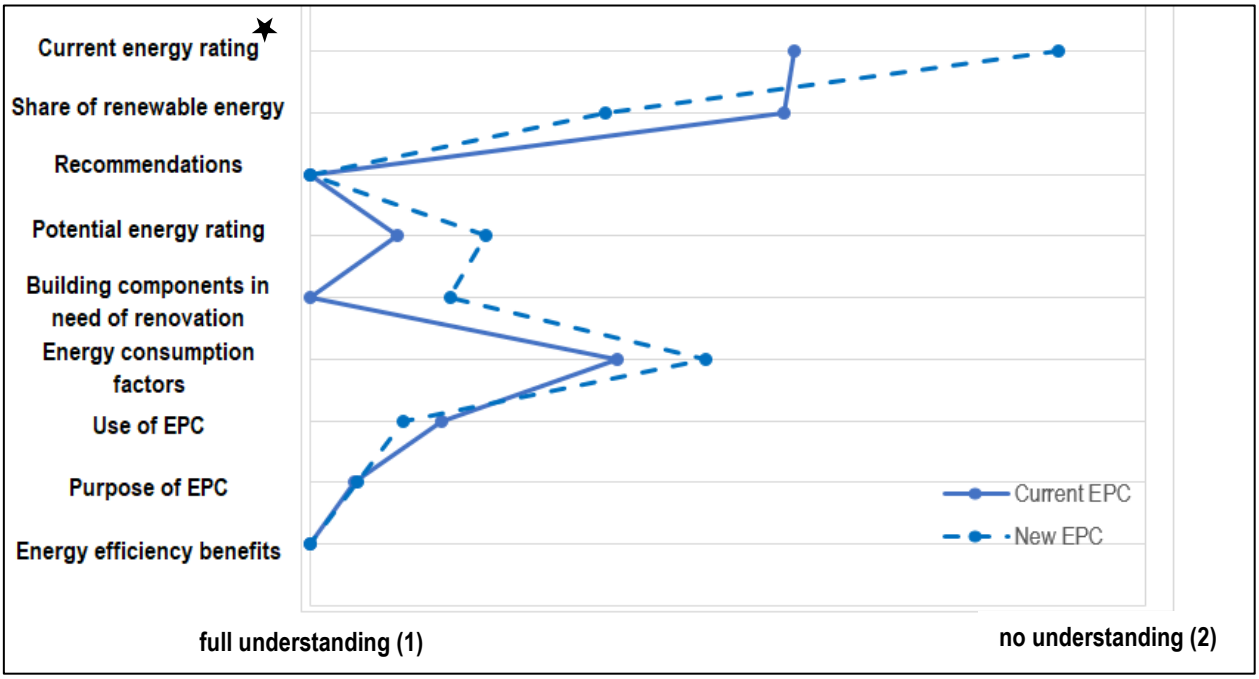

Figure 73: Understanding of EPC features in Spain

***Current energy rating:** the groups differ significantly, t(36)= -2.305 p = .014. The composite mean for the new EPC group (M = 1.895, SD = 0.315) is significantly higher than the current EPC group (M =1.579, SD=0.507), indicating lower comprehension of the current energy rating by the new EPC group.

***Mean-composite variable "understanding of EPC"**: The groups differ significantly, t(31) = -1,896, p = .034. The composite mean for the new EPC group (M = 1.379, SD = 0.112) is significantly higher than the current EPC group (M = 1.306 SD = 0.111), indicating that overall the new EPC group understood the EPC less than the current EPC group.

4.2.5.4. *Understanding of new EPC features*

Figure 74 shows how well the participants understood the new EPC aspects (or not). From the diagram we can see that only the building components/installations in need of renovation were well understood by the new EPC group. Other features (current primary energy use and context of benchmarking) was not understood by a remarkably high percentage of the participants.

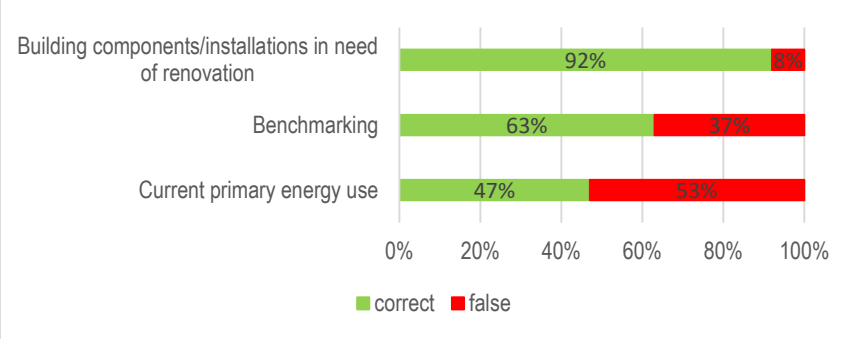

Figure 74: Understanding of new EPC features in Spain

4.2.5.5. *Perceived ease of use of presented EPC*

Figure 75 shows the overall perceived ease of use of the EPC in both groups, which is mixed and very similar. Participants in both groups evaluated the overall perceived ease of use ranging from very low to very high with the average being slightly above neutral.

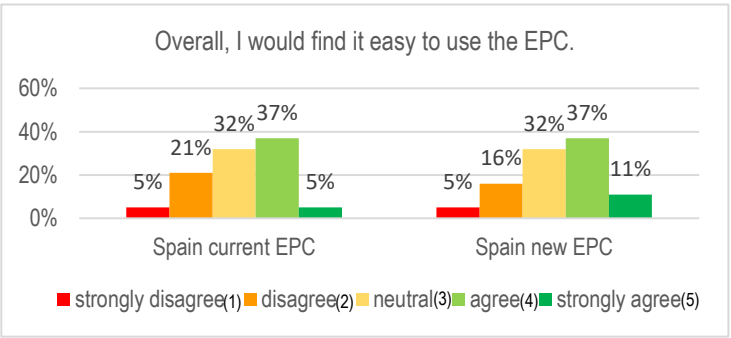

Figure 75: Overall perceived ease of use of the EPC in Spain

Overall perceived ease of use: The groups do not differ significantly, t(36)= -0.47, p = .321. The mean for the new EPC group (M = 3.316, SD = 1.057) is not significantly higher than the current EPC group (M = 3.158, SD = 1.015), indicating that there is no significant difference in the perceived ease of use between the groups. About half of the new EPC group (53%) finds the EPC self-explanatory, while only 31% of the current EPC group indicated so. Parts which were mentioned to not be self-explanatory are listed in Table 18.

Table 18: Parts of the EPC which are not self-explanatory in Spain

Current EPC	New EPC
• The report was too technical for non-experts • Sub-results could be confused with overall conclusions • Difference between the indicators • Energy consumption in general • Only the colour indication is self-explanatory • Why is the energy consumption given for the different improvement measures but not for the whole building?	• Too much information; too many numbers that are hard to interpret • Primary potential of renewable energies • Unclear why energy rating is split in three categories and not just one clear indicator • It is hard to understand for non-experts • What is the reference point for the building? • Smart ready indicator (SRI)

In line with this, 78% of the current EPC group would appreciate assistance in understanding the EPC, while also 61% of the new EPC group indicated so. Figure 76 shows how important different forms of assistance were evaluated in the two groups. On average, an accompanying manual and additional explanations in the EPC were rated as most important in the current EPC

group, while online support and additional explanations in the EPC were on average assessed to be most important in the new EPC group.

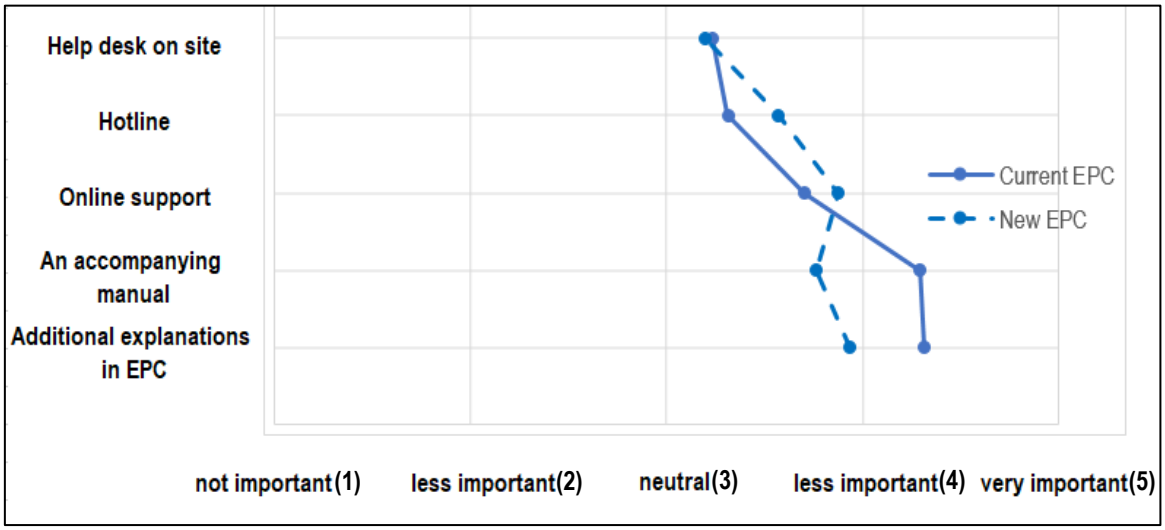

Figure 76: Importance of information in assisting in understanding the EPC in Spain

4.2.5.6. *Perceived usefulness of presented EPC*

Figure 77 shows how useful on average the EPC is perceived to receive information about different aspects in the two groups.

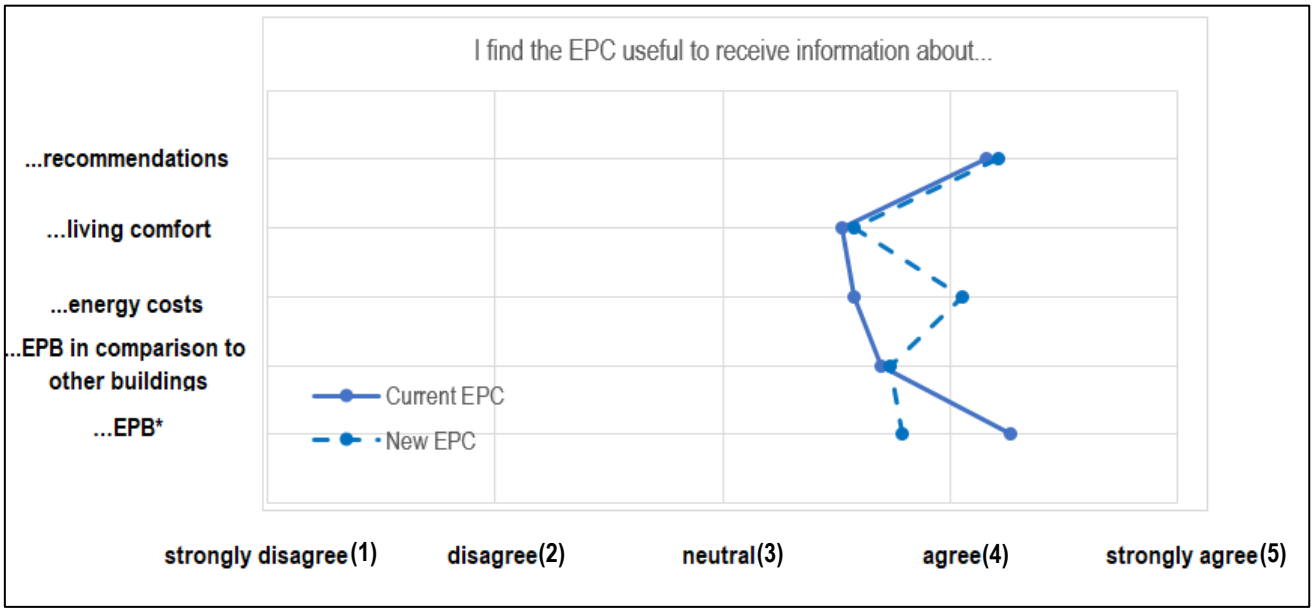

Figure 77: Perceived usefulness of EPC to receive information about additional indicators in Spain

***Energy performance of the building (EPB):** The groups differ significantly, t(36) = 1.919, p = .969. The composite mean for the new EPC group (M = 3.789, SD = 0.918) is significantly lower than the current EPC group (M = 4.263, SD = 0.562), indicating that the current EPC groups perceives the EPC more useful to receive information about the EPB than the new EPC group.

Figure 78 shows that the new EPC is perceived as significantly more useful to receive information about additional indicators (costs, comfort, and IAQ).

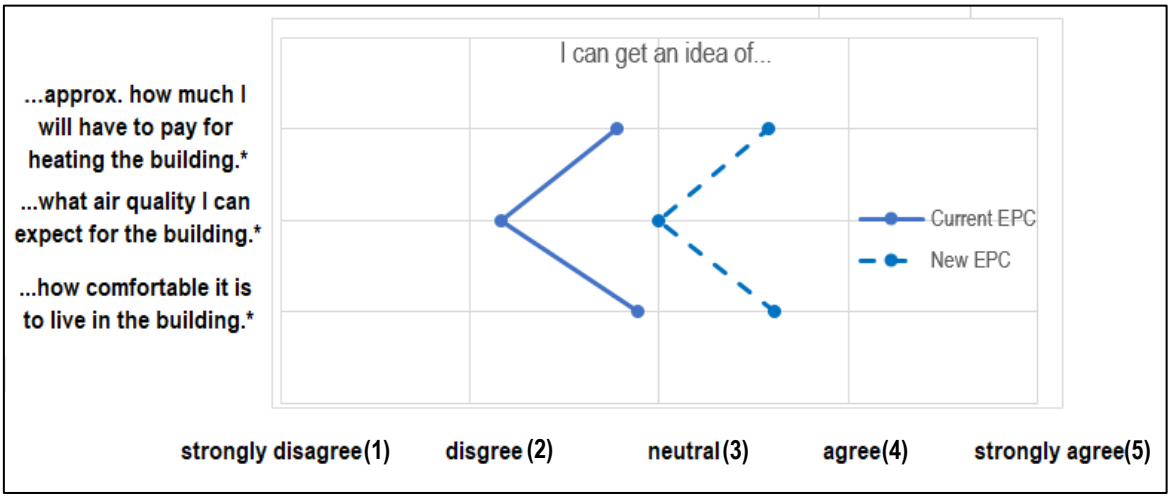

Figure 78: Perceived usefulness of EPC information in Spain

The groups differ significantly regarding all three tested items regarding the perceived usefulness of additional indicators, indicating that the new EPC is perceived as more useful regarding information about comfort, air quality and costs for heating.

***Comfort:** t(34)= -2.165, p= .019. The mean of the new EPC group is significantly higher (M = 3.611, SD = 0.85) than the current EPC group (M = 2.889, SD= 1.132).

***Air quality**: t(33)= - 2.343, p= .013. The mean of the new EPC group is significantly higher (M= 3, SD= 1,061) than the current EPC group (M= 2.167, SD = 1.043).

***Costs for heating**: t(35)= -1.834, p = .038 The mean of the new EPC group is significantly higher (M = 3.579, SD = 1.261) than the current EPC group (M = 2.778, SD= 1.396).

Overall, both groups perceive the presented EPC as useful, as shown in Figure 79.

Overall perceived usefulness: The groups do not differ significantly, t(36) = -0.254, p = .401. The composite mean for the new EPC group (M = 4.105, SD = 0.567) is not significantly higher than the current EPC group (M = 4.053, SD = 0.705).

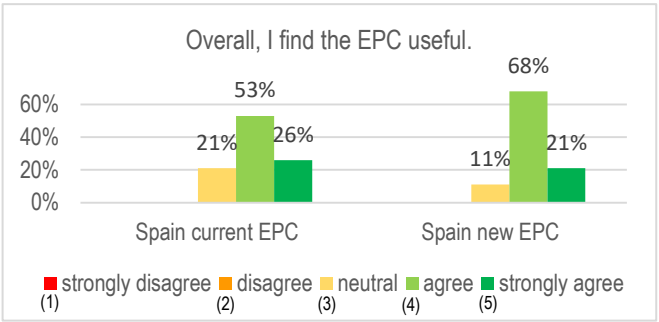

Figure 79: Overall perceived usefulness of EPC in

4.2.5.7. *Evaluation of new EPC features.*

Figure 81 shows that participants tend to agree that the division of pages is appropriate. Once again it was suggested splitting the EPC with one part for the experts and one for the end user indicating again that this feature which was already included was not well understood. Further suggestions on how to improve the EPC are listed below. Figure 80 shows how the information based on standard and actual conditions was evaluated in the two groups. Information based on actual and standard conditions were regarded as useful by most participants and to some extent easy to understand with some room for improvement.

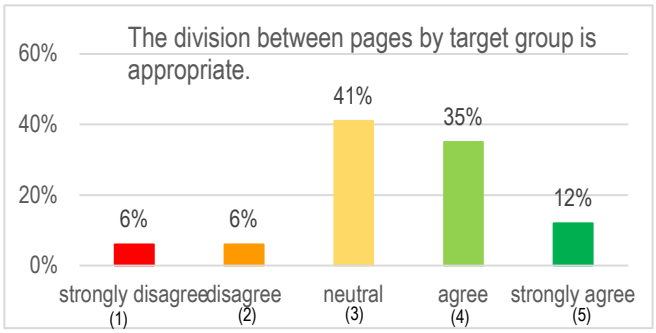

Figure 81. Perceived appropriateness of division between pages in Spain

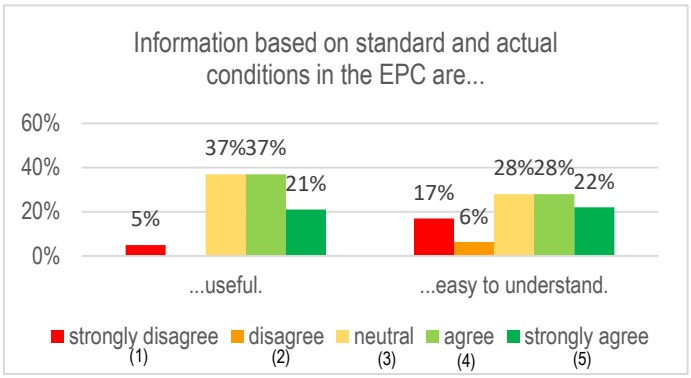

Figure 80. Evaluation of new EPC features in Spain

Improvement of division of pages:

- Only provide the first and last pages to the public, and the entire pages to anyone who wants a more detailed study.
- Add simplified overview page
- Adapt the certificate to each user
- Less data, only the most important, and if someone wants more information they can access a more complete document.
- I didn't realise that the first two pages were for everyone and the last two were for end users.
- The final energy consumption should also be indicated on the first page.
- Reduce the number of pages

In order to improve the information based on standard and actual conditions participants suggested to only include it in a technical version, to use more graphics with more quality. Somebody else mentioned to not quite understand the difference and usefulness which demands for a better communication of the said information.

4.2.5.8. *Feelings about the EPC*

Figure 82 shows how on average the two groups feel regarding the presented EPC. The diagram shows that the new EPC group feels less confused and bored and more motivated and interested than the current EPC group; however also more overwhelmed..

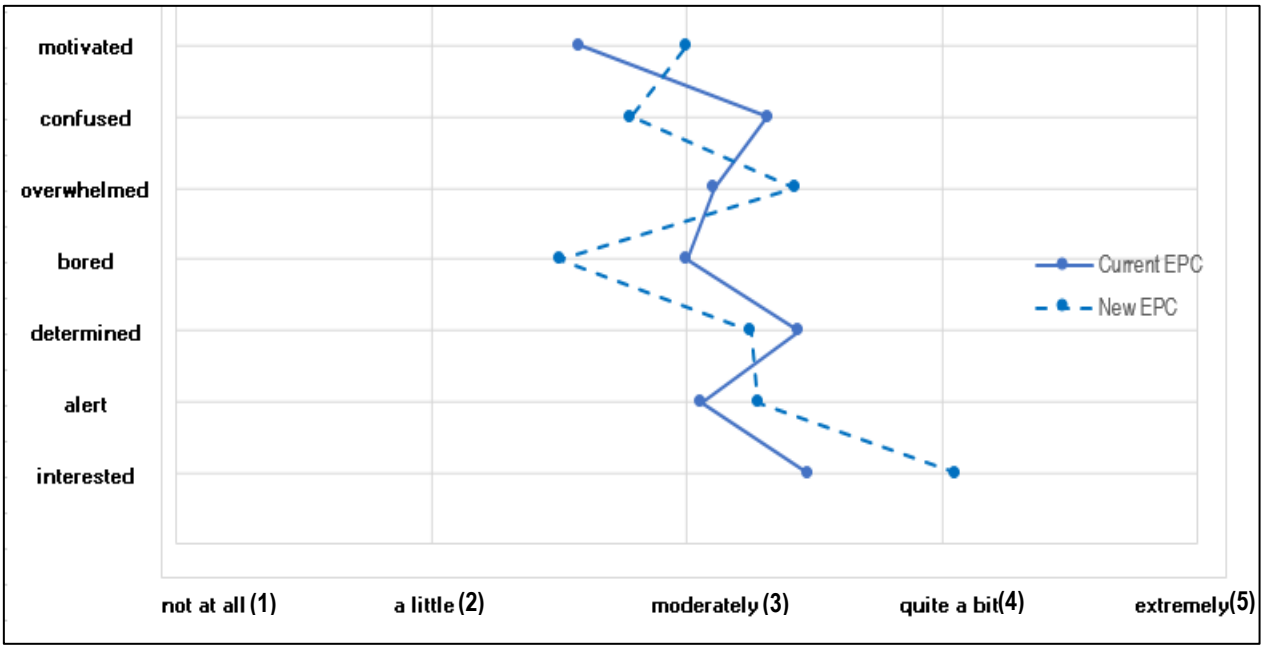

Figure 82: Feelings about the EPC in Spain

Mean-composite variable "feelings about EPC": The groups do not differ significantly, t(27) = -1.273 p = .107. The composite mean for the new EPC group (M = 3.255, SD = 0.803) is not significantly higher than the current EPC group (M = 2.933, SD = 0.542).

Other feelings mentioned by the current EPC group: All of the answers regarded negative feelings. They included feelings of confusion and perceiving the EPC as old fashioned, monotonous and too technical. One person wondered whether anything will be understood by non-experts. Another complained that the EPC was barely personalized and that the price in Euros for the overall energy consumption was not given.

Other feelings mentioned by the new EPC group: Answers included worries about the understandability for non-experts and complaints that the new EPC is very complicated, confusing and long. One person stated that it will take time to get used to the new version. Another expressed that it will take more time to issue the new EPC which will make it more expensive. Positive answers praised the informational quality of the new EPC, as overloaded but necessary and found the EPC well-structured and clear.

4.2.5.9. *Overall perception of EPC*

Figure 83 shows that both groups evaluated the corresponding EPC as being roughly in the middle of the semantic differentials for each of the following items: standardized with general information – individual with tailored information, mandatory document – useful source of information, cluttered – organized and confusing – clear. No significant difference was found. On average the new EPC group evaluated the EPC as more individual with tailored information and as a useful source of information but also as more cluttered and confusing.

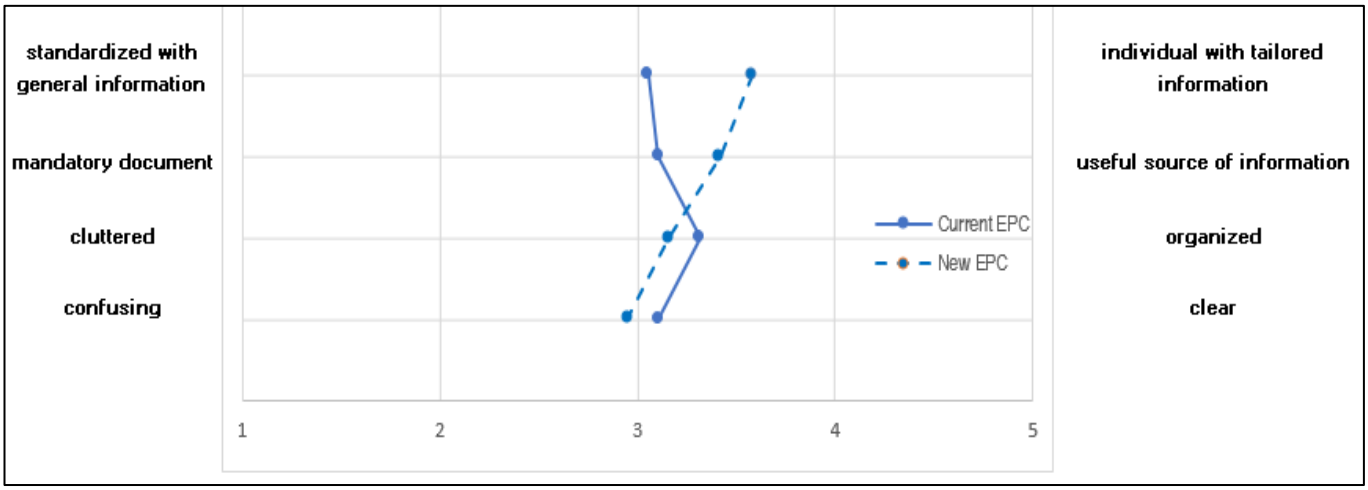

Figure 83: Characterization of EPC in Spain

Mean-composite variable "characterization of EPC": The mean-composite variable "characterization of EPC" was formed based on the means of four items testing the characterization of EPC. The groups do not differ significantly, t(36) = -0.526, p = .301. The composite mean for the new EPC group (M = 3.276, SD = 0.812) is not significantly higher than the current EPC group (M = 3.145, SD = 0.728). From the diagram we can see that the mean for the new EPC group is higher regarding the individuality and the usefulness of the EPC, but lower regarding the organization and clearness of the EPC than the current EPC group.

From Figure 84 we can see that the fulfilment of expectations for the EPC was judged ambiguously with most answers ranging in the middle between does not meet- / meets expectations.

Fulfilment of expectations: The groups do not differ significantly regarding the evaluation of appropriateness of EPC, t(36) = -0.156, p = .438. The composite mean for the new EPC group (M = 3.263 SD = 1.098) is not significantly higher than the current EPC group (M = 3.211, SD = 0.976).

Description of what is needed such that expectations are met in terms of new EPC:

- Shorter and simpler EPC, needs to be more understandable, clear and concise, more comprehensive, with less data
- An instruction manual to better understand the information
- Personalised
- No indication of costs, as these do not correspond to the actual costs and can be confusing.
- More visual

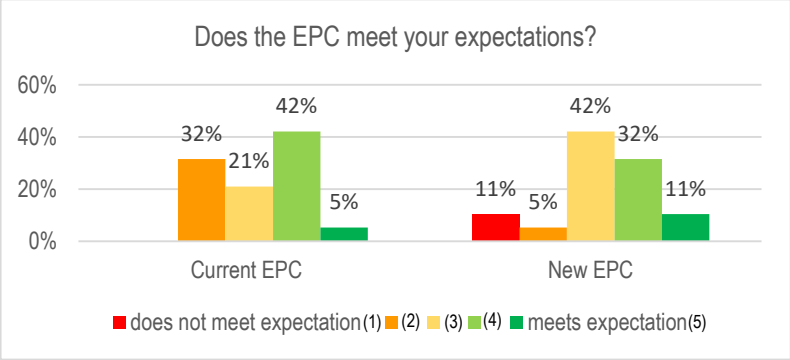

Figure 84: Fulfilment of expectations regarding EPC in Spain

From Figure 85 we can see that the means for the new EPC group and the current EPC group regarding appropriateness of the language and content of the EPC is very similar, whereas layout and length were rated higher and visualization was rated lower in the new EPC group. Overall the scores for the new EPC group range from 3 to 4 on the Likert scale indicating overall appropriateness.

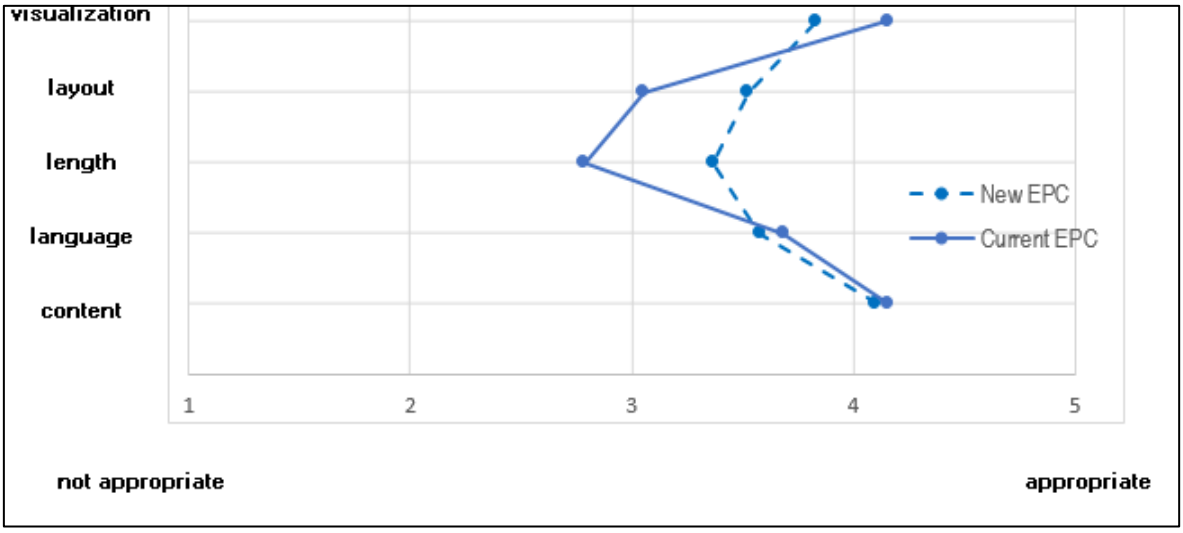

Figure 85: Perceived appropriateness of EPC in Spain

Mean-composite variable "appropriateness of EPC": The groups do not differ significantly regarding the evaluation of appropriateness of EPC, t(36) = -0.836, p = .204. The composite mean for the new EPC group (M = 3.474, SD = 0.509) is not significantly higher than the current EPC group (M = 3.674, SD = 0.910).

Table 19 and Table 20 show the suggestions to improve the new EPC by participants.

Table 19: Suggestions for improvement of the new EPC in Spain, A

Content	Language	Length
• Reduce the content • Add definitions that are easier to understand • Add a summary, needs to be more understandable for non-professionals, be more concise • Add a simple energy label through one letter classification	• Make it less technical	• The shorter the better, currently too long, remove two third of information

Table 20: Suggestions for improvement of the new EPC in Spain, B

Layout	Visualization
• One layout for professionals one for end users • Many aspect regarding colours, graphics and data do not show what is important	• More compact • The more graphics the better

4.2.5.10. *Attitude towards EPC and energy efficiency*

Figure 86 shows that the aattitude towards the EPC was positive on average with most participants finding the EPC supportive and motivating to save energy in both groups.

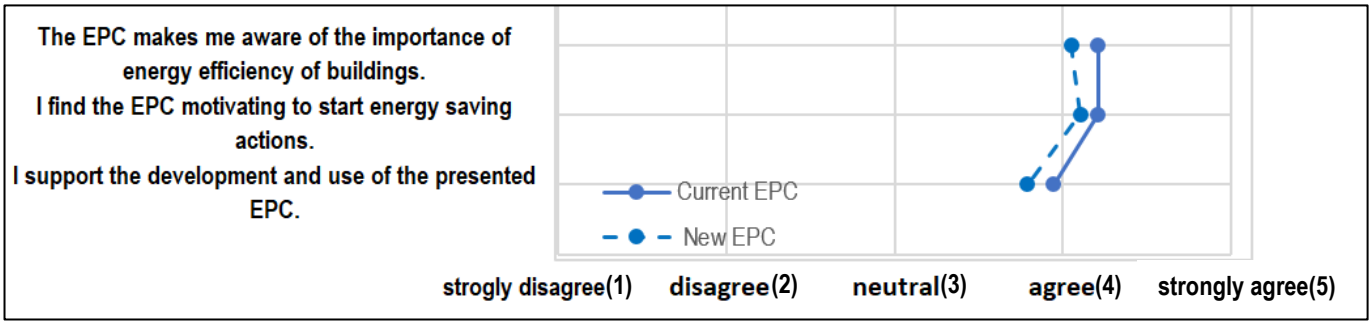

Figure 86: Attitude towards EPC in Spain

Mean-composite variable "attitude towards EPC": The groups do not differ significantly, t(36) = 0.655 p = .742. The composite mean for the new EPC group (M = 3.982 SD = 0.757) is not significantly higher than the current EPC group (M = 4.123, SD = 0.547).

4.2.5.11. *Behavioral intention to use EPC*

From Figure 87 one can see that the behavioral intention of the new EPC group is higher for three of the four items. On average, the behavioural intention to use EPC is high in both groups.

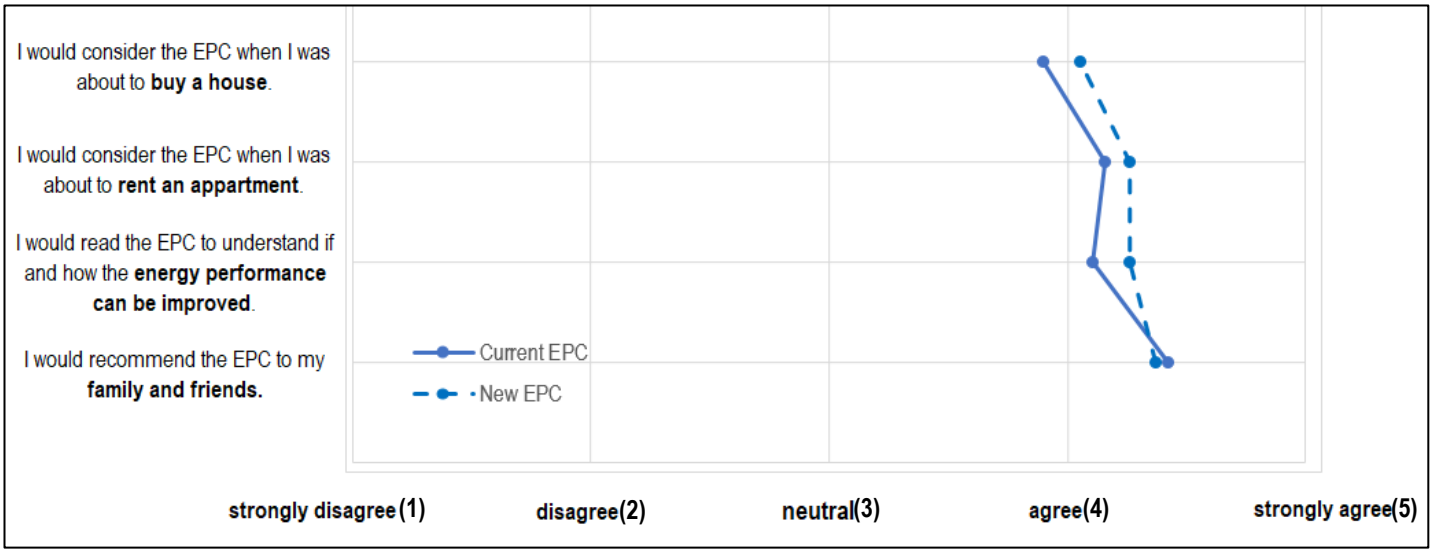

Figure 87: Behavioural intention to use the EPC in Spain

Mean-composite variable "behavioural intention to use EPC": The groups do not differ significantly regarding the behavioral intention to use the presented EPC, t(36) = -0.52, p = .303. The composite mean for the new EPC group (M = 4.237, SD = 0.659) is not significantly higher than the current EPC group (M = 4.145, SD = 0.402).

A clear majority in both groups says that they would be willing to use the EPC voluntarily. Only 16% of the new EPC group and 5% of the current EPC group indicated to not be willing to use the EPC voluntarily.

Asked which actors/sources would influence the decision when buying or renovating, energy advisors, neighbours who have renovated their building, craftsmen, the EPC, family/friends who are experts were judged as mostly important. The EPC received the highest rating, while media information received the lowest. Participants mentioned that architects, and producers of installations/techniques would also play a role in decision making.

The most influential factors in the decision to buy a house are the price of the building, the location, the operational costs, energy performance and living comfort. 90% rated the energy performance as important – very important. The aesthetics of the building were perceived as least important of all factors.

4.2.5.12. *Willingness to pay for EPC*

Figure 88 shows the willingness to pay for EPC in both groups. There is no significant difference between current and new EPC. On average both groups are willing to pay between 50 and 100€. No general statement can be made about the current prices of EPCs in Spain since pricing very much depends on the size and complexity of the building. It is noticeable that in both groups the largest share of participants is willing to pay 50-100€ for an EPC (42% in the current EPC group and 47% in the new EPC group), followed by the second largest share which is willing to pay 100-150€ (26% of the current EPC group and 16% of the new EPC group). Moreover, one participant of the current EPC group indicated to be willing to pay 900€, similar to someone of the new EPC group who indicated to be willing to spend 1000€.

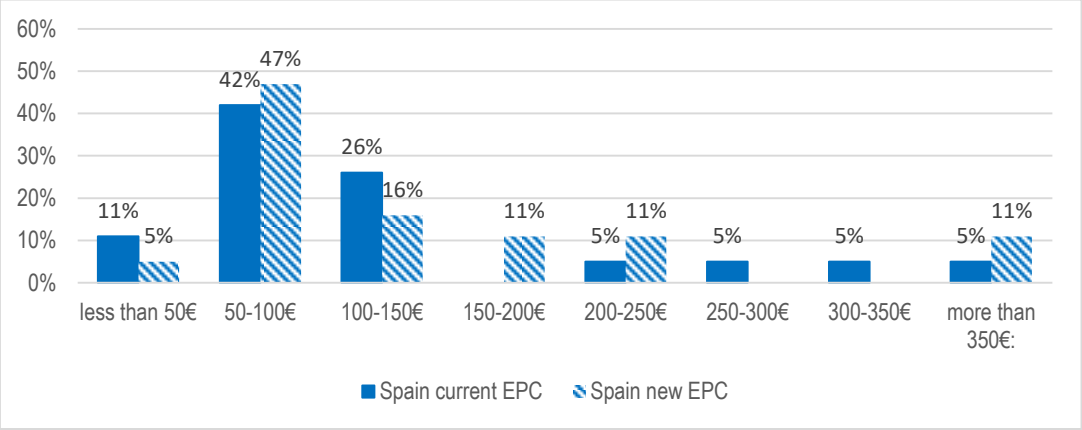

Figure 88: Willingness to pay for EPC in Spain

4.2.5.13. *Any other feedback from new EPC group*

- A job well done. My congratulations.
- The recommendations make more sense at the end and only for existing buildings that are not being renovated; the targets for installations and building components on the second page is practical, it helps to understand, this sheet has the clearest information.
- The vocabulary is complex and not accessible to everyone.
- There should be two documents, one simplified and one more detailed.
- It is a short explanation or introduction needed
- I think the whole comfort and IAQ part needs to be rethought, as well as the definition of the building in real conditions.

Table 21: Overview of the discussion in Spain

Spain		
Positives	**New EPC**	**Current EPC**
	• Reduction of numbers makes it easier to understand, • Looks nicer, • In favour of the component traffic light, • Graphs and comparisons make it easier to estimate energy efficiency, • Energy performance is very well explained • Visually more appealing, • Easier to understand for end users	
Negatives	• Too complex for non-experts, • Too much information (from page 3 onwards), • Vocabulary is too complex, • Explanation between standard and actual conditions should be at the beginning instead of on page 3, • Box plot diagrams are hard to understand, • Renewable energy section is hard to understand, • Graphs of thermal comfort and IAQ are not clear	• Difficult to understand for non-experts, • Too many tables, • Lacks information hierarchy, • Using two indicators is confusing, • Too technical, • Recommendations are not clear for end users, • Does not show pricing information, • Energy efficiency measures are too repetitive and provide too little information, • Improvement from measures is not clearly indicated
Suggestions/Comments	• Should be simpler and easier, • Addition of a simplified summary sheet/addition of an index • Use of simpler and easier to understand vocabulary, • Divide the document in two parts: one simple and one detailed, • Final energy indicator should be on front page, • Replace pie charts with bar charts • Two versions: detailed for experts, simple for end-users	• Add a clear comparison of EEM packages that includes energy/saved costs/investment costs

4.2.5.14. *Conclusion of the third Spanish user workshop*

In Spain the genders are about equally represented in the groups, with a higher proportion of females in the new EPC group (58%) and a higher proportion of male in the current EPC group (56%). Most participants in both groups are at least 35 years old and younger than 60. It is noticeable that 42 % of the new EPC group is older than 50 years, while only 10% is older than 50 years old in the current EPC group. The education level of both groups was very high with most participants having a university degree. The vast majority in both groups is owning the building they live in (84% in the current EPC group and 79% in the new EPC group). Most participants in both groups live in an apartment (68% of the current EPC group and 58% of the new EPC group), few participants of both groups indicated to live in an apartment block.

In both groups the proportion of participants who already had experience with EPC was bigger than the fraction who had never been in contact with EPC before. Of the new EPC group 74% were in contact before and of the current EPC group 63% were in contact before. Most had gained experience while buying or selling a home.

Understanding of EPC elements was high in general for both current and new EPC group. The current energy rating which was significantly better understood in the current EPC group. Also, the overall understanding of the current EPC group was significantly higher. New features of the new EPC were mostly not understood well. Only the “Building components/installations in need of renovation” feature was understood by the vast majority.

Participants in both groups evaluated the overall perceived ease of use ranging from very low to very high with the average being slightly above neutral. There was no significant difference between current and new EPC. About half of the new EPC group (53%) finds the EPC self-explanatory, while only 31% of the current EPC group indicated so. Parts which were not self-explanatory for the new EPC were: primary potential of renewable energies, splitting of the energy rating, smart ready indicator (SRI). In line with this, 78% of the current EPC group would appreciate assistance in understanding the EPC, while also 61% of the new EPC group indicated so.

Perceived usefulness of the new EPC to receive information about additional indicators could be significantly improved compared to the current EPC. In all tested additional indicators (comfort, air quality and cost of heating) the perceived usefulness was significantly higher in the new EPC group. However, the perceived usefulness to receive information about the energy performance of the building was significantly lower in the new EPC group. Overall, both current and new EPC were perceived as useful by participants with no significant difference between the two groups.

When asked to characterize the EPC, both groups evaluated the corresponding EPC as being roughly in the middle of the semantic differentials for each of the following items: standardized with general information – individual with tailored information, mandatory document – useful source of information, cluttered – organized and confusing – clear. No significant difference was found. Judging the appropriateness of EPC regarding visualization, layout, length, language and content, no significant difference between current and new EPC was found. Scores in the new EPC group ranged from 3 to 4 on the Likert scale indicating overall appropriateness. Nevertheless, suggestions were made to improve each of the previously rated aspects. Regarding content a majority wanted it to be reduced or wanted additional explanations to improve understandability. Regarding length it was suggested to shorten the EPC. Regarding the layout it was suggested to have one layout for professionals and one for end-users. This was actually already applied in the new EPC but it seems like it was not noticed. Visualization and language were mostly praised.

Fulfilment of expectations for the EPC was judged ambiguously with most answers ranging in the middle between does not meet- / meets expectations. No significant difference was found between current and new EPC. When asked what was needed to meet the expectations participants repeated they would like to have a shorter and simpler EPC and an instruction manual.

Evaluating the new features of the EPC, participants tended to agree that the division of pages is appropriate. Once again it was suggested splitting the EPC with one part for the experts and one for the end user indicating again that this feature which

was already included was not well understood. Information based on actual and standard conditions were regarded as useful by most and to some extent easy to understand with some room for improvement.

Feelings about the EPC were mixed for both versions. Ranging in towards the middle rather than the extremes. No significant difference was found. Other feelings were purely negative towards the current EPC and mixed for the new EPC. Both were criticized again as being too long, technical, and not end-user friendly.

Attitude towards the EPC and energy efficiency was positive on average with most participants finding the EPC supportive and motivating to save energy. No significant difference was found between the groups.

Behavioural intention to use the EPC was high trough out all items. There was no significant difference between the groups, however. A clear majority said they would use the EPC voluntarily. This was true for both current and new EPC. Asked which actors/sources would influence the decision when buying or renovating, all of the suggested actors were judged as mostly important with the media receiving the lowest and the EPC receiving the highest rating. The willingness to pay for the EPC did not differentiate significantly between the current and new EPC. The range for both was less than 50€ to more than 350€ with the majority being willing to pay between 50€ and 150€.

Other given feedback included: simplifying the vocabulary, adding short explanations, splitting the EPC in two versions one for experts one for end users. Overall the points from the discussion in the workshop broadly resemble those which have already been made during the questionnaire. The participants preferred the new EPC over the current Spanish version because of the reduction in numbers and the increased use of graphics as well as overall aesthetic appeal but had complaints and suggestions regarding understandability and information density. Most commonly in the discussion as well as in the questionnaire participants wanted the new EPC to be shorter and more concise. Another idea which was widely agreed on was to split the report in two or add a summary sheet for the non-expert user.

4.2.6. Acceptance test regarding new EPC among pilot countries

The following subchapter reports the results of acceptance test regarding the new EPC among the five pilot countries. This is done in order to point out differences and commonalities among the pilot countries so that strong and weak points of the new EPC can become obvious. Because this analysis was done later in addition to the originally planned results, no inferential statistics were carried out. Results thereby reflect general trends rather than statistically validated facts.

4.2.6.1. *Understanding of new EPC elements in new EPC among pilot countries*

Understanding of new EPC element is presented in Figure 89 and Figure 90. There is some variance between the countries but overall trends for each item can be made out. Understanding of the “current energy rating” was very low throughout all of the groups. A reason for this could be that THE energy label/energy rating of the building could not be identified, since there are three main indicators given, each of them based on standard and actual conditions of use. So, some participants were confused which one the energy label for the building was. The “Current primary energy use”, “content benchmarking”, “installations in need of renovation”, “share of renewable energy”, “energy consumption factors” and “use of EPC” elements were understood by a majority but still need some improvement. The “recommendations”, “potential energy rating”, “energy service using the most energy”, “energy efficiency benefits” and “purpose of EPC” elements were understood by almost everyone. This shows that they seem to be presented in an understandable fashion. Comparing the overall understanding of the new EPC to the respective current EPCs, no significant difference could be found in Austria, Belgium, Finland and Greece, while the current EPC was significantly better understood in Spain.

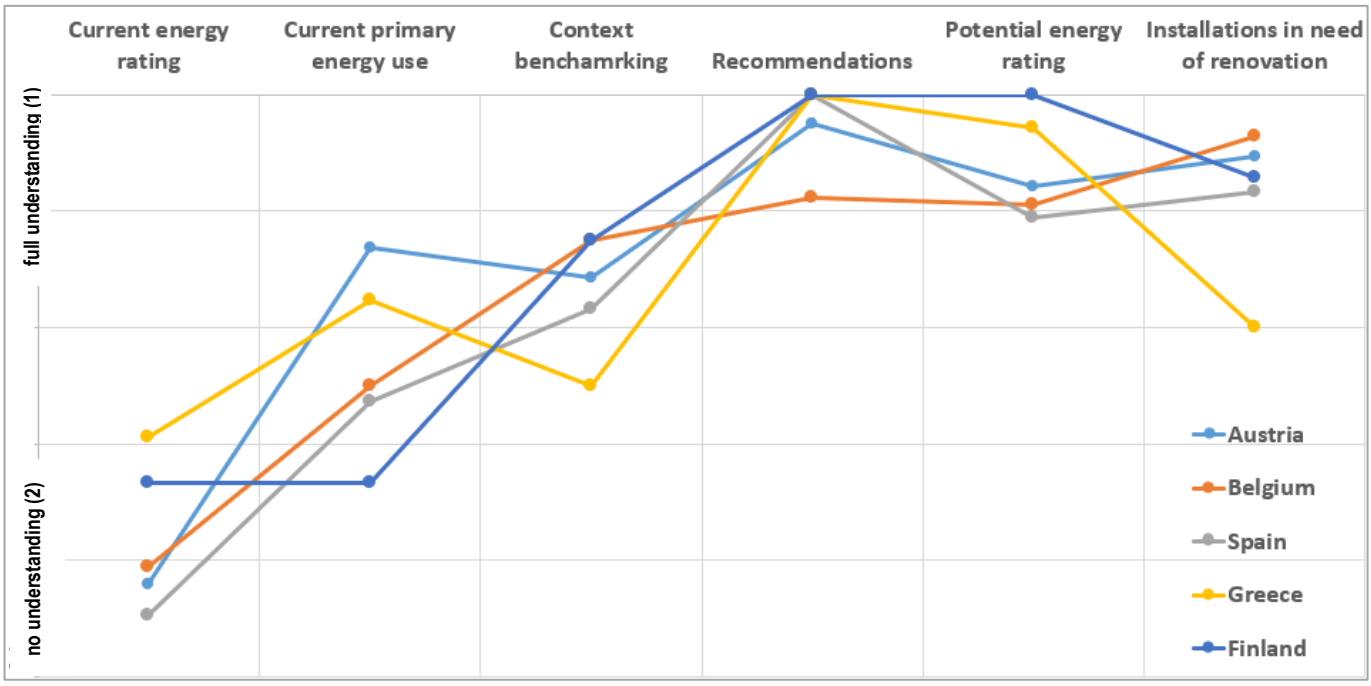

Figure 89: Understanding of EPC element in new EPC among pilot countries (1/2)

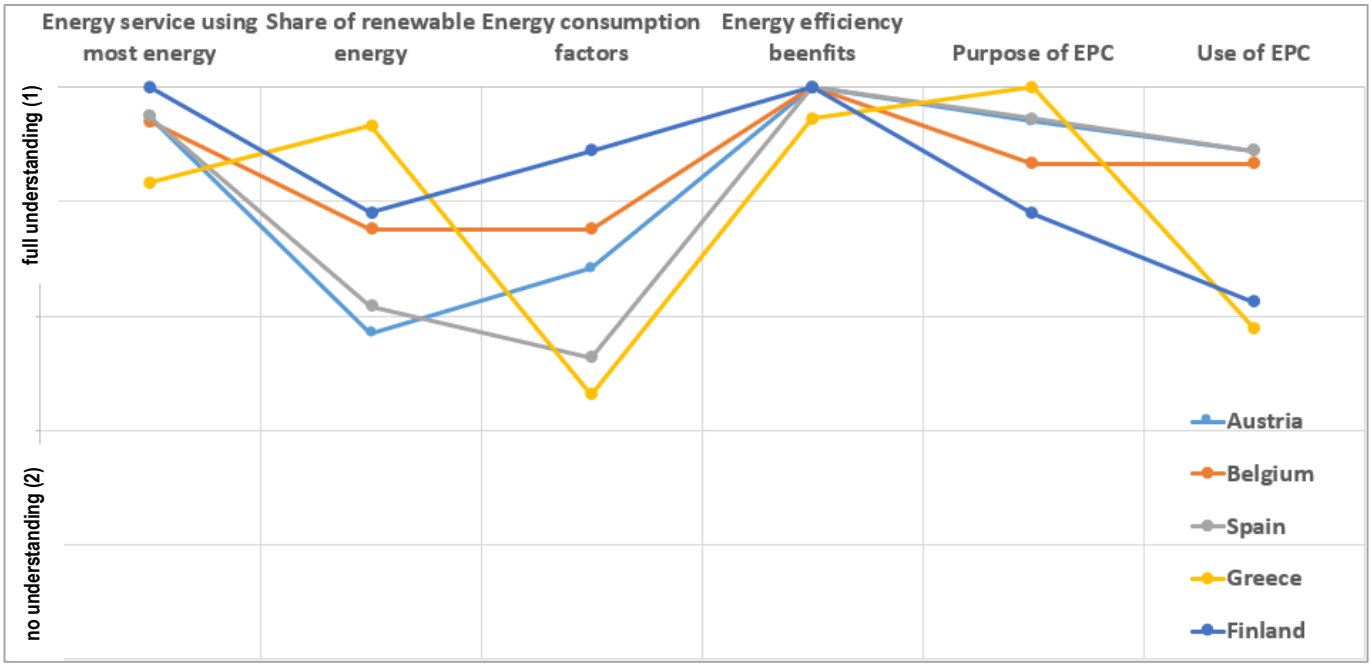

Figure 90: Understanding of EPC element in new EPC among pilot countries (2/2)

Figure 91 shows that in Finland and Greece the new EPC is perceived as easy to use by the majority of participants, while in Spain and Belgium about half rated the EPC not easy to use. In Austria only 27% rated the new EPC as easy to use. In Austria, Spain and Belgium, 70%, 53% and 50%, respectively, did not perceive the new EPC as easy to use although most of the information was understood correctly. This could be interpreted to mean that participants do not understand the information at first glance, have to concentrate a lot to understand or are not sure whether they understand the information correctly.

Comparing the overall perceived ease of use of the new EPC to the respective current EPCs, no significant difference could be found in the ePANACEA pilot countries, except for in Belgium, where the current EPC was significantly perceived as easier to use.

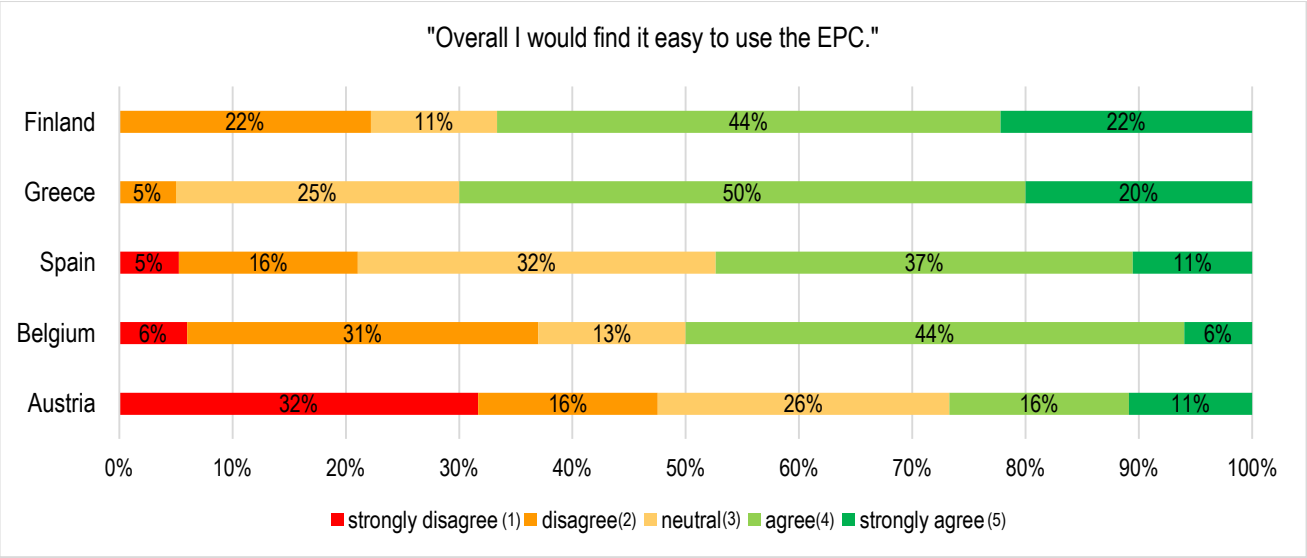

Figure 91: Overall perceived ease of use of the new EPC among pilot countries

Figure 92 shows that in all of the groups, additional assistance to understand the EPC is viewed as important to very important. Looking at all pilot countries, more participants indicated to need assistance in understanding regarding the current EPC. The variance across the groups is relatively low. The difference between the importance of the different types of assistance is small with “additional explanations” and “manual” being viewed as the most important and “help desk on site” as the least important. Additional explanations and a manual are considered most important among all groups in all countries.

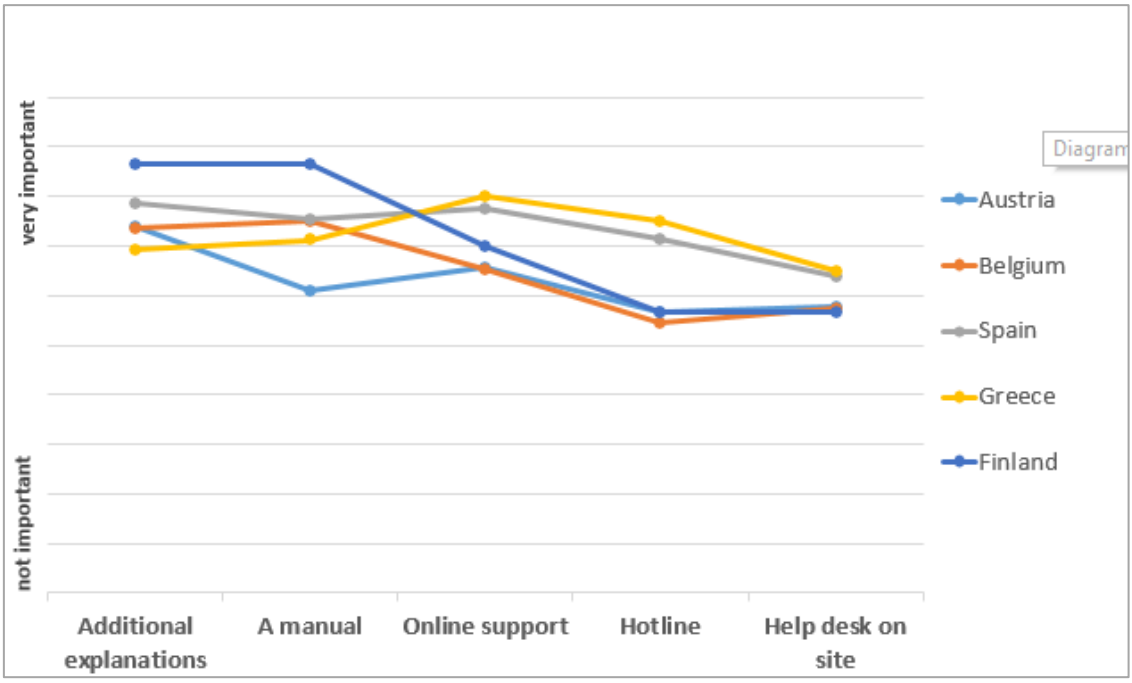

Figure 92: Importance of information in assisting in understanding in new EPC among pilot countries

4.2.6.2. *Overall perceived usefulness of new EPC among pilot countries*

Figure 93 shows that across countries overall usefulness of the new EPC was viewed as relatively high by a majority of participants. In Finland and Austria however, there is a small minority which does not perceive the EPC as useful. Comparing the overall perceived usefulness of the new EPC to the respective current EPCs, no significant difference could be found in the ePANACEA pilot countries, except for Belgium, where the current EPC was perceived significantly better.

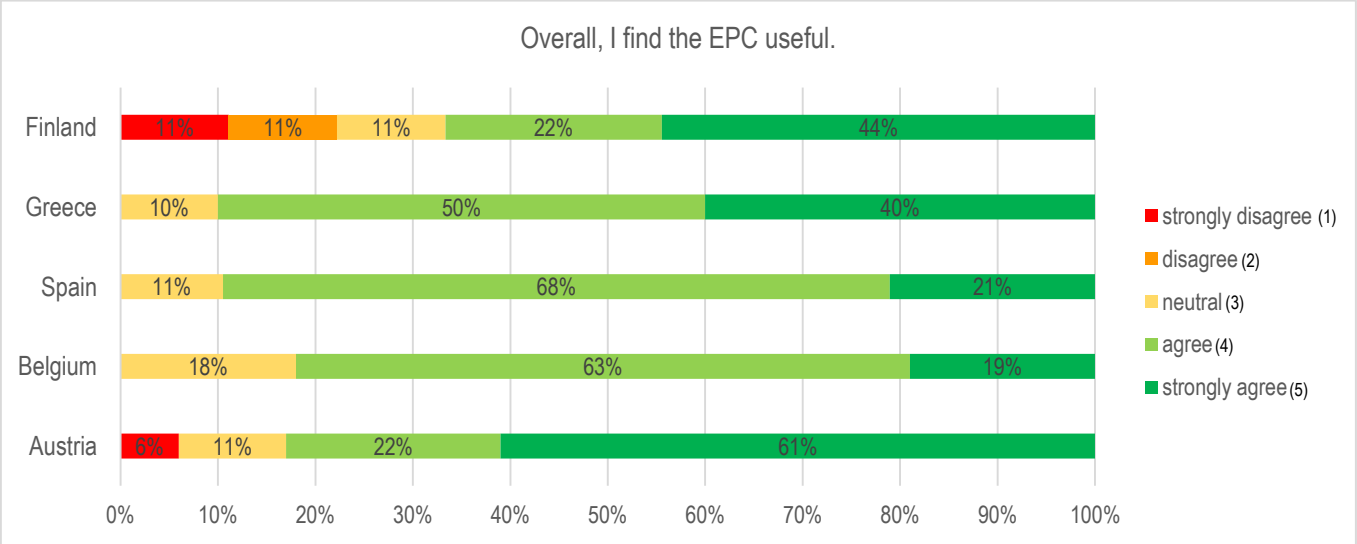

Figure 93: Overall perceived usefulness of new EPC among pilot countries

4.2.6.3. *Characterization of new EPC among pilot countries*

Figure 94 shows that characterization of the new EPC varies a lot across countries. Greece characterizes the new EPC by far as the most positive compared to the other countries. Overall the new EPC is characterized as more organized than clutter, but less as a useful source of information than a mandatory document and less individualized than standardized. However, in comparison to the respective current EPC the new EPC was rated better on the last two mentions in Austria, Belgium, Greece and Spain. Hence, the perceived individuality and usefulness of the new EPC seems to have improved compared to the current EPC versions in these ePANACEA pilot countries. Characterization as confusing vs clear is mixed with two countries rating it over the middle of the scale, and three countries below. When comparing this to the current EPC in the ePANACEA countries, the current EPC was rated better in these aspects in four out of five countries (Austria, Belgium, Finland and Spain). This indicates that the new EPC has gained in usefulness and individuality but lost in clearness and organization compared to current EPCs in the ePANACEA pilot countries.

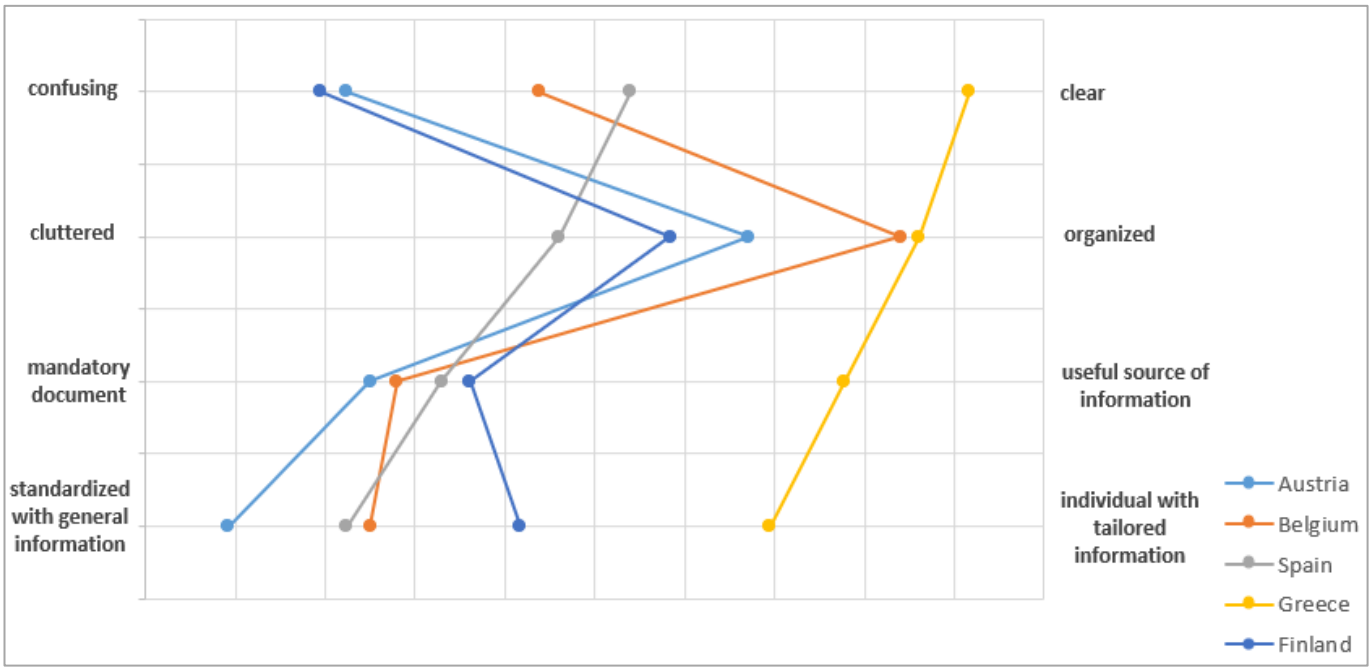

Figure 94: Characterization of new EPC among pilot countries

4.2.6.4. *Division of pages of new EPC among pilot countries*

Figure 95 show that most participants in Finland, Greece, Spain and Belgium perceive the division of pages as neutral or slightly positive. In Austria the perception leans toward the negative side of the scale. Overall the division of pages still needs some improvement, especially because in four out of five countries (Austria, Belgium, Spain and Greece) there were participants who expressed to not have understood that there was a division of pages by target group or suggested improvements which were already implemented. This strongly suggests that the division of the pages and the meaning behind it is not yet sufficiently well communicated.

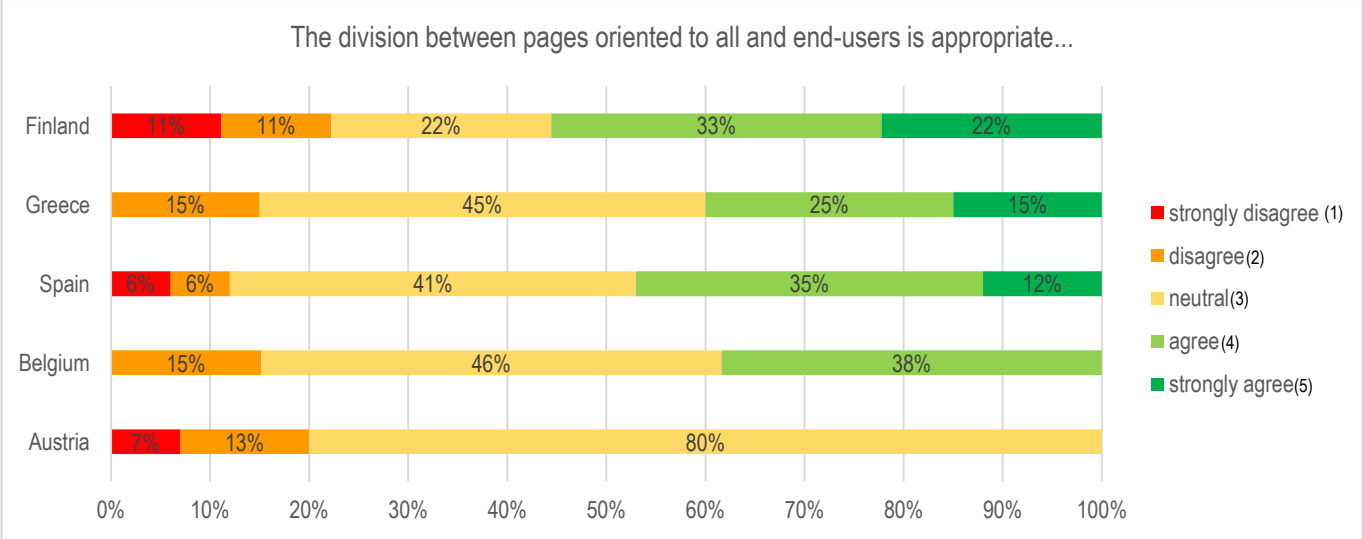

Figure 95: Division of pages of new EPC among pilot countries

4.2.6.5. *Perceived usefulness & ease of understanding based on actual and standard conditions among pilot countries*

Figure 96 shows that standard and actual conditions in the new EPC are perceived as useful by most. Variance across the ePANACEA pilot countries is relatively low.

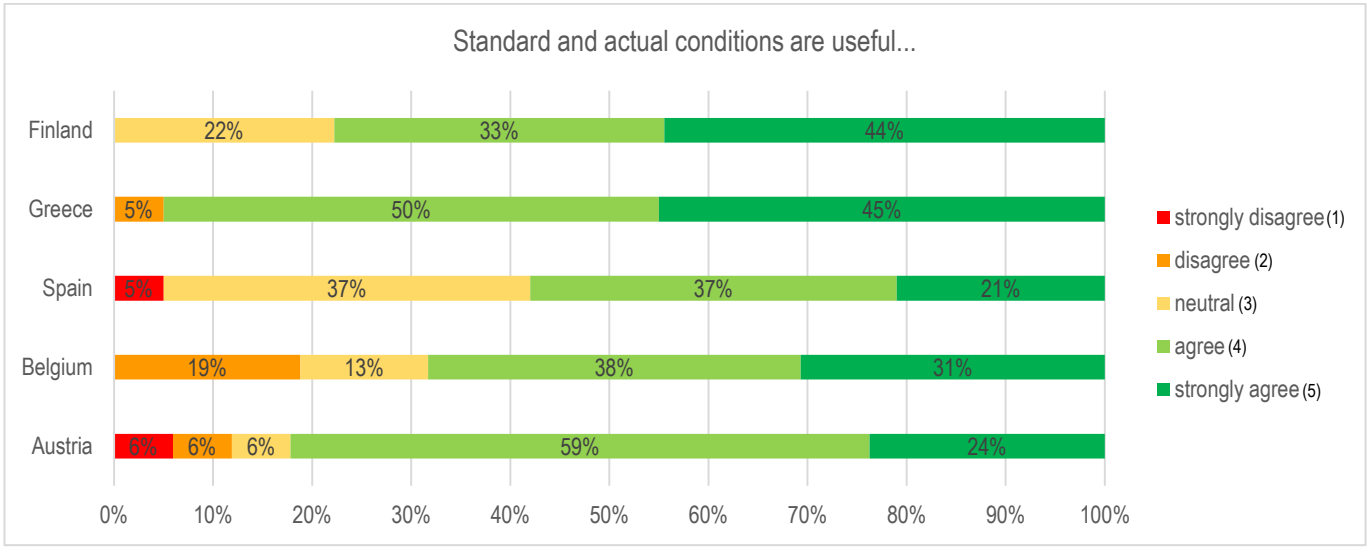

Figure 96: perceived usefulness based on actual and standard conditions of new EPC among pilot countries

Figure 97 shows that ease of understanding of standard and actual conditions in the new EPC is relatively low in most ePANACEA pilot countries. Especially Austria and Belgium perceive the standard and actual conditions as not easy to understand. This pattern among the countries is similar to that of the perceived usefulness of actual and standard conditions. One can conclude, that overall participants find the information based on actual conditions in addition to information based on standard conditions useful, however, the current presentation in the new EPC is not clear enough. The difference should be explained right in the beginning of the document and it should be clearly indicated if legal current energy rating is based on standard conditions or actual conditions of use.

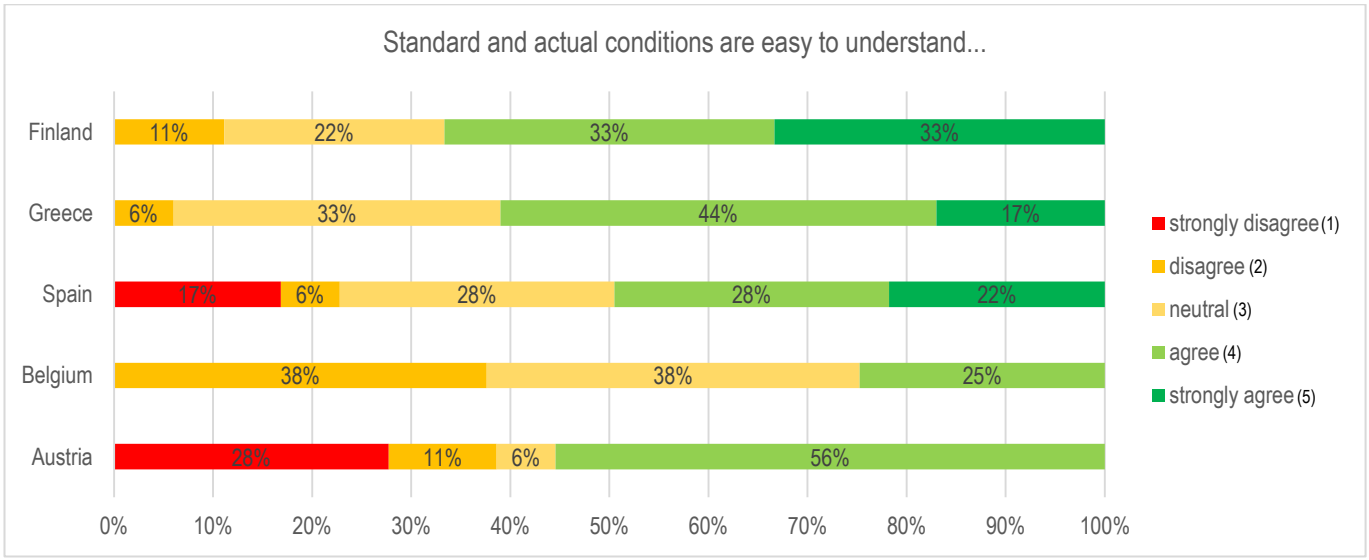

Figure 97: ease of understanding based on actual and standard conditions of new EPC among pilot countries

4.2.6.6. *Behavioral intention to use the presented EPC among pilot countries*

Figure 98 shows that the behavioral intention to use the new EPC is high throughout all of the pilot countries. This shows that even though some aspects of the new EPC were regarded rather negative, participants were nevertheless willing to use the new EPC in the respective context. However, only in Spain the willingness to use the EPC was higher regarding the new EPC than the current EPC.

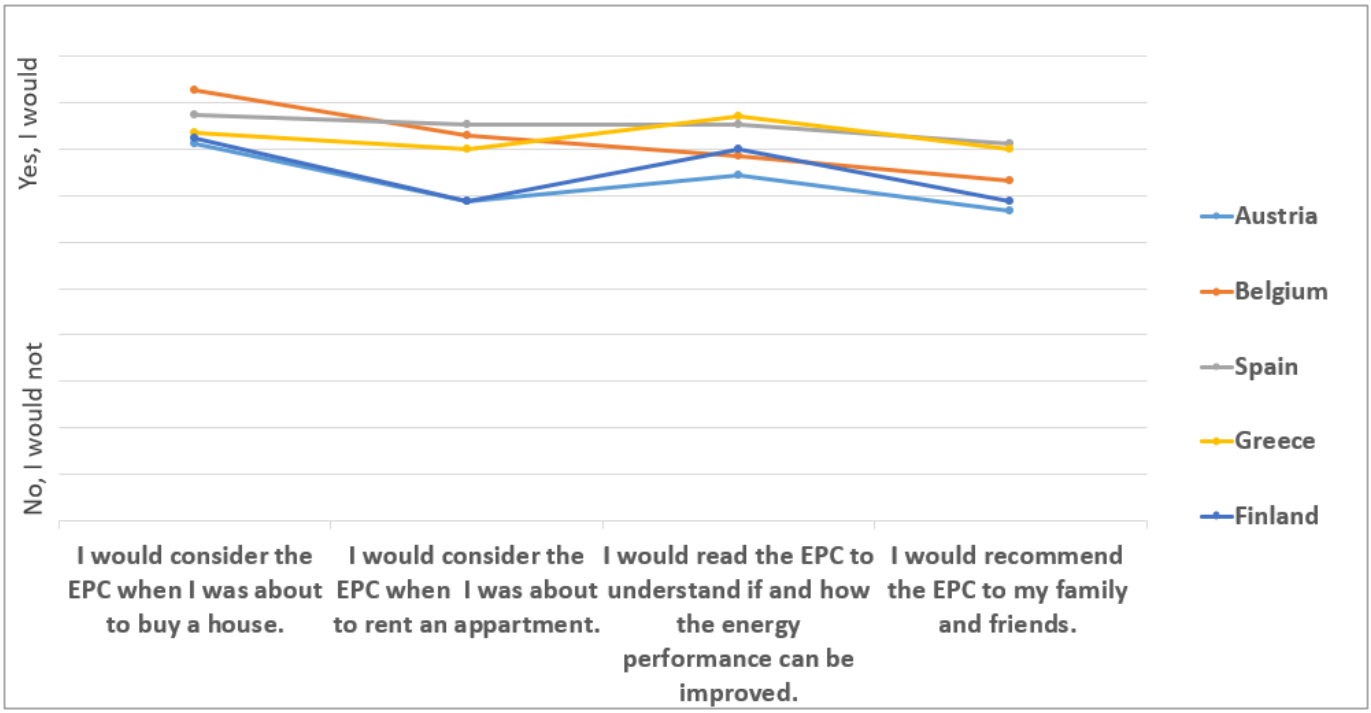

Figure 98: behavioural intention to use the EPC among pilot countries

4.2.6.7. *Willingness to pay for the new EPC among pilot countries*

Figure 99 shows that with increasing price the willingness to pay steadily drops in all of the countries. Finish and Greek participants' willingness to pay drops the quickest with nobody willing to pay more than 250€. Willingness to pay was the highest with Austrian participants, this may be due to the fact that currently the prices for EPC are comparatively high in Austria.

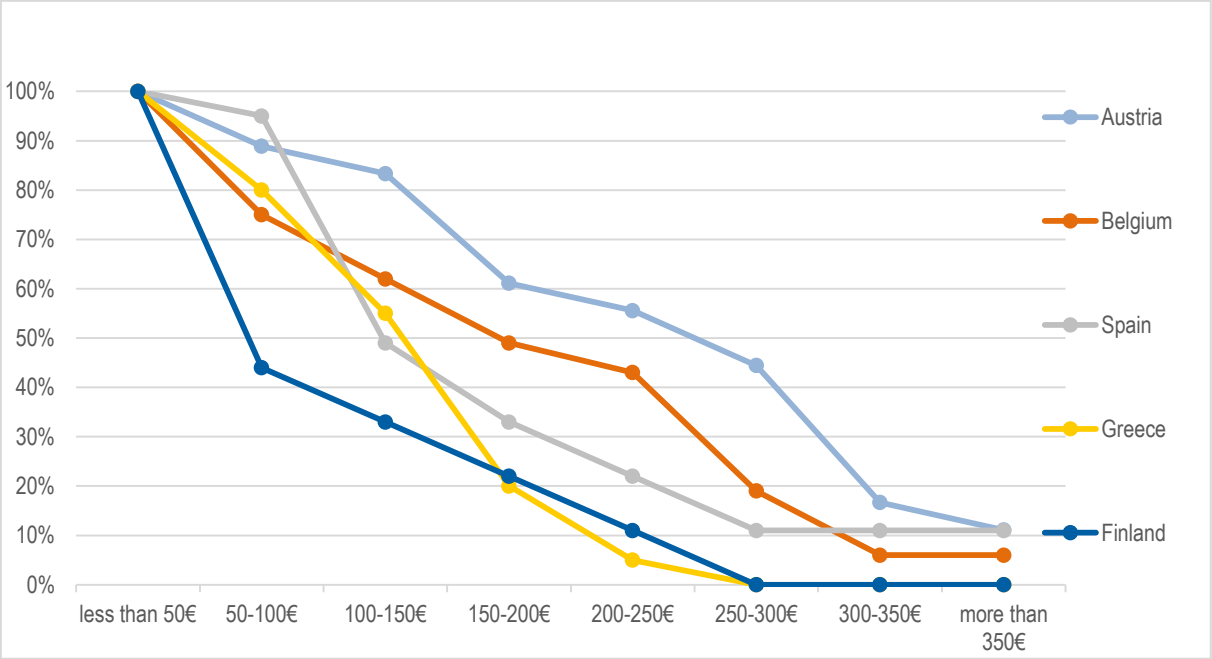

Figure 99: Willingness to pay for new EPC among pilot countries

5. DISCUSSION

This chapter discusses the methodology that was used to develop the new EPC summary pages and to test and compare the acceptance of the current and the new EPC. It also discusses the results of the acceptance test.

5.1. Discussion of methodology

The elements that are not included in the current EPC schemes of ePANACEA pilot countries should be included in the new EPC summary pages anyway because we learned from previous interviews, workshops and feedback loops with consortium partners that e.g. the division of pages and the provision of information based on standard and actual conditions is desired. The same applies to information that is only contained in some current EPC schemes. Missing elements/information in the respective current EPC schemes can be considered as deficiencies compared to the newly drafted EPC summary pages.

The new EPC summary pages are not fully aligned with the ePANACEA methodology yet, as these were developed in parallel in the project. The new EPC summary pages are therefore more a result of the needs and wishes of the users and project partners with whom we spoke during the development process. Furthermore, we should not forget that the claim of the EPC pages is not to represent all the information that can be provided with the ePANACEA methodology, as they are only summary pages. In order to better align the methodology and the new EPC summary pages there should be an exchange in both ways - i.e. for the methodology it should be considered what results users want to see and for the creation of the new EPC pages it should be considered what output the methodology is able to deliver.

Also, the ePanacea proposal and the EPBD draft do not fully coincide since the ePanacea proposal is based on the information received from participatory actions with EPC users. Therefore, the version of this project includes the information that the market demands.

The target number (n = 30) was not reached in Finland, which makes it more difficult to find significant differences between the two groups and the results less robust. However, this can be regarded as minor as still a tendency about participants' acceptance can be reported. Also, looking at the other participatory actions that were carried out with users of EPC during the ePANACEA project also in Finland this last third user workshop can be regarded as one component of a series of 3 workshops + stakeholder interviews. In total, the user activities allow to gain a picture about users' perception and acceptance of EPC, also in Finland.

5.2. Discussion of results

We used concrete comprehension questions to test how comprehensibly the EPC conveys information. **However, we need to be aware that comprehension does not only depend on the content and the way information is presented, but also on person-related parameters such as previous knowledge in the subject area**. The last user workshops had shown that the difference in background knowledge among end-users and other stakeholders influences their perspective and evaluation of EPC proposals.

Based on the results of this acceptance test we can make statements about users' *intention* to use the EPC. **But, the results do not allow us to make predictions about users' *actual use* of the EPC and even less about users' decision making during a purchase or rental decision and regarding energy efficiency measures.** This is due to the GAP between intention to use and actual use and the fact that many other factors influence decision making next to the EPC (e.g. costs for EEMs, energy costs, social environment). **The EPC can only be considered as one of multiple factors influencing strategic energy behavior.**

Moreover, there are many other factors influencing the use of EPC (subjective and contextual). **Hence, it is not the quality of the EPC alone that influences its usage**. Therefore, we cannot expect that the use of the EPC will increase much more, once the EPC is improved (in case the acceptance and impacts of the new EPC summary pages are higher). Looking at the context, we can assume that the EPC will be taken into account more due to rising energy prices (gas, electricity, oil) which result in an increased awareness of energy efficiency and the will to increase it. However, costs of materials and shortage of craftsmen increase the prices for energy efficiency measures.

The possibility of participating in the development process of new EPC summary pages might have increased participants' acceptance of EPC and influenced the results positively. Moreover, the evaluation of the EPC versions could be influenced by whether participants already took part in a previous ePANACEA workshop and already have discussed/seen how an improved EPC could look like.

Reasons why the outcomes of the acceptance test regarding the new EPC are not significantly better in the ePANACEA pilot countries could be that (besides some criticism of the information presentation) the new EPC has to fulfil a higher standard, as it is supposed to be applicable in all EU countries, whereas the current EPCs are national. Also, looking at the participants with an expert background, who are used to work with the current EPCs, a habituation effect could play a role. The possibility is reinforced by participants' statements such as that they know where things are in the current EPC and can therefore more easily find the information straight away and work with it.

6. CONCLUSION

During the project life time of ePANACEA new EPC summary pages were developed, taking into account critiques, needs and suggestions for improvement by different stakeholders such as end-users of EPC, experts in the field (energy advisors, EPC issuer, and architects) and project partners, while also matching the ePANACEA objectives and methodology. Therefore, the version of this project first of all includes the information that the market demands, following what the ePANACEA methodology can deliver and what the revision of the EPBD envisages.

The acceptance of the new EPC summary pages and current EPC schemes in the ePANACEA pilot countries (Spain, Belgium (Flemish region), Austria, Greece and Finland) was tested and compared in the scope of a third online user workshop with an online survey that was filled in during and after the workshop as main survey tool. For this, the workshop participants were divided into two groups so that one group received and evaluated the new EPC while the other referred to the current EPC. The acceptance of EPC versions was tested based on e.g. the understanding of information, the perceived ease of use and usefulness, attitude towards the presented EPC and the use intention. The target for the number of workshop participants was not reached in Finland, which makes it more difficult to find significant differences between the two groups and the results less robust. However, a tendency about participants' acceptance can still be reported.

The analysis of the questionnaires and workshop discussions shows that in Greek and Spanish workshop genders were roughly equally represented, while in Belgium, Finland and Austria at least two thirds of the participants were male. The majority of all groups owns the house they are living in. Austria has the largest share of tenants with 30%. In all pilot countries different age groups of the working society were present. Overall, the participants have a comparatively high level of completed education as the majority in all groups has a university degree. At least 70% of all groups identified themselves as end-user of EPC, while also other stakeholders such as architects, energy advisors and EPC issuer were present in all groups. Additionally, researchers in the field of energy efficiency took part in the Finnish user workshop. About 70% or more participants had experience with the EPC before the workshop in all groups, except for in Finland where only 43% in the current EPC group and 78% in the new EPC group had experience with the EPC before which presents a noteworthy difference regarding the starting position for evaluation of EPC.

Based on the outcomes of the third round of workshops we can conclude that there are not many significant differences in the evaluation of the current EPC and the new EPC within one pilot country, considering the main themes used to test acceptance of EPC: understanding, perceived ease of use, perceived usefulness, feelings, overall perception of EPC, attitude towards EPC and behavioural intention to use EPC. Only in Belgium the current EPC scored significantly better in terms of perceived ease of use, perceived usefulness and appropriateness than the new EPC summary pages. However, comparing the evaluation of the new EPC among countries, the new EPC was not rated conspicuously poorly in Belgium compared to the other countries. But, in Belgium the current EPC scored higher than in other countries, matching the impression that the Belgian (Flemish) EPC is already progressive and user-friendly. The new EPC was only evaluated significantly better (looking at the main mentioned themes) regarding feelings towards EPC in Austria and regarding appropriateness and attitude in Greece. From this we cannot conclude that the new EPC is significantly accepted better in these countries.

The results rather show a tendency that the current and new EPC are *equally well accepted* in the other pilot countries. However, the perceived usefulness of the EPC to receive information about additional indicators such as comfort, IAQ and costs associated with running the building, the new EPC scores significantly higher in Austria, Belgium, Greece and Spain. However, this has not led to the new EPC being perceived as more useful overall. Also, in comparison to the current EPC the new EPC was rated better on the semantic differentials for the items: standardized with general information – individual with tailored information and mandatory document – useful source of information in Austria, Belgium, Greece and Spain. Hence, the perceived individuality and usefulness of the new EPC seems to have improved compared to the current EPC versions in these ePANACEA pilot countries. When comparing the semantic differential cluttered – organized and confusing – clear, the current

EPC was rated better in these aspects in four out of five countries (Austria, Belgium, Finland and Spain). This indicates that the new EPC has gained in usefulness and individuality but lost in clearness and organization compared to current EPCs in the ePANACEA pilot countries. This could also be the reason why the new EPC was not rated as easy to understand by 70%, 53% and 50% in Austria, Spain and Belgium, respectively, although most of the information was understood correctly. This could be interpreted to mean that participants do not understand the information at first glance, have to concentrate a lot to understand or are not sure whether they understand the information correctly. Points which have been repeatedly praised with regard to the new EPC in all pilot countries were the improved appealing visualization and the roadmap in order to show the recommendations. Also, the benchmarking of final energy use was perceived as useful. Three new EPC groups described the new EPC to be more comprehensible for laymen than the current EPC (although perhaps not comprehensive enough yet). Criticisms that were mentioned in the previous workshops such as low usefulness and individuality of the EPC were not repeated.

Reasons why the outcomes of the acceptance test regarding the new EPC are not significantly better in the ePANACEA pilot countries could be that (besides some criticism of the information presentation) the new EPC has to fulfil a higher standard, as it is supposed to be applicable in all EU countries, whereas the current EPCs are national. Also, looking at the participants with an expert background, who are used to work with the current EPCs, a mere effect could play a role. The possibility is reinforced by participants' statements such as that they know where things are in the current EPC and can therefore more easily find the information straight away and work with it.

The comprehension test shows that it is not clear yet what THE energy label/energy rating for the building is as there are three main *rated* indicators (primary energy use, final energy use and GHG emissions) and all of them are provided based on standard and actual conditions of use. Therefore, it must be better highlighted in the new EPC that the current primary energy use based on standard conditions is the parameter that determines the energy rating/energy label of the building. Also, in general the provision of information based on standard and on actual conditions is not clear enough, as participants still ask for the difference, the purpose of it and what is taken into account for actual conditions as calculation basis.

Other information that was newly introduced in the new EPC (e.g. benchmarking, potential energy rating, and share of renewable energy etc.) was understood correctly by the majority of participants although many participants mentioned to not fully understand the boxplots presenting the IAQ and comfort. Also, it appears that that the division of pages between the target groups (the first two pages oriented towards all and the two last pages oriented towards end-users) was not clear. Many participants had not even realized until the question that the pages are addressed to different stakeholder groups. That a division of the pages is necessary is supported by the fact that participants often criticized the use of technical terms which are not understandable by laymen.

Moreover, participants of all pilot countries repeatedly criticized that there is too much information which is presented in small space which leads to confusion and loss of focus on the most important information. Additional information could therefore be provided in a different additional format. On the other hand, additional explanations in the EPC or a manual in order to understand the provided information would be appreciated by the majority of participants in all pilot countries. Both – separating main and additional information and providing additional explanations - could be realized in a digital/online-version of the EPC. Although the new EPC has received criticism and there are several suggestions for improvement asking for further development of the new EPC summary pages, the behavioral intention to use the new EPC - as well as with regard to the current EPC - e.g. for decision making when buying/renting a house or before renovating is high throughout all ePANACEA pilot countries.

Only in Spain the willingness to use the EPC was higher regarding the new EPC than the current EPC. So, the intention to use the current EPC was also high, which is surprising as it does not necessarily fit with the statements from the previous stakeholder interviews and workshops during which end-users stated that they are not aware of the EPC and would not consider it important or useful. This may be because approximately one third of the participants of this workshop also identified themselves as experts in the context of energy efficiency and because the change in context within the last year (war in

Ukraine, energy crisis) has strengthened the sense and need for energy efficiency. This supports the thought that it is not only the quality of the EPC alone that influences its usage, but also the context within which it is applied.

But, the majority of participants indicated to not be willing to pay high prices for the EPC – neither the current, nor the new. There was no significant difference in the willingness to pay between the EPC groups. Finish and Greek participants' willingness to pay drops the quickest with nobody willing to pay more than 250€. Willingness to pay was the highest with Austrian participants which may be due to the fact that currently the prices for EPC are comparatively high in Austria (about 450€ for an EPC for a single home).

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7.2. Table of tables

7.3. Other references

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8. ANNEX: NEW EPC SUMMARY PAGES

Energy performance certificate

Building ID	IES Plaza de Cruz
Address	Cruz square Spain
Country	SPAIN, Pamplona
Year of construction	1910
Last renovation	2020
Reference floor area	1446 m²
Climatic Zone	D1
Sea level	443 m NN
Building use	Education building
Date of issue	15/11/2022
Certifier name	Albert McGilbert
Date of validity	15/11/2032
Heating	District heating
Cooling	-
DHW	mechanical
Ventilation	-
Solar	-
PV	100 m²
Power storage	-

Current rating of your building

standard conditions
actual conditions

	Total primary energy use kWh/m²y	Final Energy Use kWh/m²y	Greenhouse gas emissions CO_2-eq
A	≤ 80	≤ 25	17 / 19
B	≤ 160	≤ 50	≤ 30
C	≤ 220	98 / 105	≤ 40
D	290 / 330	≤ 150	≤ 50
E		≤ 200	≤ 60
F	≤ 400	≤ 250	≤ 70
G	> 400	> 250	> 70

Purpose of this document:
- *Compare current ratings of properties to see which properties are more energy efficient*
- *Find out how you can save energy by installing improvement measures*

Total primary energy standard conditions — Share of renewables systems

83 kWh/m²y | 247 kWh/m²y

This graph shows the share of the total primary energy that is renewable 25% which generated on-site and/or sourced externally. 75 % is classified as non renewable.

Recommendations and energy efficiency potential:
actual conditions

		Savings kWh/m²y Final energy use	Cost savings per year	Investment total	Green House Gas emissions saving
1	An additional **thermal insulation** on the wall of 18 cm decreases the U-value to 0.19 W/m²K.	46 kWh/m²y	9 200 €/y	140 000 €	3 925 kgCO2-eq/y
2	Solar collector	15 kWh/m²y	3 350 €/y	15 000 €	1 280 kgCO2-eq/y
3	Room thermostat	4 kWh/m²y	580 €/y	4 000 €	340 kgCO2-eq/y

Investment and cost savings: calculated at the date of issue of the EPC; using prices from the database:
Statistic Austria: 05 / 2022
district heating: 10 Cent/kWh

This illustration suggests energy efficiency measures in a sensible sequence which takes into account the cost-effectiveness of the measures and the individual situation of your building. It shows the potential rating that your house would achieve after the respective cumulative measures. The recommendations assume actual conditions.For the energy rating of buildings, EPB services are taken into account (i.e. heating, cooling, domestic hot water, ventilation, and lighting).

building envelope | heating | cooling | dynamic envelope | Renewable energies on-site or nearby | control systems or user behaviour

Energy performance certificate

Energy performance of building components and installations standard conditions

worst ← indicative scale → best

Building component or installation	Description	Energy performance
roof	200 mm loft insulation	U = 0.18 W/m²K Target: 0.20 W/m²K
wall	brick from 1910, partial insulation	U = 0.54 W/m²K Target: 0.35 W/m²K
floor		U = 0.52 W/m²K Target: 0.4 W/m²K
window	double glasing	U = 0.93 W/m²K Target: 1.4 W/m²K
heating	district heating; radiators 60°/35°	$\eta_{s,h}$ = 125%
cooling		
hot water	district heating	$\eta_{s,h}$ = 125%
ventilation	partially LED lamps	
lightning		VEEI = 2.9

U [W/m²K] = heat transfer coefficient (weighted average);
$\eta_{s,h}$ = seasonal space heating energy efficiency
$\eta_{s,c}$ = seasonal space cooling energy efficiency

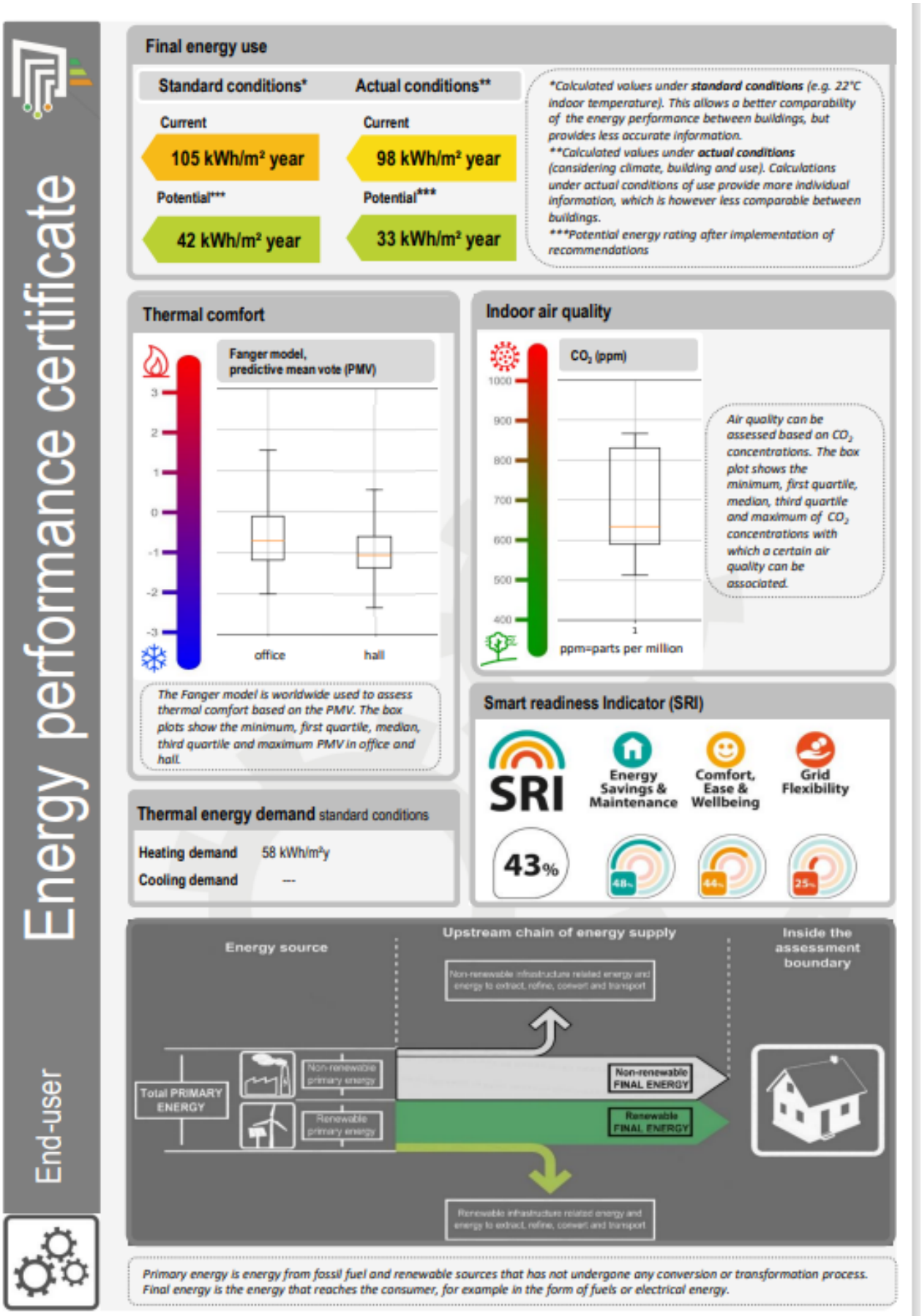
ACH = air changes per hour
VEEI = Limit Value of Energy Efficiency (VEEI-Spanish acronymic)

Potential of renewable primary energy, generated on-site or nearby from different renewable energy sources

	Actual use	Necessary to cover energy use of the building	Means to achieve covering	Potential on site total	Means to achieve potential
Photovoltaic [kWh/y]	1 000	5 715	extra 28 m², 5 kWp, direction angle: 180° (south), inclination 30°	38 016	216 m², direction angle: 180° (south), inclination 30
Solar thermal system [kWh/y]	0	12 150	27 m², direction angle: 180° (south), inclination 30°, 450 kWh/m²y solar yield estimated	24 300	extra 54 m² would be possible on the roof
Biomass	0	0	Biomass boiler, wood chip	0	Biomass boiler, wood chip
Indicator renewable For example: hydropower, wind	0	0		0	

Definitions

- *on-site / nearby definition see ISO 52000-1:2017: 9.5. Boundary parameters*
- *kWh produced by electrical gain from PV and by thermal gain from Solar thermal system: final energy is equal to primary energy*
- *The primary energy from biomass: calculation with the heating demand, the annual efficiency and the primary energy renewable factor*
- *For thermal energy taken from environmental heat sources: the annual COP differs on the source: air: 2.5, geothermal probe: 4 ground collector: 3.5, ground water: 5 final energy is equal to primary energy.*
- *The renewable primary energy from district heating: calculation with the heating demand, the annual efficiency and the primary energy renewable factor for district heating*
- *The potential of renewable energy technologies must be considered separately because not all measures can be combined with each other. The information about actual and potential use of renewable energy generated on-site assumes standard conditions.*


Energy performance certificate
End-user
Final energy use
Standard conditions*
Actual conditions**
Current
105 kWh/m² year
Potential***
42 kWh/m² year
Current
98 kWh/m² year
Potential***
33 kWh/m² year
*Calculated values under standard conditions (e.g. 22°C indoor temperature). This allows a better comparability of the energy performance between buildings, but provides less accurate information.
**Calculated values under actual conditions (considering climate, building and use). Calculations under actual conditions of use provide more individual information, which is however less comparable between buildings.
***Potential energy rating after implementation of recommendations
Thermal comfort
Fanger model, predictive mean vote (PMV)
office
hall
The Fanger model is worldwide used to assess thermal comfort based on the PMV. The box plots show the minimum, first quartile, median, third quartile and maximum PMV in office and hall.
Indoor air quality
CO2 (ppm)
ppm=parts per million
Air quality can be assessed based on CO2 concentrations. The box plot shows the minimum, first quartile, median, third quartile and maximum of CO2 concentrations with which a certain air quality can be associated.
Thermal energy demand standard conditions
Heating demand 58 kWh/m²y
Cooling demand ---
Smart readiness Indicator (SRI)
SRI
Energy Savings & Maintenance
Comfort, Ease & Wellbeing
Grid Flexibility
43%
Energy source
Upstream chain of energy supply
Inside the assessment boundary
Non-renewable infrastructure related energy and energy to extract, refine, convert and transport
Total PRIMARY ENERGY
Non-renewable primary energy
Renewable primary energy
Non-renewable FINAL ENERGY
Renewable FINAL ENERGY
Renewable infrastructure related energy and energy to extract, refine, convert and transport
Primary energy is energy from fossil fuel and renewable sources that has not undergone any conversion or transformation process.
Final energy is the energy that reaches the consumer, for example in the form of fuels or electrical energy.

Energy performance certificate

End-user

Final energy use and associated costs of energy services

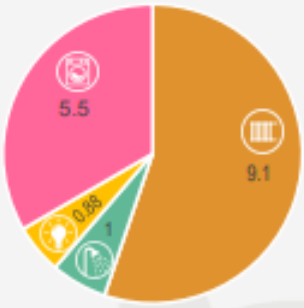
	standard conditios* kWh/m²year	€/m²year	actual conditions** kWh/m²year	€/m²year
Heating	91	9.1	87	8.7
Cooling	-		-	
Hot water	10	1	6	0.6
Ventilation	-		-	
Lightning	4	0.88	5	1
Sum EPB services	105	10.98	98	10.3
Equipment / other services	25	5.5	21	4.62
Sum EPB services + other services	130	16.48	119	14.92

*This section informs about the energy use and costs per m² and year, disaggregated for energy services. It considers **EPB services** (included in the energy rating of buildings): heating, cooling, domestic hot water, ventilation, and lighting.*

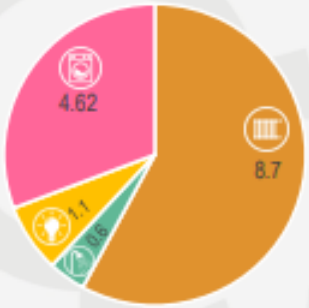
It provides the information based on standard and actual conditions.

*This section informs you about the final energy use of **EPB services** and **other services** in addition to the energy rating above services of the household like cooking or washing are included.*

Standard conditions* 16.48 €/m²y



Actual conditions** 14.92. €/m²y



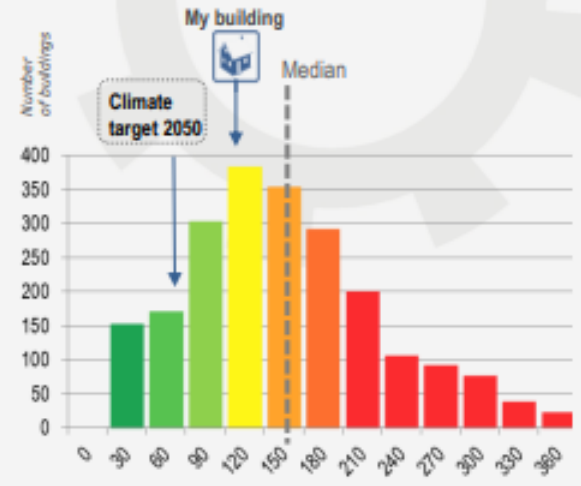
The costs per m² and year are additionally shown as pie charts. Costs are expected to change over time.

** Calculated values under standard conditions of use, 22°C indoor temperature*

*** Calculated values under actual conditions of climate, use & building*

Price: date of issue of the EPC (15/11/2022): 22 Cent/kWh electricity, 10 Cent/kWh district heating national database: Statistic Austria 11/2022

Benchmarking final energy use



This graph puts the information about the final energy use of your building in relation to the national climate target 2050 and the final energy use of other similar buildings (assuming standard conditions)

Climate target 2050 80 kWh/m² year **My building** 105 kWh/m² year