D4.4 Transnational comparison of pilot cases

QualDeEPC H2020 project

MAIN AUTHOR: Sriraj Gokarakonda, Stefan Thomas, Maike Venjakob (Wuppertal Institute)

DATE: 24/02/2021

PUBLIC

Project **QualDeEPC**
"High-quality Energy Performance Assessment and Certification in Europe Accelerating Deep Energy Renovation"
Grant Agreement no. 847100
H2020-LC-SC3-EE-2018

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 847100

Document Factsheet	
Project duration	From September 2019 to August 2022
Project website	www.qualdeepc.eu
Document	D4.4 Transnational comparison of pilot cases
Work Package	WP 4 Testing the applicability through pilot cases
Task	Task 4.4: Transnational comparison of pilot cases
Version	1
Version date	24/02/2022
Main Author	Sriraj Gokarakonda, Stefan Thomas, Maike Venjakob (Wuppertal Institute)
Contributors	Partners contributing
Reviewers	WP leaders and reviewers
Type of deliverable	[R]
Dissemination level	[PU]

Table 1: Document Factsheet

Document Status	
Review status	☐ Draft ☒ WP leader accepted ☒ Coordinator accepted
Action requested	☐ To be revised by partners ☐ For approval by the WP leader ☐ For approval by the Project Coordinator ☒ To be delivered to the Commission

Table 2: Document Status

Document History			
Version	**Date**	**Main modification**	**Entity**
Final draft	24/02/2022	-	-
Final version	04/03/2022	Minor additions from project partners	-

Table 3: Document History

PROJECT PARTNERS

WI: Wuppertal Institut für KLIMA, UMWELT, ENERGIE gGMBH

CRES: Centre for renewable energy sources and saving

DENA: Deutsche Energie-Agentur GmbH (dena)

EAP: Energy agency of Plovdiv Association

EKODOMA

ENERGIAKLUB: Energiaklub Szakpolitikai Intezet Modszertani Kozpont Egyesulet

E-P-C: EPC Project Corporation Climate. Sustainability. Communications. mbH

FEDARENE: Federation euopeenne des agencies et des regions pour l'energie et l'environnement

ESCAN: Escan SL

CIT ENERGY MANAGEMENT AB

BME: Budapest University of Technology and Economics

DISCLAIMER OF WARRANTIES

"This project has received funding from the European Union's Horizon 2020, research and innovation programme, under Grant Agreement No 847100"

This document has been prepared by QualDeEPC project partners as an account of work carried out within the framework of the EC-GA contract no 847100.

Neither Project Coordinator, nor any signatory party of QualDeEPC Project Consortium Agreement, nor any person acting on behalf of any of them:

(a) makes any warranty or representation whatsoever, express or implied,
  (i). with respect to the use of any information, apparatus, method, process, or similar item disclosed in this document, including merchantability and fitness for a particular purpose, or
  (ii). that such use does not infringe on or interfere with privately owned rights, including any party's intellectual property, or
  (iii). that this document is suitable to any particular user's circumstance; or

(b) assumes responsibility for any damages or other liability whatsoever (including any consequential damages, even if Project Coordinator or any representative of a signatory party of the QualDeEPC Project Consortium Agreement, has been advised of the possibility of such damages) resulting from your selection or use of this document or any information, apparatus, method, process, or similar item disclosed in this document.

PUBLISHABLE SUMMARY

To achieve the EU's energy efficiency targets, both the rate of building energy renovation and its depth, i.e. the amount of energy savings post renovation need to be improved. QualDeEPC, funded under the EU's Horizon 2020 programme, aims to develop high-quality energy performance assessment and certification in Europe that accelerates deep energy renovation.

Following EU-wide review of existing EPC schemes, and extensive stakeholder discussions in the seven partner countries, QualDeEPC developed an enhanced EPC scheme by improving seven elements of existing EPC schemes and tested their applicability and convergence potential for their EU-wide uptake. A detailed analysis of the EPC schemes in the partner countries and the EU was conducted (Gokarakonda, Venjakob, et al., 2020) and gaps, shortcomings (Gokarakonda, Thomas, et al., 2020) and best practices (Kostova, Gokarakonda, et al., 2020) were identified, and also based on the national stakeholder workshops, QualDeEPC chose seven priorities for improvement in the proposed enhanced EPC scheme (Kostova, Thomas, et al., 2020; Thomas et al., 2021).

A.	Improving the recommendations for renovation, which are provided on the EPCs, towards deep energy renovation.
B.	An online tool for comparing EPC recommendations with deep energy renovation recommendations.
C.	Creating Deep Renovation Network Platforms (One-Stop Shops plus networking and joint communication of supply-side actors).
D.	Regular mandatory EPC assessor training (on assessment and renovation recommendations) required for certification/ accreditation and registry.
E.	Achieving a high user-friendliness of the EPC.
F.	Voluntary/mandatory advertising guidelines for EPCs.
G.	Improving compliance with the mandatory use of EPCs in real estate advertisements.

Table 4: Seven priorities for improvement in the proposed enhanced EPC scheme

For testing the priorities on renovation recommendations and user-friendliness in the enhanced EPC, 98 pilot buildings were selected from seven partner countries. For all the pilot buildings, standard EPCs were prepared as per current practice, and enhanced EPCs were prepared using the enhanced EPC scheme. Three further priorities – Online tool, Deep Renovation Network Platforms, and Advertisement Guidelines – were tested by means of a questionnaire to building owners and other stakeholders.

The results show significant potential for improvement in the existing EPCs and convergence between various member states. In most countries, the number of recommendations and their ambition increased in the enhanced EPCs that provide a clear list of options, and almost 50% of energy savings potential were suggested in the enhanced EPCs. The building representatives found a proposed feature called 'traffic light system' that classified the efficiency of building envelope and technical systems, and the information on energy and cost savings to be informative. Key barriers for EU-wide convergence include the differences between the minimum legal requirements, and the inputs, outputs and calculation procedure in the national calculation tools that make it difficult to present comparable information between various countries.

TABLE OF CONTENTS

INDEX OF TABLES

INDEX OF FIGURES

1 INTRODUCTION

The objective of the Task 4.4 is to assess in comparison between countries and pilot cases, what worked well or less well from the five elements of an enhanced ECP scheme that the QualDeEPC project has identified as its priorities for the development of enhanced EPC schemes, which were tested in the pilot cases. Based on these findings, this Task also analysed the possibility and potential for EU-wide convergence on enhanced EPC schemes, at least regarding these five elements, and based on the results from assessment in QualDeEPC partner countries. The results were fed back to Task 3.5 for the revision of Deliverable D3.1 to D3.2 and are presented in the form of this report (D4.4). It is one basis for Task 4.5, summary of testing results and recommendations.

For assessing two of the seven priorities, 'Improving the recommendations for renovation, which are provided on the EPCs, towards deep energy renovation' and 'High user-friendliness of the EPC', 98 pilot buildings have been selected from seven QualDeEPC partner countries. For all the pilot buildings, standard EPCs were prepared as per current practice to reflect the status quo (D4.2), and enhanced EPCs (D4.3) were prepared using these two priorities. Three further priorities - Online tool, Deep Renovation Network Platforms, and Advertisement Guidelines – were tested by means of a questionnaire to building representatives or stakeholders. The standard EPCs and enhanced EPCs, the survey results, as well as supplementary data and relevant information from their pilot cases, and the feedback collected in other work packages were analysed along well-defined criteria, with particular focus on similarities and differences between the QualDeEPC partner countries to demonstrate the potential of enhanced EPCs for convergence and an EU-wide uptake.

Inputs for transnational comparison

The inputs for the transnational comparison include the following:

- Tasks 4.2 and 4.3: Preparation of Energy Performance Certificates according both to current practice and to the experimental enhanced assessment and certification schemes for the buildings pilot cases, which includes the following activities:
    - Applying enhanced Energy Performance Certificate assessment and certification procedures and tools
    - Producing experimental enhanced Energy Performance Certificates for the pilot cases
    - Documenting differences, experiences, and what worked well or not during the preparation of the enhanced Energy Performance Certificate, in comparison to the existing national EPC scheme; based also on feedback from EPC auditors
    - Collecting feedback from facility managers/building representatives(s) on the enhanced Energy Performance Certificate, improved renovation recommendations, and by means of a questionnaire, on the usefulness of Online tool, Deep Renovation Network Platforms, and Advertisement Guidelines
- Feedback from QualDeEPC country partners on the proposed features of the enhanced EPC certificate and feasibility of developing improved renovation recommendations, in draft form and later by the national summary report in Task 4.5, also taking into account:
- Task 3.4, national workshops and questionnaires, which are based on the draft concepts, assembled in the Green paper, collected feedback and responses from stakeholders (EPC professionals) and building representatives

Further sections of the report are organised based on the five of seven identified priorities for improvement, as per the Green paper, that were tested in WP 4 either by enhanced EPCs and

questionnaires/discussions (enhanced EPC certificate form and improved renovation recommendations), or by the questionnaires only (Online tool, Deep Renovation Network Platforms, and Advertisement Guidelines).

2 IMPROVING THE RECOMMENDATIONS FOR RENOVATION PROVIDED ON THE EPCS TOWARDS DEEP ENERGY RENOVATION

Section 3.2 of 'D3.2 White paper on good practice in EPC assessment, certification, and use' (Veselá et al., 2021) suggests improved renovation recommendations that are consistent with, and guide towards 'deep energy renovation'. This would be a major enhancement compared to the recommendations currently provided in most (standard) EPCs, which usually only meet minimum legal requirements, and many possible recommendations may be completely omitted if deemed too costly by the EPC issuer. Furthermore, the enhanced EPC developed by QualDeEPC presents these improved recommendations in pages 3 and 4, and in a way that they can become the first step towards deep energy renovation (see chapter 3). The presentation of recommendations in enhanced EPCs differs from the standard EPCs in most QualDeEPC partner countries. Therefore, this chapter compares the recommendations from the enhanced EPCs with those from the standard EPCs to identify changes and improvements, or lack thereof, from the standard EPCs. The criteria for this comparison and analysis include, the comparative analysis of recommendations between enhanced and standard EPCs for pilot buildings and vice-versa; and feedback from QualDeEPC country partners, building representatives, stakeholders on the feasibility of issuing the enhanced EPCs with improved recommendations, as suggested in the white paper.

2.1 Comparative analysis of the standard and enhanced EPCs for the pilot buildings

2.1.1 Consistency and completeness of information

The enhanced EPC template contains specific features in the EPCs for presenting the recommendations that may or may not be present in the standard EPCs. This section contrasts 14 key features for presenting the recommendations between enhanced and standard EPCs in various QualDeEPC partner countries, and vice-versa.

First, the enhanced EPC is compared with the standard EPC to identify the missing information in the enhanced EPC, as shown in figure 1. Of the 14 key features, 10 features are identified as primary features that require extensive or exclusive input data and calculation procedure, from which other secondary features can be calculated/derived with minimum effort (self-evaluation). Furthermore, the results from 1) a comparison of the standard and enhanced EPCs by the QualDeEPC country partners (general and for pilot buildings), 2) questionnaires answered by pilot building representatives, and 3) stakeholder roundtable meetings indicate that while certain features in the enhanced EPC are perceived to be an improvement, other features are perceived to be partial improvement over the standard EPC, or better represented in standard EPCs than enhanced EPC, or less relevant in their countries (See Annex 2 - Section 4.1 in national summary reports for more information).

Overall, the enhanced EPC presents many features that are not usually present in standard EPCs. Standard EPCs of Spain and Bulgaria already contain at least half of the proposed features in the enhanced EPC. Most QualDeEPC partner countries present recommendations grouped as building components and technical systems. However, the quality and level of information provided in the recommendations widely differs between the partner countries.

Five primary features in the enhanced EPCs are present in at least four partner countries and few of them have been considered as improvements over the standard EPC. The feature related to presenting energy rating with a 'traffic light system' for recommendations is seen as an improvement in the majority of the partner countries, although this information is not present in any of their standard EPCs. In addition, features related to the description of useful combination of recommendations and their stepwise implementation, and further information and links that provide financial assistance programmes to implement recommendations are seen as improvements.

In general, Germany, Hungary and Latvia perceive most the proposed features in the enhanced EPCs as improvement over the standard EPCs, while Sweden perceives that most features in the enhanced EPCs are better represented in the standard EPCs.

Figure 1: Comparison of key features between enhanced and standard EPCs for presenting recommendations

In addition to comparing enhanced EPCs with standard EPCs, there are also some key features in the standard EPCs that are absent in the enhanced EPCs, although they are sometimes perceived as important features, as shown in figure 2. Especially in Bulgaria, Greece, Spain and Sweden, many features from the standard EPCs are not present in the enhanced EPC, making their transfer to enhanced EPC incomplete. Features related to CO_2 emissions and information on cost of renovation for individual recommendations for various building components and technical systems, and their presentation are perceived as key missing features, based stakeholder feedback (See Annex 2 - Section 4.1 in national summary reports for more information).

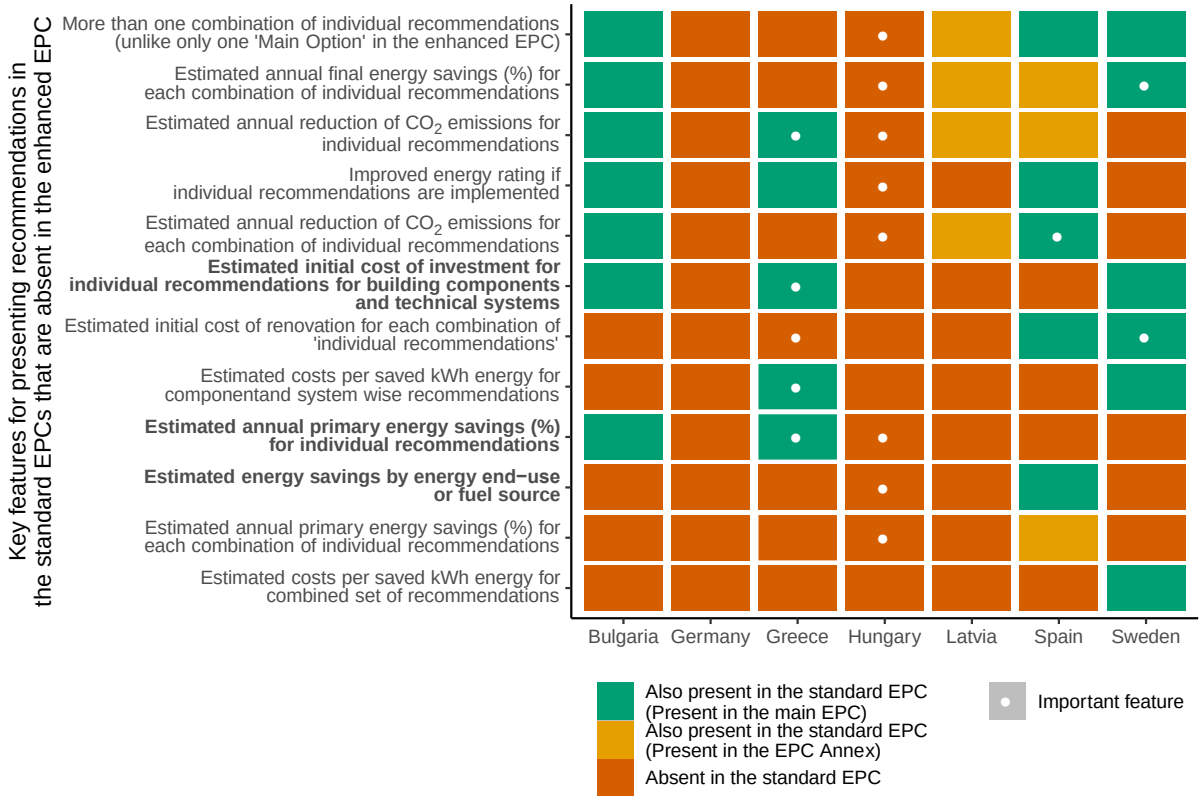


Figure 2: Key features that are absent in the enhanced EPCs but present in the standard EPCs of some countries

2.1.2 Are recommendations in the enhanced EPC in line with a roadmap towards nZEB?

2.1.2.1 Basis for recommendations

The enhanced EPC presents recommendations in two categories - first, improvements in the building envelope, and second, improvements in technical (and renewable energy) systems. Furthermore, a description of useful combination of recommendations and their stepwise implementation, 'renovation recommendations – renovation concepts' are presented in two separate boxes. The first box contains recommendations that are included in the 'Main Option', which lists a set of cost-effective recommendations (i.e., cost-effective at least in case of major renovation scheduled anyway). The second box lists further recommendations that are not included in Main Option e.g. due to high investment cost and long payback period, but maybe be feasible if further funding is available, e.g., under improved national incentive programmes. The information in both these boxes, together individual recommendations for building components and technical systems, should provide a roadmap towards nZEB. Moreover, a separate box presents 'Further information' that provides information on energy performance certification, use of EPCs and renovations to improve energy performance including financial assistance programmes. The following table shows the calculation methodology and basis for providing recommendations in standard and enhanced EPCs.

QualDeEPC partner country	Calculation tool	Basis for recommendations that are included in the standard EPC	Basis for recommendations that are included in the main option in the enhanced EPC

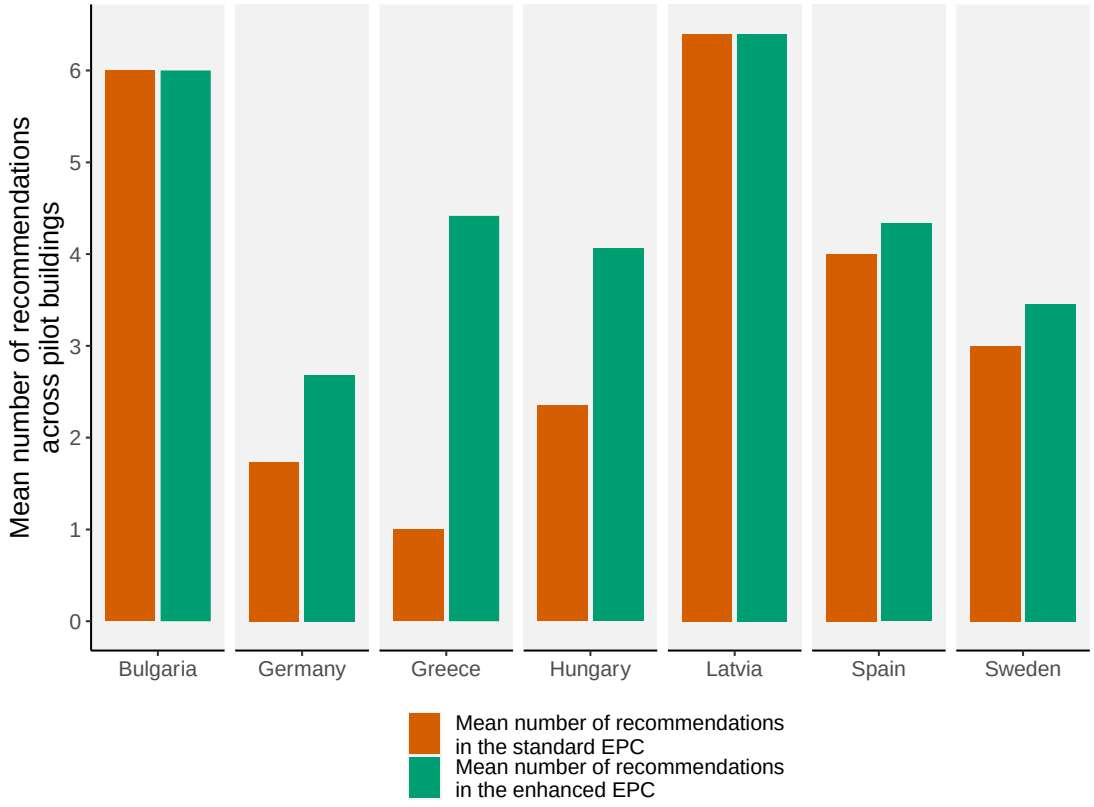
Bulgaria	Official software of the Sustainable Energy Development Agency (SEDA), but it is not a mandatory one, the assessors can use any type of calculation tool as long as it complies with the approved calculation methodology of Ordinance No 7 "Energy efficiency in buildings"	As per the national regulations and legislations of Bulgaria for energy efficiency in buildings	As per the national regulations and legislations of Bulgaria for energy efficiency in buildings
Greece	National official software tool TEE-KENAK	Based on the requirements set out in the national 'Regulation for the Energy Performance of Buildings', as amended in 2017	Based on the requirements set out in the national 'Regulation for the Energy Performance of Buildings' and further enriched in terms of number of recommendations, towards deep energy renovation
Germany	Calculations are based on DIN V 18599 or a combination of DIN V 4108-06 and DIN V 4701-10 in case of residential buildings without cooling.	The EPC issuer can choose freely, but may consider current funding programs.	The EPC issuer can choose freely, but may consider current funding programs. The main should be to improve the energy rating.
Hungary	Winwatt commercial tool was used for the calculations, which is based on the 7/2006 (24 May) TNM decree "Methodology for calculation and requirements on energy performance of buildings"	According to existing approach and energy efficiency measures for full building renovation in Hungary	According to new approach proposed by the enhanced EPC template. It is in accordance with a proposed enhanced methodology to revise 7/2006 (24 May) TNM decree.
Latvia	Calculation tool (based in MS Excel) developed by energy assessor (who made the EPC for pilot buildings) according to National regulation No. 348 "Methodology for calculating the Energy Performance of a Building"	According to existing approach and energy efficiency measures for full building renovation in Latvia	According to existing approach and energy efficiency measures for full building renovation in Latvia
Spain	Official software of CE3X	According to existing approach and energy efficiency measures for full building renovation in Spain	According to existing approach and energy efficiency measures for Deep energy renovation towards NZEB
Sweden	N/A	Cost-effective measures (what should be considered cost-effective, and what to consider in the profitability	Few additional measures compared to Standard EPC were added because of lack of guidance on what is cost effectiveness

		analysis, is not clearly defined)	

Table 1: Basis for recommendations in standard and enhanced EPCs

2.1.2.2 Comparison of total number of recommendations between standard EPCs and enhanced EPCs

Figure 3 presents the comparison between the number of recommendations presented in the standard and enhanced EPCs of all pilot buildings in various QualDeEPC partner countries. There is a significant improvement in the number of recommendations in the enhanced EPC then the standard EPCs in Germany, Greece and Hungary, while there is marginal improvement in Spain and Sweden. In Bulgaria and Latvia, the EPCs are based on a detailed energy audit and the recommendations in the standard EPCs are usually exhaustive, and therefore, the number remains same in both the standard and enhanced EPCs.



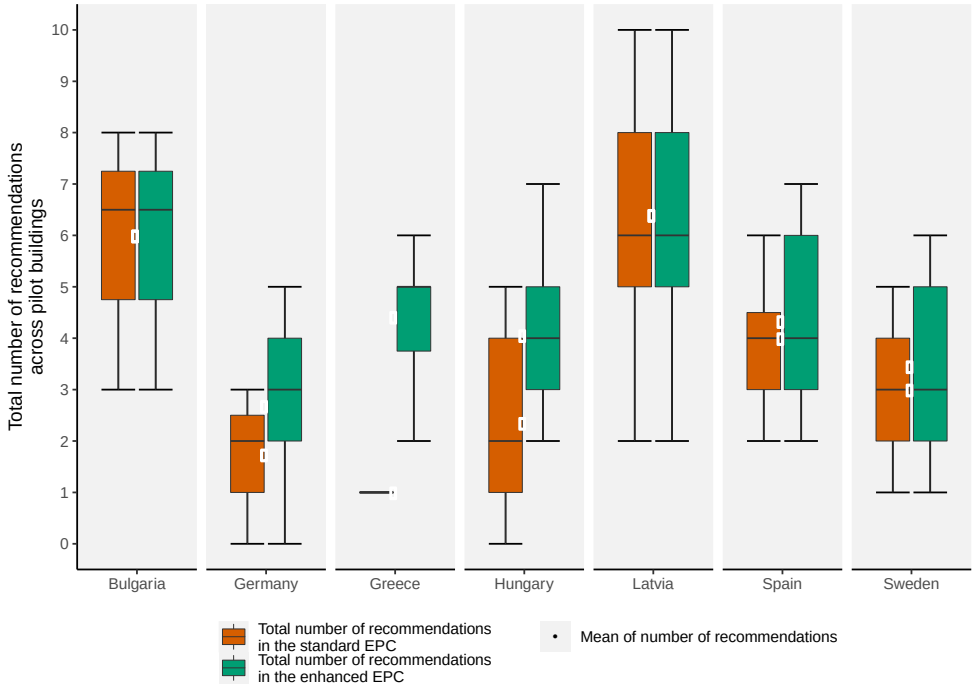


Figure 3: Box plot of total number of recommendations provided in standard and enhanced EPCs of pilot buildings

2.1.2.3 Comparison of potential energy savings between standard EPCs and enhanced EPCs

The following figure shows comparison of potential energy savings between the standard EPCs and the enhanced EPCs if their recommendations are implemented. Compared to the recommendations in the standard EPCs, the enhanced EPCs show significantly higher potential for energy savings in Greece and Spain, and a low to marginal additional potential in Sweden. In Greece, the reason for this result is that the standard EPC allows for a maximum number of three recommendations to be included in the field dedicated to recommendations. In Bulgaria and Latvia, the reason for this result seems to be that the standard EPC is already based on a detailed energy audit, and the EPC comes with detailed information on the recommendations. For Sweden, Table 6 in chapter 3.2 below mentions challenges that the EPC assessors had in selecting recommendations for the enhanced EPC. This feedback has been reflected in updating QualDeEPC's proposal for the renovation recommendations in the White Paper (D3.2).

In Germany and Hungary, potential energy savings are not provided in the standard EPC, but the energy savings that could be achieved when implementing the recommendations in the enhanced EPC are quite high, in the range of 40 to 50 percent on average.

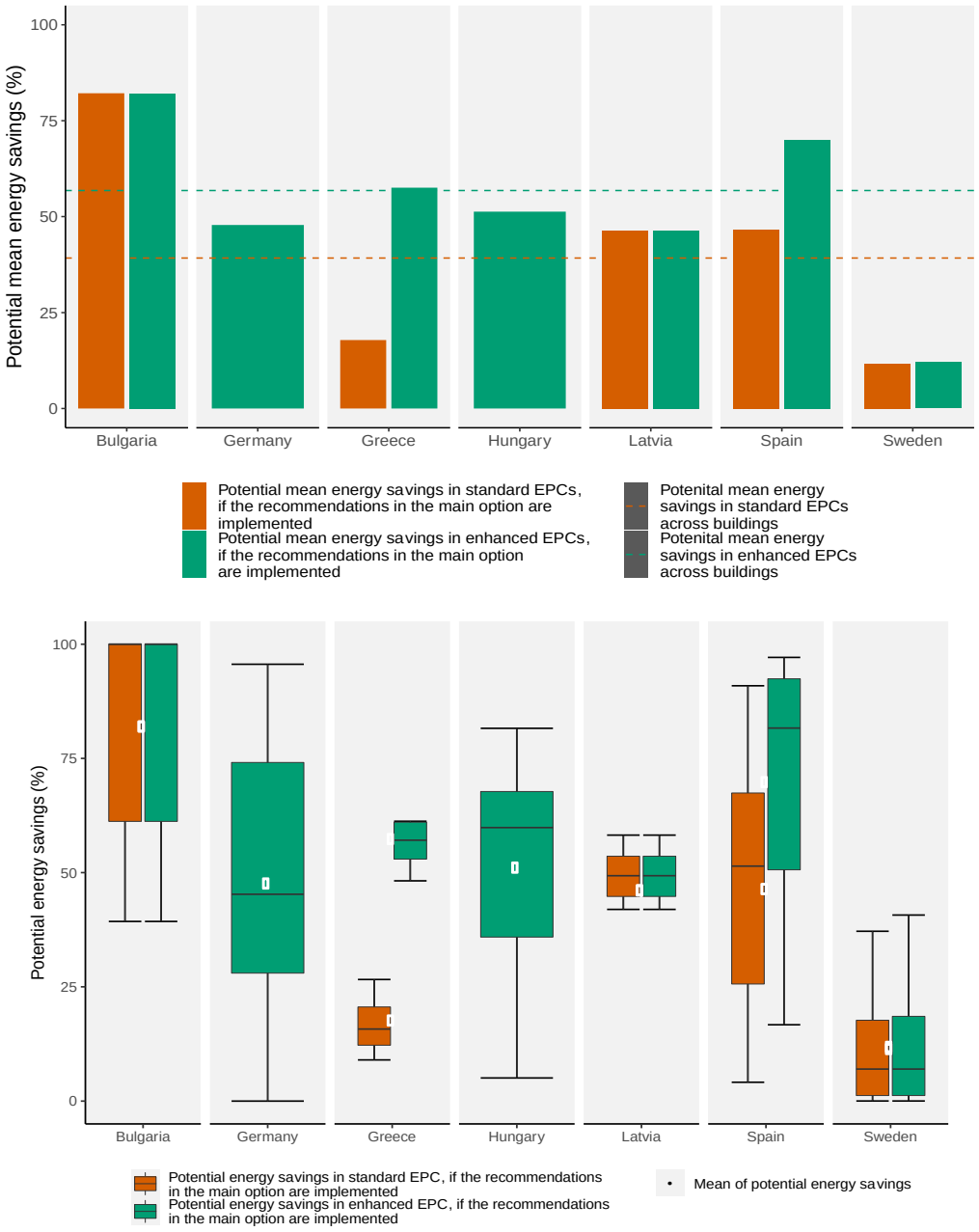


Figure 4: Box plot of energy savings achieved in standard and enhanced EPCs of pilot buildings. Notes: In Bulgaria, Spain and Sweden, energy savings in standard EPC are provided for more than one measure/set of measures. Recommendation/s with the highest savings are taken for the purpose of comparison. In standard EPCs from Greece, usually only one recommendation is provided, which is taken as the basis for energy savings achieved in standard EPC (the common approach of energy assessors is to select and include recommendations with a reasonable payback period which can also improve the energy classification of the building). In Germany and Hungary, potential energy savings are not provided in the standard EPC.

Further to the potential energy savings, the following table shows the number of buildings in which the main option in the enhanced EPCs meet requirements for NZEB, air-tightness, reduced thermal bridging and minimum 50% renewable energy source (RES) or equivalent measures. At least, 50 percent pilot buildings in Bulgaria, Greece, Hungary and Spain have the potential to meet the requirements for NZEB, post renovation. NZEB in the enhanced EPCs, met requirements for air tightness and reduced thermal bridging levels, and a minimum 50% renewable energy source (RES) or equivalent measures. In Greece, Hungary and Spain, at least half of the pilot buildings achieved NZEB status. In Hungary and Latvia, almost all buildings achieved the required levels of air tightness and reduced

thermal bridging (although to a lesser extent in Hungary). The highest potential for renewable energy is seen in Hungary and Spain.

		Number of buildings in which main option in the enhanced EPCs meets requirements for			
QualDeEPC partner country	Total buildings	NZEB	Air tightness	Reduced thermal bridging	Minimum 50% renewable energy source (RES) or equivalent measures
Bulgaria	8	5	0	0	0
Germany	19	1	0	0	4
Greece	12	6	0	0	0
Hungary	17	10	16	10	13
Latvia	15	0	15	15	0
Spain	15	11	0	15	9
Sweden	11	1	0	0	0

Table 2: Summary of pilot buildings that ticked the check boxes for meeting the requirements for NEB; air tightness, reduced thermal bridging and RES

2.2 Experiences of partners or their subcontractors when developing the recommendations

In the table below we have summarized experiences form project partners or their subcontractors when developing the Enhanced EPCs.

QualDeEPC partner country	Experiences of partners or their subcontractors when developing the Enhanced EPCs
Bulgaria	Selection of the main option requirements as well as to the energy savings achieved by implementing it and the energy rating which is for the moment not defined.
Germany	The nationally adapted, enhanced EPCs in Germany were very well accepted by the EPC issuer (subcontractor). The supplied short guideline provided enough information on how to fill in the enhanced EPC in general, as well as the traffic light system and deep energy renovation recommendations in particular. The feedback of the EPC issuer was mostly positive
Greece	In general, the development of the enhanced EPCs has proven to be smooth and without major difficulties. The few problems/difficulties encountered can be summarized as follows: - real energy consumption data acquisition: a) regarding the residential pilot buildings, in almost all cases the building representatives / users do not keep records (bills) of previous years, hence these data were not filled-in in the relevant table of the enhanced EPCs. b) regarding the non-residential pilot cases, although such records are kept, under the circumstances and due to the Covid 19 work overload of the schools' building managers, it has not been possible for them to allocate any extra effort in order to gather the information requested in the frame of the project, therefore, such data have not been included in the enhanced EPCs of the non-residential pilot buildings. - in the traffic light system characterizing the energy renovation measures efficiency level, some difficulties were encountered in relation to the technical systems characterization, as there have not been given any instructions, at that time, on which efficiency specifications to be inserted in the relevant fields; hence these data were filled-in in an arbitrary way and missing in some cases (e.g. for solar systems).

	- in the recommendations section of the enhanced EPC, as there have not been given any instructions on a standardized approach on the description to be inserted, some internal consultations have taken place so as to make a decision on a standard approach, resulting in time delays and still without any satisfactory results on the final approach decided, as no any cost data were provided there (not including cost data in the recommendations was a common decision of the project partners).
Hungary	For the Enhanced EPC it was hard to calculate the potential savings since the actual values are not part of the Standard EPC recommendations in Hungary. Also, by aiming at deep renovation in some cases it was challenging to find the best solution, which is both fulfilling the deep renovation concept and cost efficient as well. In most cases the measured energy consumption was not filled due to the table provided in the Enhanced EPC template, which is not unambiguous and due to the fact, that in Hungary it is not compulsory to collect/provide consumption data for the EPCs the data was scarcely available. It was also hard to promote cost effectiveness for the solutions, since the fuel prices are relatively low in Hungary and all renovation options are costly, thus the payback times are long. In some cases, due to limiting building and economical characteristics it was impossible to reach the deep renovation of the building.
Latvia	Developing the Enhanced EPCs for the selected pilot buildings was rather simple task since almost all of the information needed in Enhanced EPCs was available in the Standard EPC. Standard EPC in Latvia does contain mandatory annexes which include the information on suggested energy efficiency improvement measures. During development of Enhanced EPC in some cases it was problematic to evaluate the rating (traffic light system) of a building envelope component or a technical system component. In Latvia building renovation usually is performed by implementing all suggested energy efficiency measures at once. Therefore, the main option in Enhanced EPC in Latvian case basically contains all suggested measures. It was theorized to included additional measures in Enhanced EPCs (which were not included in Standard EPC). These would be installation of solar collectors and solar photovoltaics. But this was not done since the practice of installing such RES solutions is quite limited in Latvia in residential apartment buildings and non-residential buildings which were chosen as pilot buildings in this project.
Spain	We had to do calculations for final energy consumption in order to calculate energy savings. We had to do the certification again for some of the pilot cases because the target was to produce recommendations in order to achieve one or several of the following: NZEB, air tightness, reduction thermal bridges, and the standard EPC of some of the buildings did not achieve that goal We also had to do the calculation for the recommendations about Cost effectiveness (e.g., payback time)
Sweden	• Overall, the EPC assessor preferred the enhanced EPC template to the standard EPC. • It was not possible to fill in the original table for measured energy consumption. Instead, this table was divided in two – one table including metered data for different energy sources, and a second table where the metered data was apportioned to different types of use (heating, cooling, DHW etc.) based on assumptions and calculations by the EPC assessor. • The EPC assessor thought that the part with evaluation of energy performance of building components and technical systems was a positive addition, but struggled a bit with the rating limits (choosing the appropriate traffic lights). Also, it was not clear whether a red or yellow light in the first table means that a recommendation of renovation measure is needed. • The EPC assessor also appreciated the table that summarizes the renovation recommendations, and that some key figures (cost, savings, profitability) need to be filled in. This gives a better overview of the recommended measures than the standard EPC. • Moreover, the EPC assessor was positive to the encouragement to suggest useful combinations of measures. • Despite the positive aspects described above, the EPC assessor did not see the possibility to include recommendations of measures that would be considered deep energy renovation.

	Since no guidance is given on what measures to include in the main option, and what aspects to consider in the profitability calculations (future renovation, maintenance needs etc.), few additional recommendations were included compared to the standard EPC. However, with such guidance, in combination with the evaluation of building components and systems, the EPC assessor thinks that the template has a potential to encourage more renovation recommendations and further energy savings.

Table 5: Remarks on the comparison of key features for presenting recommendations between enhanced and standard EPCs

In summary, it can be said that there were no major difficulties in developing the Enhanced EPCs for pilot buildings. The difficulties with developing Enhanced EPCs mostly are connected to the Standard EPC in each country – if the information asked in Enhanced EPC is not present in the Standard EPC, then there were difficulties to include these data in Enhanced EPCs. But this type of difficulty is not avoidable when any type of changes to the existing system are suggested. It also seems that these difficulties in developing the Enhanced EPCs can be tackled by introduction of guidance on filling in the Enhanced EPCs and the energy efficiency recommendations towards deep energy renovation.

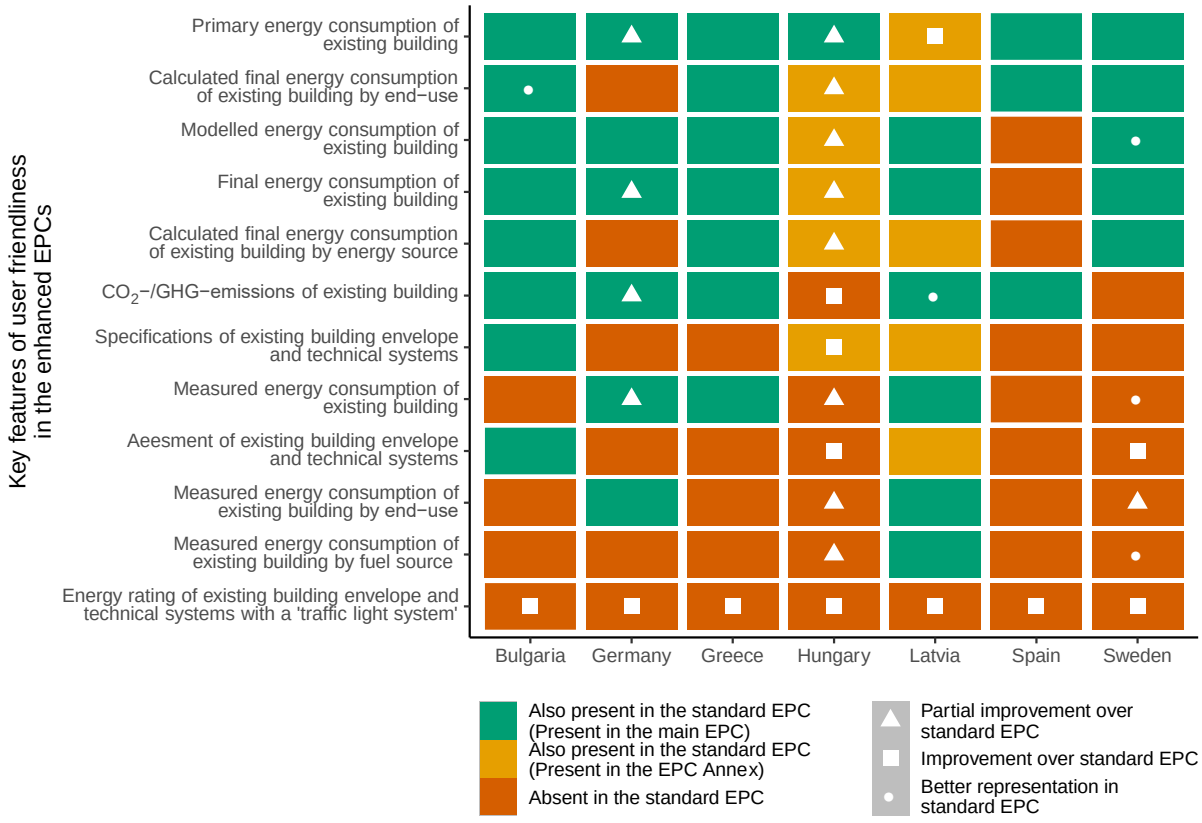
3 HIGH USER-FRIENDLINESS OF THE EPC: THE ENHANCED EPC TEMPLATE

3.1 Comparative analysis of the standard and enhanced EPCs for the pilot buildings

3.1.1 Consistency and completeness of information

Figure 5 shows consistency of information between enhanced and standard EPCs for the pilot buildings. It mainly covers pages 1 and 2 of the enhanced EPCs, along with features of pages 3 and 4 that are not discussed in the previous chapter.

It can be seen that most key features in the enhanced EPCs are already present in the standard EPCs of most countries, with a notable exception of Spain, and to an extent Sweden. However, in Hungary and Latvia, most of these features are presented in the Annex, rather than on the main EPC, where they are prominently visible. The QualDeEPC team considered that information on the renovation recommendations is more important than on the current energy status of the building. If a Member State has different legal requirements or thinks more information on the current energy status of the building is still important and necessary to inform building representatives and users, this can be added in one or more additional pages to the enhanced EPC.



Note: Markers on better representation in standard EPCs and perception of importance are summarised views of the QualDeEPC country partners, and views from stakeholders and building representatives obtained through workshops, interviews and questionnaiers

Figure 5: Comparison of key features of user friendliness between enhanced and standard EPCs

3.1.2 *Feedback from stakeholder roundtable discussion on completeness of information*

The following table shows the feedback form QualDeEPC country partners as presented in their national summary reports on the features of user friendliness in the enhanced EPCs.

QualDeEPC partner country	Completeness of information
Bulgaria	**Overall**: The enhanced EPC is seen as an improvement as it presents most of the information present in the standard EPC and has a potential for convergence between different QualDeEPC countries. **Improvements:** Key positive aspects include the design and colour scheme, additional space provided for description of recommendations, and the new field for description of combination of suggested recommendations. **Challenges**: The absence of the following standard EPC features from the enhanced EPC are considered as major challenge: • Distribution of annual energy consumption of existing building by end-use • RES share in the total energy consumption • Specification of Efficiency of technical systems • A single and comparative table presented comparison of specifications, energy performance of building components and systems before and after the implementation of recommendations
Germany	**Overall**: Generally positive impression of the enhanced EPC, e.g. “enhanced” EPC shows weakness of the building in more detail. **Improvements:** Information on the energy efficiency potential of the building is seen as an improvement. Also, the rating of the building components and renovation recommendations are advantageous. The different display of the energy classes is mostly neutral for residential buildings, since the boundaries are defined and visible in both EPCs. For non-residential buildings the “new” display proved more difficult, because of the missing energy classes and their defined boundaries in the German Building Energy Act. Due to the cross-country approach of the template, some details on the HVAC systems, renewable energy sources and the glossary are missing. The HVAC systems and renewable energy sources might, however, be described at the technical systems. **Challenges**: The missing information of CO_2-emissions, the missing reference scale, the fewer annotations and missing glossary, as well as the missing check marks for the achievement of certain aspects of the regulation requirements, and RES.
Greece	**Overall**: The respondents presented their preference for the Enhanced EPC in terms of the understandable language and figures and that the Enhanced EPC gives more information in a more comprehensive way. The separate assessments for the different envelope elements and systems, available in the Enhanced EPC is very useful and in a more user-friendly way. No additional work effort is required by the energy auditors in order to use it. **Improvements:** It is easy to understand if the minimal energy efficiency requirements of building set in the national legislation are met by the information provided on the proposed template mostly by the “traffic light systems”. **Challenges**: In the existing standard Greek EPC the indicator is in kWh/m^2 provided by the current calculation methodology. Shifting to kW/y would not be possible to have such data outputs of the national calculation tool. Furthermore, without providing the indicator (kWh/m^2), comparison of EPCs of buildings of the same use or for statistical analysis purposes would not be feasible. Therefore, we use the indicator kWh/m^2 in the enhanced EPC, together with the information on potential total kWh/y savings with the implementation of the Main Option (in the relevant box of the enhanced EPC form).

	The information on calculated energy consumption by end use is missing in the enhanced EPC. In the energy consumption table of the enhanced EPC, the contribution (%) of energy sources to the building energy balance -which was provided in the standard Greek EPC- is missing. It looks non-feasible to add more columns in the energy consumption table as it is formatted in the proposed template. Some of the missing information has already been transferred to the enhanced form, such as CO_2 emissions, consumption comparison to reference building and comfort conditions. In the 'Renovation recommendations - component evaluation' of page 3, there is less information in the enhanced EPC than in the existing Greek Standard EPC - The only useful additional feature in the enhanced EPC is the technical characteristics of the various components (U values of envelope components and power provided by the recommended technical system). The EU energy label for the technical systems is not considered a technical data but rather a qualitative data. At the same time, the economics of the recommendation/s are limited to payback time, while in the existing standard EPC the information provided is of higher level of analysis.
Hungary	**Overall**: There is a significant improvement in presenting the information in the EPC in an understandable language, tables and figures. Also, the energy efficiency potential of the building is clearly shown. The units of measurements are not widely understood, the future energy costs are not well showcased and the recommendations are not encouraging to the respondents to perform deep energy renovation. **Improvements**: • Presentation and colour scheme • New information added (year of construction, additional specification) • Assessment of building envelope and technical systems by energy rating helps a non-expert user to better understand the efficiency of their building elements • Cost effectiveness can be useful for end user, especially when calculated accurately • Energy class names in standard EPC are removed as they were misleading and for lowest classes derogatory **Challenges**: • Enhanced EPC requires additional expert hours and entails additional costs to the sellers as most of the EPCs are produced during sale of the building • Both standard and enhanced EPCs do not compare the building to other buildings, as end users are not aware of the average consumption levels of similar buildings • Few key indicators are missing • Presenting the measured energy consumption can be misleading/confusing for the end-users, when it is significantly different from the calculated values • The table for the presenting measured values is confusing, as different energy carriers are mixed and final energies are summed up, which is misleading. • Cost-effectiveness should be properly calculated, also considering both the price of the fuel and the installation material and labour cost, as the values presented using poor methodology can be misleading
Latvia	**Overall**: **Improvements**: • Energy rating system introduced for building envelope elements and technical systems of building helps a non-expert user to better understand the values given in the EPC • The Enhanced EPC form contains links with further information, which helps non-expert user to find further information on EPCs and how to carry on with renovation of their building **Challenges**:

	• The enhanced EPC provides less information. However, merging the enhanced EPC to standard EPC, while retaining the mandatory annexes from Standard EPC, can help the EPC to benefit from exemplar features from both EPCs.
Spain	**Overall**: The changes in the enhanced EPC are perceived as improvement over the standard EPC. The Enhanced EPC has additional data such as the energy consumption data of the building and the energy rating of the building envelope elements and technical systems. **Improvements**: • The traffic light indicator has been the most acclaimed change. It facilitates the understanding of the certifications and the quality or efficiency of the different systems for end consumers. • The potential final energy savings and the improved value for final energy consumption, which both have been recognized as great indicators for end consumers. • The Enhanced EPC contains links with further information if needed, which is quite useful for non-experts, and also a short description of further renovation options. • It can be seen whether the building meets minimum energy performance standards as set by the national legislation **Challenges**: • The elimination of the CO_2 emissions classification and indicator • Enhanced EPC provided only one combination of recommendations measures as 'main option', whereas standard EPC provides more than one combination of recommendations
Sweden	**Overall**: Key changes in the enhanced EPC, such as the energy saving potential of the building are seen as improvements, while the missing elements from standard EPC are seen as a drawback **Improvements**: • A picture of the building is included in the first page • Summary of potential energy savings, if suggested recommendations are implemented • Energy rating system for building envelope elements and technical systems of building **Challenges**: • Information of radon is missing, as buildings with radon-problem require high ventilation rate. • Ventilation airflow rate and control is missing. In Sweden, this is needed for determining the energy performance requirement for a new building, and thus also the resulting energy class. • Mandatory inspection of ventilation and heating system respectively is missing. In Sweden, this requirement in the EPBD directive is implemented within the EPC. • No part with measures carried out since the last EPC. • No reference value for comparison to "similar buildings". • Terminology difficult to understand, e.g., difference between primary energy demand, specific energy demand • Some of the stakeholders think that the classification scale is difficult to interpret • Indicating a new potential energy class might be associated with some difficulties, e.g., changes of energy class limits over time and uncertainties regarding savings. • Several of the building representatives find it discouraging that they probably won't be able to reach higher than C or D, also with major renovation. Also, it is confusing that energy class D or E could be rather good for an existing building, since it sounds quite bad (far from A). • It would be useful if it were made clear if presented values were based on estimations, measurements or standard values. • Potential energy savings might have the opposite effect that the building representatives thinks that potential savings are limited to the value stated in the report, especially when the recommendations are unambitious and not up to their full potential.

Table 6: Differences in user-friendliness in enhanced EPCs between various building types

Overall
• Enhanced EPC has been considered as an improvement over the standard EPCs in the way it presents key information about the building energy performance.
Improvements
• Energy rating of existing building envelope and technical systems with a 'traffic light system'.
Challenges
• Fraction of energy from renewable energy sources is not clearly identified. • Energy consumption of the building by end-use and fuel source is not clearly identified. • Features in the standard EPC that are country specific and are not present in the enhanced EPC. These missing features in the enhanced EPC are perceived as important because of their familiarity or requirements of national legislation. E.g., the standard EPC in Sweden presents information on radon and ventilation rate.

3.2 Feedback from building representatives

The user friendliness of Standard EPC and Enhanced EPC was quantified based on feedback from questionnaires filled in by building representatives. The results were quantified by giving values to the possible answer options in questionnaires. The questionnaires contained 5 possible answers for each of the 17 questions. The possible answers to questions and the values given to each of the answers were:

- Agree – 100%;
- Somewhat agree – 75%;
- Neutral – 50%;
- Somewhat disagree – 25%;
- Disagree – 0%.

The questions were formed in such way that this type of answer value is possible for each of the 17 questions. The 17 questions in the questionnaire were asked about Standard EPC and Enhanced EPC. To get a score in a particular question all answers from questionnaires were summarized and the average value of a particular question was calculated.

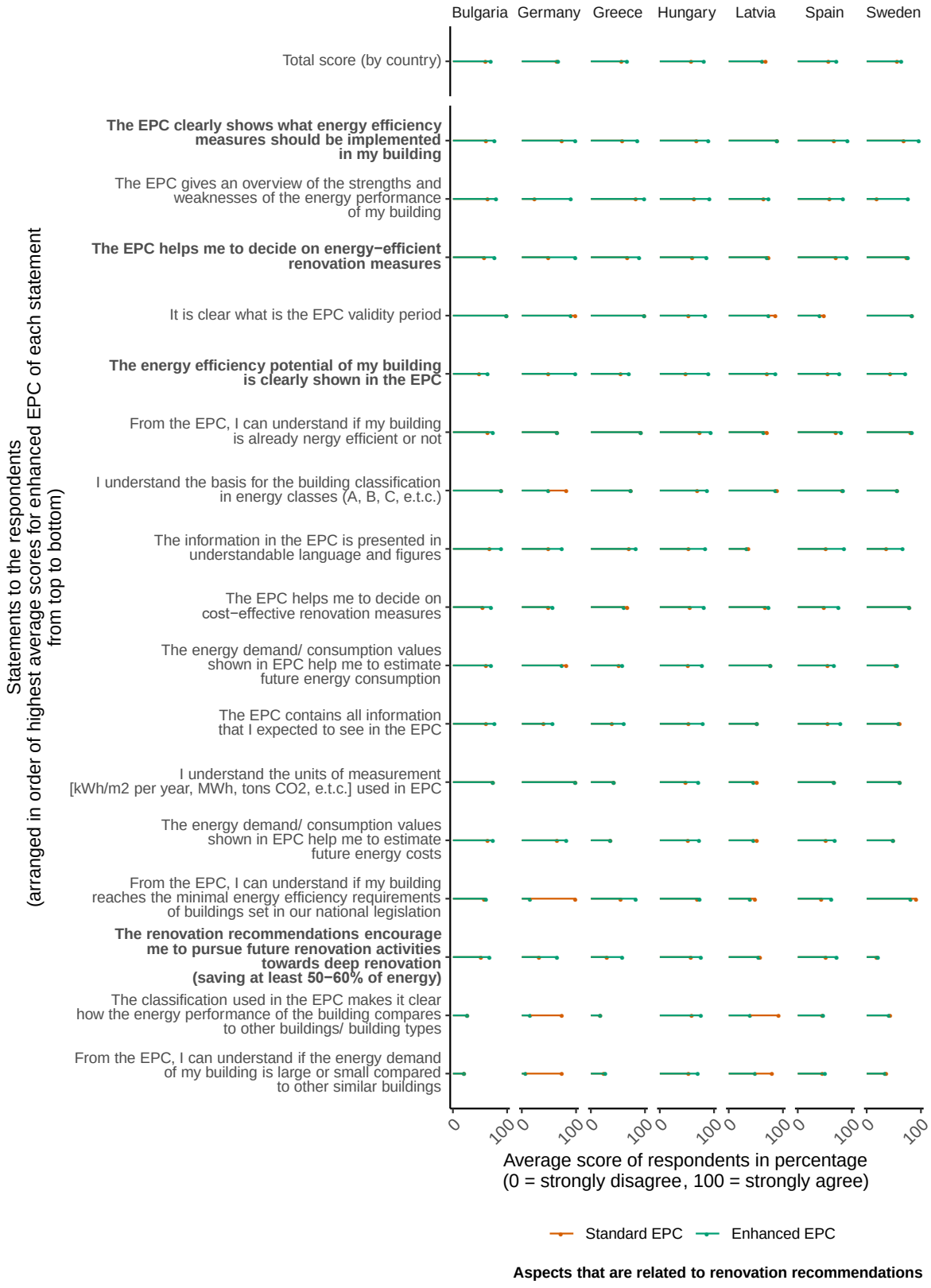


Figure 6: Feedback from the building representatives on user friendliness

The enhanced EPC scored high (and higher than the standard EPC) in all countries for most of the statements related to renovation and renovation recommendations. For example, clearly shows what energy efficiency measures should be implemented, helps in decision making to actually implement these measures by showing the full potential (energy saving potential) of these measures.

However, an exception is Latvia, which had a very good presentation before. In Germany and Latvia, standard EPC has additional scale of comparison to other buildings, but enhanced EPC does not, so enhanced EPC scores worse for the two questions relating those questions, e.g., the last two questions in the above figure.

4 ONLINE TOOL FOR RECEIVING FIRST DEEP ENERGY RENOVATION RECOMMENDATIONS

4.1 Feedback from building representatives

The following figure shows the feedback from building representatives to the structured questionnaire regarding a simple online calculation tool that can be used for estimating the potential energy efficiency measures and savings in buildings, and the information contained in such a tool. This has been developed and proposed as another priority by QualDeEPC. Building representatives could use such a tool to better inform themselves prior to consulting an energy consultant or an EPC issuer. The question to the building representatives was: "Would you like to receive the following information from such a tool?" and the responses were recorded as 'yes' or 'not interested'.

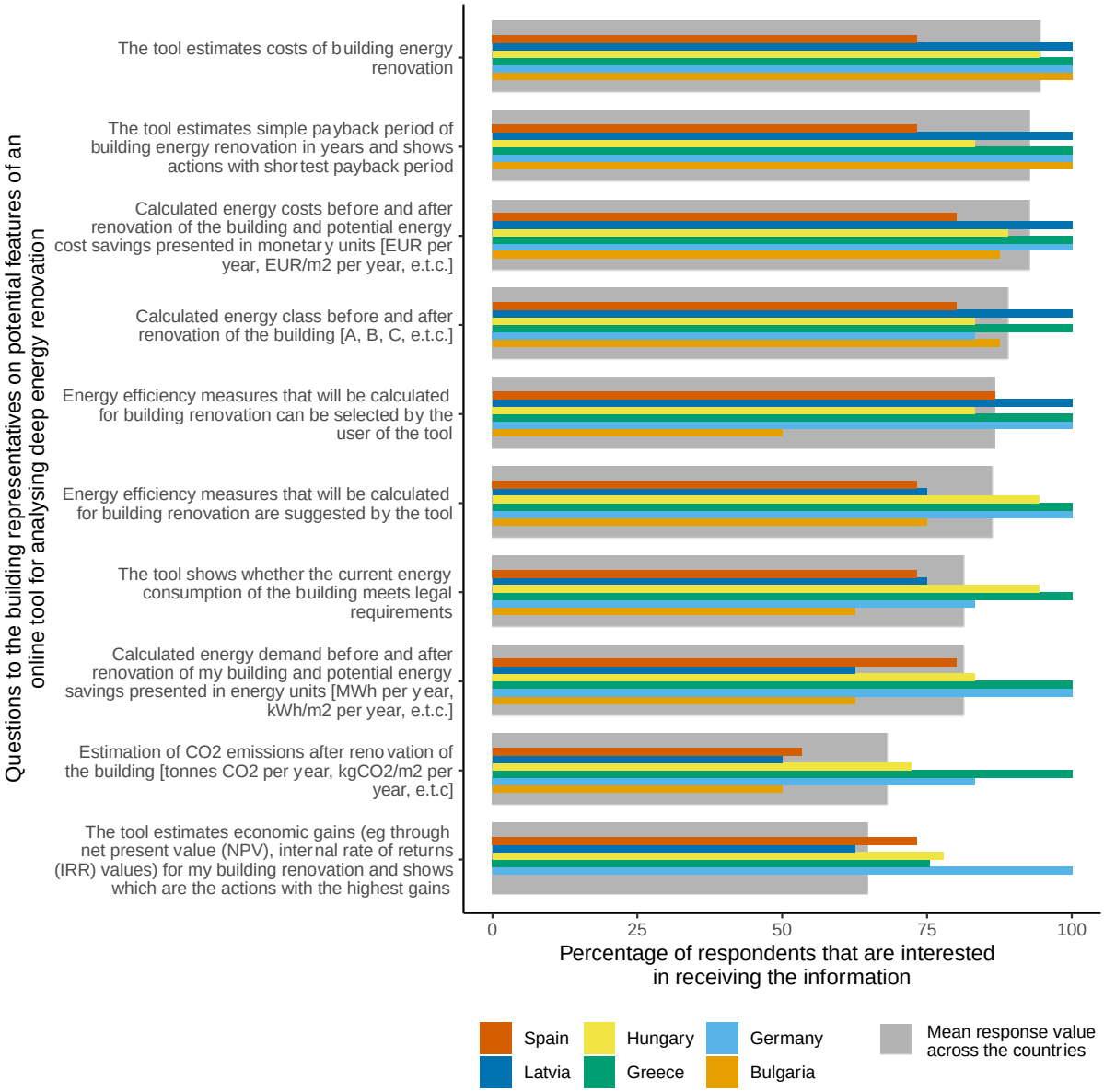


Figure 7: Feedback from building representatives on potential features of an online tool for analysing deep energy renovation. Note: Responses from Sweden are only in the form of descriptive feedback and the filled in questionnaires are unavailable.

It can be seen from the above figure that most questions received an average interest of above 75%. Across countries, building representatives are interested in understanding total costs for renovation, simple payback period, and energy cost savings and improvement in energy class when renovation recommendations are implemented. Comparatively, CO_2 emissions savings and economic gains (if expressed in the metrics net present value or internal rate of return, which are more accurate but less understood by most people than simple payback period) received the lowest interest.

5 DEEP RENOVATION NETWORK PLATFORMS

5.1 Feedback from building representatives

The following figure shows the feedback from building representatives to the structured questionnaire on which aspects of the comprehensive website (Deep Renovation Network Platform) proposed by QualDeEPC and containing all information on EPCs, building renovation and all other relevant information on building energy efficiency would be interesting to them. The question asked to the building representatives was whether they would use a type of information or not. Most questions received an average response ("I would use it") of above 75%. For building representatives, finding general information on costs of and financing opportunities for renovation for deep renovation, building components, building services, renewable energy, potential energy and cost savings; and a platform for finding and receiving offers/quotes from energy efficient experts, contractors, technicians, and vendors to implement recommendations appeared to be most interesting features; while linking EPCs and deep renovation passports with such a platform did not generate much interest; for the latter, we do not know how many of the respondents are familiar with this relatively new concept.

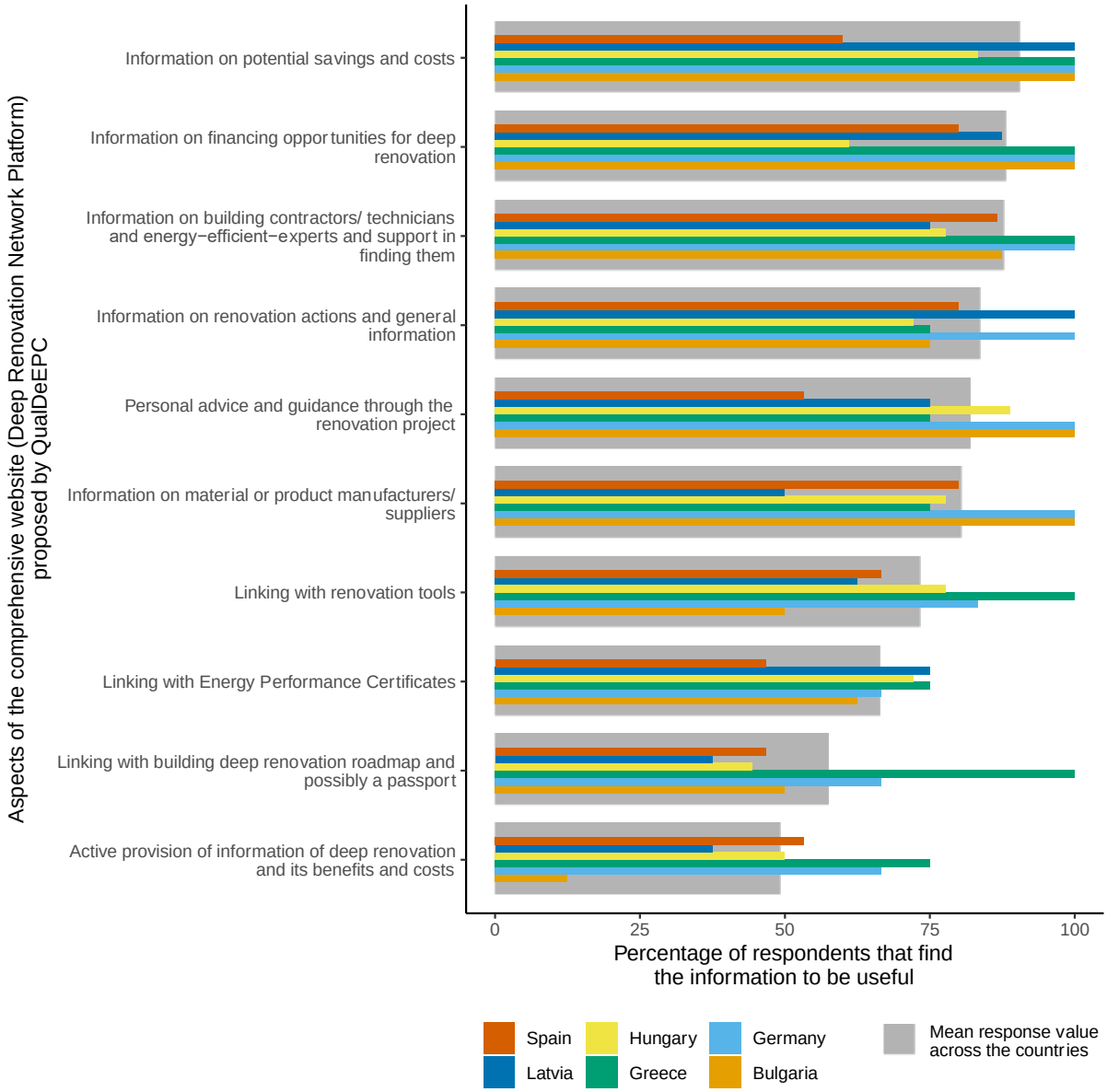


Figure 8: Feedback from building representatives on potential features of a deep renovation network platform. Note: Responses from Sweden are only in the form of descriptive feedback and the filled in questionnaires are unavailable.

6 VOLUNTARY/MANDATORY ADVERTISING GUIDELINES FOR EPCS

6.1 Feedback from building representatives

As per EPBD, it is mandatory to show the energy class and energy data from the building's EPC in advertisements when selling or offering for renting a building. However, anecdotal evidence suggests that often compliance with this regulation may be low. QualDeEPC has, therefore, proposed that Member States offer advertisement guidelines to ease compliance with this requirement, following the example e.g. of Sweden. A question regarding this proposal was also included in the questionnaire to building representatives in six of the seven EU Member States represented in the QualDeEPC project, but not in Sweden, since such guidelines already exist in Sweden.

The following figure shows the feedback from building representatives to the structured questionnaire aspects that would be useful in such guidelines and to comply with this regulation. The first question was, whether building representatives are familiar with the legal requirement to show the energy class/data in the advertisements. Most of the respondents mentioned that they are not familiar with the voluntary/mandatory guidelines for advertising EPC information in sale/rental advertisements. Then, a number of features were presented under the general question: "Which guidance would be useful for you to comply with this regulation when selling/letting a building?", with the options to select either "It would be useful for me" or "I don't need it" as the reply. Among the aspects that received interest are ways to find out the current energy demand/consumption and energy costs of the building, energy class and date of issue of the EPC.

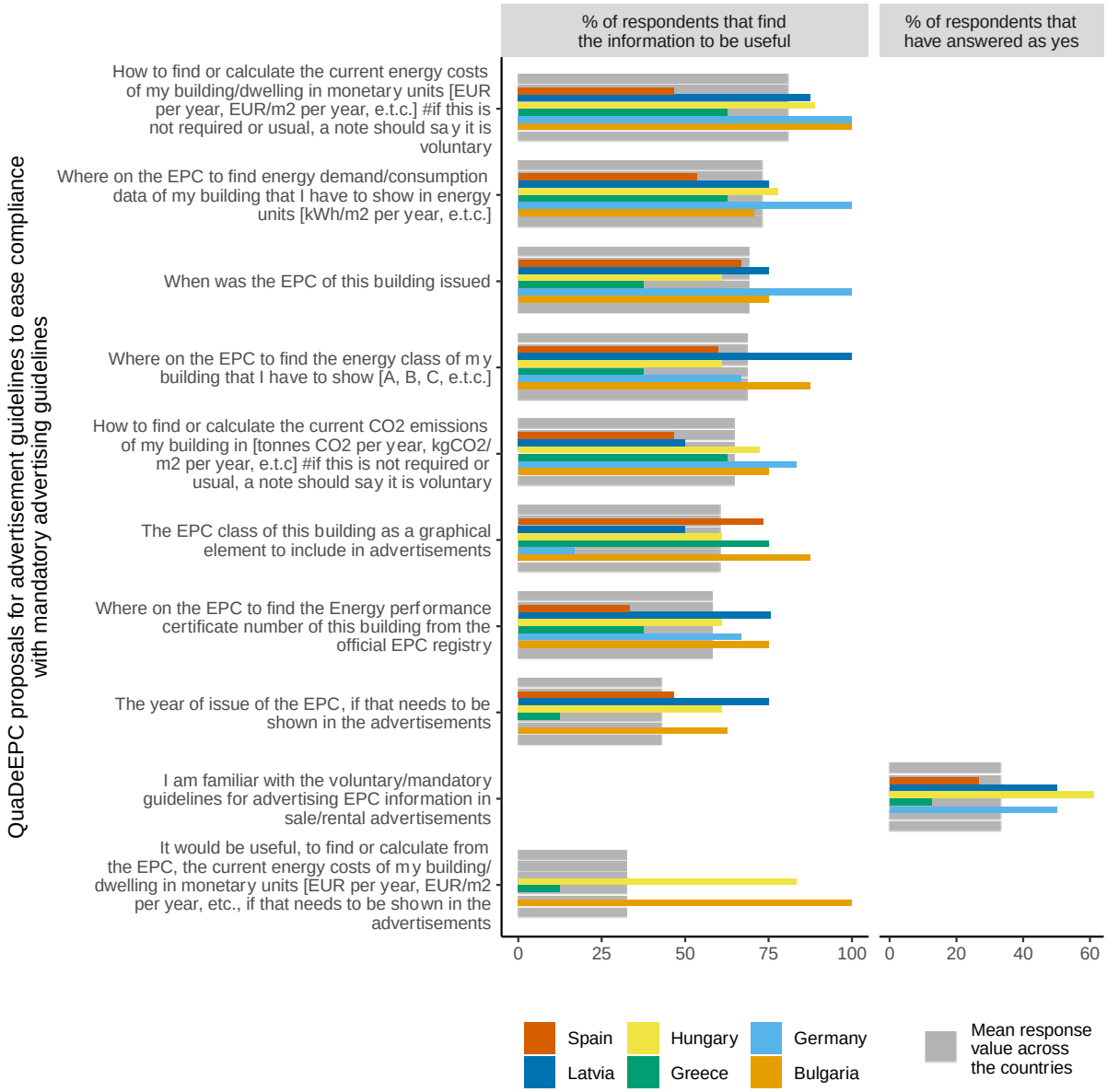


Figure 9: Feedback from building representatives on potential content of voluntary/mandatory advertising guidelines for EPCs

7 CONCLUSIONS

In general, various aspects of Energy performance certificates (EPCs) differ between various Member States. However, there exists a high potential for convergence of EPCs between them. Evidence from testing the enhanced EPC scheme developed by QualDeEPC clearly shows that improved renovation recommendations and their presentation on the EPCs in a user-friendly manner is an important first step towards deep energy renovation.

Some of the improvements proposed by QualDeEPC for recommendations for renovation on the EPCs are already present in some QualDeEPC partner countries and in the partner countries where these features are not present, most of these features are perceived as improvement over the standard EPC. Key similarities for presenting the recommendations in the standard EPCs include presenting the individual recommendations for various building components and technical systems, their cost effectiveness and technical specifications and improvement in energy class if they are implemented. In countries that do not require a detailed energy audit for preparing the EPCs, there is a higher potential for improvement in the quality and number of recommendations and consequently, higher potential for energy savings.

In terms of user-friendliness, at least half of the proposed features in the enhanced EPCs are present in most QualDeEPC partner countries. The enhanced EPC has been considered as an improvement over the standard EPCs in the way it presents key information about the building energy performance. The energy rating of the existing building envelope and technical systems with a 'traffic light system' was perceived as a key improvement. Key challenges include unclear identification of renewable energy fraction, energy consumption by end-use and fuel source, and other country specific requirements. Most of these challenged could be overcome through national adaptation.

Overall, the online tool received wide acceptance from the stakeholders. On national level, these platforms should be operated by the energy agencies, which will give the possibility to consult them not only online, but also physically and receive the required support from them. The cost related information is perceived too unreliable due to the dynamically fluctuating market environment. However, this could be overcome by annually updating the cost database. Instead of a standalone online tool, few participants proposed that this should be part of the DRNPs (see point C.).

Furthermore, the concepts and tools developed by QualDeEPC are considered improvements and highly welcomed by representatives of pilot buildings and stakeholders: enhancing the user-friendliness of the EPC (template), providing essential information (online tool, DRNP), and guidance for complying with the legal requirements for real estate advertisements (advertising guidelines). Enhanced EPCs and the energy efficiency recommendations included in these EPCs showed that there is almost 50% of energy savings potential in the evaluated buildings. This is an important step towards deep energy renovation and Building Renovation Passports. The whole process of WP4 showed that there is the need for detailed guidance to EPC assessors on how to fill in the Enhanced EPC template and particularly how to deal with the renovation recommendations, to ensure comparability and quality of all data, and ambition of the renovation recommendations.