Next-generation energy performance certificates and deep energy renovation

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Abstract

An important instrument to enhance the market uptake of energy-efficient new buildings and the energy-efficient renovation of existing buildings in the European Union (EU) are the Energy Performance Certificates (EPC). However, their implementation and use has varied between EU Member States. The European Commission has therefore provided funding to a number of Horizon2020 projects to develop next-generation EPC schemes.

One of these is the QualDeEPC project, aiming to both improve quality and cross-EU convergence of EPC schemes, and particularly the link between EPCs and deep renovation. The objective of the project is to improve the practical implementation of the assessment, issuance, design, and use of EPCs as well as their renovation recommendations, in the participating countries and beyond.

This paper presents the policy proposals and concepts for tools that the QualDeEPC project has developed as priorities for enhanced EPC schemes:

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

The paper will focus on the aspects related to improving the impact of EPCs for stimulating deep renovation. It will also present lessons learnt from the discussion with stakeholders at national and European workshops and from the testing of the proposals and tools in around 100 buildings, as well as from the first steps of their country-specific adaptation.

Introduction

Considering that 40 % of the European Union's energy consumption can be traced back to its buildings (European Commission 2020), it is essential to improve their energy efficiency in order to achieve the EU's energy efficiency targets. Both the rate of energy renovation and its depth, i.e. the amount of energy savings during a renovation, need to be improved.

An important instrument to enhance the market uptake of energy-efficient new buildings and the energy-efficient renovation of existing buildings in the European Union (EU) are the Energy Performance Certificates (EPC), required by the Energy Performance of Buildings Directive (EPBD). However, their implementation and use has varied between EU Member States. There are several challenges to overcome in order to in-

crease market confidence and stimulate investments in energy-efficient buildings, such as enhanced reliability, quality of the renovation recommendations that are to be provided on EPCs, cost-effectiveness, and compliance with relevant EU standards and the EPBD. The European Commission has therefore provided funding to a number of Horizon2020 projects to develop next-generation EPC schemes.

One of these is the QualDeEPC project, aiming to both improve quality and cross-EU convergence of EPC schemes, and particularly the link between EPCs and deep renovation. The objective of the project is to improve the practical implementation of the assessment, issuance, design, and use of EPCs as well as their renovation recommendations, in the participating countries and beyond.

The QualDeEPC project is being implemented with eleven partners from eight different European countries over a period of three years, from September 2019 to August 2022. In order to reach the objectives, the project is organising its activities in four stages:

1. Analysis of existing EPC schemes, good practices, shortcomings, and priorities for improvement.
2. Development and testing of concrete proposals and tools for enhanced EPC assessment, certification and verification, as well as Deep Renovation Network Platforms.
3. Adaptation to country needs and implementation of consensus elements, as well as developing a roadmap for further dialogue, and.
4. Development of a sustainability strategy and conclusive policy recommendations for regional, national, and transnational dialogue, and transfer of the concepts and tools to other EU Member States and regions.

In the first stage, the project analysed the EPC schemes in all EU Member States and the UK, with regard to almost 50 existing or potential features ('elements') for an enhanced next-generation EPC scheme (Gokarakonda et al. 2020a), what is good practice (Kostova et al. 2020a), and what are short-comings and national priority approaches to their resolution (Gokarakonda et al. 2020b). The latter were discussed in the first of four rounds of workshops in the seven Member States, for which the project will adapt and, to the extent possible, implement improvements to their EPC schemes: Bulgaria, Germany, Greece, Hungary, Latvia, Spain, and Sweden. A longlist of around 20 potential improvements were also discussed in these workshops.

Based on the discussion in the workshop and further analysis, QualDeEPC chose the following seven priorities for enhanced EPC schemes as the focus of its further work (Kostova et al. 2020b):

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

For these priorities, the QualDeEPC project by now has developed policy proposals and concepts for tools (Veselá et al. 2020). They were discussed in the second round of national workshops and an EU workshop, and some of them were tested in almost 100 pilot buildings. The final policy proposals and concepts will be presented in the project's *White Paper on good practice in EPC assessment, certification, and use* (scheduled for end of June 2021).

In the next sections, this paper presents the four out of seven policy proposals and concepts for tools that focus on the aspects related to improving the impact of EPCs for stimulating deep renovation: enhanced renovation recommendations; the online tool; the Deep Renovation Network Platforms; and a more user-friendly template for the EPCs. For each of them, it also presents lessons learnt from the discussion with stakeholders at the national and European workshops. First findings from the testing of the enhanced renovation recommendations and the more user-friendly EPC template in around 100 buildings are also provided. A section with some general discussions, conclusions and an outlook to the future stages 3 and 4 of the project concludes the paper.

Enhancing the recommendations for renovation, which are provided on the EPCs, towards deep energy renovation

Currently, the renovation recommendations in EPCs in most European countries are oriented towards the minimum legal requirements and are often low-cost options, but not necessarily the most cost-effective ones. In this project, we aim to improve the renovation recommendations to be compatible with deep energy renovation and to be a first step towards a building deep renovation roadmap. The proposed options and efficiency levels are oriented towards QualDeEPC's proposal for defining deep energy renovation. This is based on national definitions and standards for Nearly-Zero Energy Buildings (nZEBs), either for renovations where such standards exist, or for new buildings (Veselá et al. 2020). The definition repeatedly proposed by the European Commission of saving 60 % was found to not be universally applicable in the project's partner countries, while standards for nZEBs should be defined everywhere by now in accordance with the EPBD and should be based on cost optimality of the insulation levels and systems. However, this approach, too, faces large variations in the ambitions set and details for nZEBs in the EU member states. Hence, QualDeEPC proposes four strategies to cover various cases, in which the nZEB definition is 1) already provided for existing buildings, 2) only provided for new buildings but achievable by existing buildings, 3) only provided for new buildings and most likely not achievable by existing buildings, and 4) very lax or still not defined.

We can conclude that there is an important need to create guidance on (1) which renovation actions should usually be recommended on EPCs, and (2) what should then be their energy efficiency or rating levels, so that the renovations will be consistent with 'deep energy renovation', even when implemented step by step according to an individual renovation roadmap. The project team, therefore, developed a proposal for such a set of renovation recommendations, based on our definition of 'deep energy renovation'.

Table 1 summarizes the proposed deep energy renovation recommendations. Since the specific values differ by country and climate zone, it was decided to first use text-based recommendations and provide country-specific values later. As an example, country-specific values are shown for Germany in the rightmost column of Table 1.

In most cases of added insulation, two categories for deep energy renovation options are proposed. Firstly, "enhanced" insulation, which should be at least as or even more energy-efficient than the legal standard in case of major renovation. Secondly, "exceptional" insulation, which might also be described as the "best energy-efficient option available". The latter might be just economically feasible or may require funding to be economically feasible. Hence, this approach might be at the upper limit of what is defined as "cost optimal" in the EPBD.

In more and more countries, the use of shading is becoming or has become important to reduce the cooling load during summer. Here, the most efficient option is to add shading externally, e.g. Venetian blinds or overhangs. Another option is the use of vegetation for shading.

If natural ventilation is not sufficient, mechanical ventilation systems will help to supply the needed air exchange efficiently. For deep energy renovation, it is proposed to either use an exhaust fan system with an exceptionally low need for electrical power or a ventilation system with at least 80 or 90 % heat recovery and very low or low electrical power consumption of the fans, respectively.

For the heating, cooling, and domestic hot water (DHW) systems, a large variety of options is available on the market. Moreover, the specific choice depends on the system that was already installed and environmental conditions (i.e. climate zone). Hence, it was difficult to list the best options for deep energy renovation. However, for all of these technical systems, an EU energy label is available. Thus, a category A or above of this label is suggested for deep energy renovation.

For some partner countries, the lighting is also evaluated in residential buildings. Light-emitting diode (LED) lighting and the installation of dimmers are chosen as deep energy renovation options.

Some renovation recommendations rely on or are a consequence of other recommendations. The options "reducing thermal bridging" and "air tightness" rely mainly on the external wall, roof and ground floor insulation as well as on the window replacement. The integration of renewable energy sources, as well as the insulation of pipes, might already be covered by installing or replacing heating, ventilation, and air conditioning (HVAC) systems. Nevertheless, these elements should be listed as criteria for deep energy renovation, since also stand-alone options are available.

Even though the recommendations should be generally applicable in all partner countries and climate zones, there may be the need for specific adaptation. For example, in most partner countries, lighting is not relevant to residential buildings. This will be evaluated further for country-specific purposes in stage 3 of the project.

FEEDBACK FROM STAKEHOLDER WORKSHOPS AND FIELD TESTS

Stakeholder Workshops

The feedback on the general, text-based description of the deep energy renovation recommendation was mostly positive. However, for detailed U-values, which have to be defined nationally, the feedback was diverse. For example, in Sweden, some of the recommendations were received as very ambitious for existing buildings, whereas in Germany most stakeholders agreed that they could be more ambitious. Moreover, the answers in the questionnaire showed that the "exceptionally efficient" renovation options can mostly not be implemented in a cost-effective way without funding programs.

As a consequence of the feedback from the stakeholders, some changes to the Green paper were suggested. A policy proposal or guiding statement on the cost-effectiveness of "exceptionally efficient" renovation measures should be included in chapter 3.2 of the White paper. This statement may include that "exceptionally efficient" measures might not be the most cost-effective measure, but might be combined with other measures or subsidised by funding programs. In addition, the project team will reconsider the wording "enhanced" and "exceptional". Better words may be needed for a standard meeting the current legal nZEB standard or slightly better, and another standard exceeding nZEB requirements, which may usually only be cost-effective with financial support. However, since the nZEB definitions vary across EU member states, the specific, national definitions will be developed in the coming work of QualDeEPC. Furthermore, where appropriate, it should be stated that the recommended U-values or equipment standards are usually applicable when a renovation (e.g. roofs, walls) or replacement (e.g. windows, heating systems) is needed or implemented, and that the EPC issuer should make that clear, unless it would be cost-effective to renovate or replace the component right away.

Field Tests

During the first field testing of enhanced recommendations for renovation towards deep energy renovation, it turned out that for a number of countries and building types, reaching a nZEB or deep energy renovation status in buildings will not be economically feasible based on the full renovation cost and energy cost savings alone. The simple payback periods in some cases far exceed the expected building renovation measure life expectancy (20 to 30 years). This means that it will be cheaper for the building or dwelling owner to do nothing and pay more for energy than to renovate the building and then pay less for energy, unless there will be financial support for the investment and/or the energy renovation is coupled to a major renovation scheduled anyway. In the latter case, only the incremental cost of the energy renovation must be counted as energy efficiency investment. It seems that this is a problem in several participating countries, particularly those with low heating energy prices. At the moment, there is also a lack of clear methodology which allows to analyse

Table 1. Deep energy renovation recommendations by QualDeEPC.

	Specific recommendation	Example value (Germany)
External wall insulation	Wall with enhanced thermal insulation properties (nZEB for renovation standard or similar)	U=0.2 W/(m²K) [funding program]
	Wall with exceptional thermal insulation properties (nZEB for new buildings standard or similar)	U=0.15 W/(m²K) [quality requirement passive house]
Roof insulation	Roof with enhanced insulation	U=0.2 W/(m²K) [Reference building]
	Roof with exceptional thermal insulation properties	U=0.14 W/(m²K) [funding program]
Insulation of ceiling of an unheated basement/ ground floor	Floor connected to the unheated basement or ground floor with reinforced insulation	U=0.25 W/(m²K) [funding program]
Window replacement	Window with enhanced insulation properties: e.g. low-e glazing	U_W=1.3 W/(m²K) (g=0.6) [new building}
	Window with exceptional insulation properties, e.g. triple glazed	U_W=0.95 W/(m²K) (g=0.6) [funding program]
Door replacement	Door with enhanced insulation properties	U = 1.8 W/(m²K) [new building]
	Door with exceptional insulation properties	U=1.3 W/(m²K) [funding program]
Replacement/ Installation of shading	External blinds (Venetian, shutters or awning)	
	Fixed horizontal/vertical shading devices, e.g. overhangs	
Replacement/ installation of the mechanical ventilation system	Ventilation system (no heat recovery) with an exceptionally low electrical power requirement	P_{el}<0.2W/(m³/h)
	Ventilation system with heat recovery of min. 80% and very low electrical power consumption	η>80%, P_{el}<0.45W/(m³/h)
	Ventilation system with heat recovery of min. 90% and low electrical power consumption	
Replacement/ modernization of the heating system	Heating system with EU energy label Cat. A or above	
Replacement/ modernization of the cooling system	Cooling system with EU energy label Cat. A or above	
Replacement/ modernization of the DHW system	DHW system with EU energy label Cat. A or above	
Integration of renewable energy sources	Significant extent of energy demand/ consumption should be covered by renewable energy sources; *alternatively*, exceptional thermal insulation	
	photovoltaic system (including for self-use)	
Lighting	LED	
	Dimmers	
Reduction of thermal bridging	Reduced thermal bridging for non-structural building elements, e.g. balconies, terraces, dormers, and fixed shading devices	
Increased air tightness	Air exchange rate of 1.5 h^{-1} or lower at 50 Pa pressure difference OR Air tightness according to new building standard	n_{50}≤1.5h^{-1}
Others	Insulation of all pipes	
	Building automation system	
	Replacement of circulation pumps	
	Hydraulic balance optimisation for water-based heating systems	

Note on example values for Germany: these values might be either based on new building standards (remarks [Reference building] or [new building]) or, often for the more ambitious 'exceptional' option, on the requirements set by the federal building funding program (Bundesförderung für energieeffiziente Gebäude – BEG) as of 2021 (remarks [funding program]). A similar approach might be possible for other EU member states.

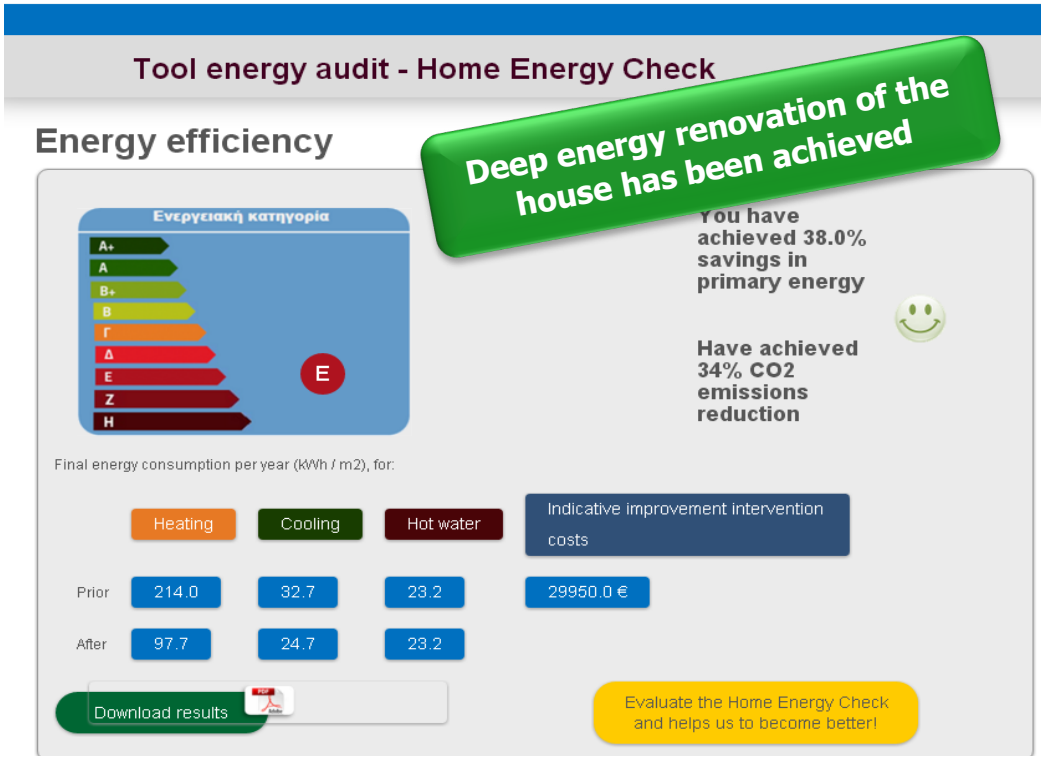


Figure 1. Comparison of results from the online tool.

and quantify other benefits from building renovation (such as an increase in building real estate price, visual improvements in buildings, increased lifespan of a building and its components, etc.). If such a methodology is not developed and no financial support provided, the existing approach of only showing energy savings and simple payback times may lead to extremely slow building renovation rates.

Online tool for comparing EPC recommendations to deep energy renovation recommendations

The Master[1] tool developed for QualDeEPC is the general version of a broad user-friendly platform for users, who want to be informed about the energy demand, rating and CO_2 emissions of their residential building. It is easy to use, allowing homeowners to simulate their dwellings, through the input of their building's necessary characteristics (typology – selecting one of 10 building types, geographical area, floor area, characteristics of building shell and heating/ cooling systems, etc.) in only 13 steps. In addition, the user can receive recommendations for improving the energy efficiency of their home to high levels (equivalent to deep energy renovation) for the walls, roof, floor, windows, shading, heating, cooling, DHW, and RES, and see the results and the indicative cost of the potential renovation activities. These recommendations could be compared to those of an EPC, or be used to prepare a discussion with an energy consultant or EPC issuer. The tool will clearly state that its results are only indicative and will recommend to obtain an energy audit.

In the end, the results from the comparison between the current and energy-improved case are given. Additionally, the new energy class of the house is given together with the achieved energy conservation (in %), the CO_2 emissions reduction (in %) and an estimate of the cost for the improvement measures tested (Figure 1).

From the moment the input data are completed, an .xlm file is produced and run by the software for the energy efficiency of buildings. The software is used again to test the selected energy improvements and all results are shown in the last screen of the tool (Figure 1). An extra message states if deep energy renovation criteria have been met when implementing the selected energy improvements.

FEEDBACK FROM STAKEHOLDER WORKSHOPS

In general, the design and content of the tool in principle was mostly accepted in the partner countries. However, in most countries, stakeholders emphasized that this tool should be regarded as a first step for building renovation, and that this fact should be pointed out to the users. Hence, it should be made clear that such an online tool is useful to homeowners to see the potential in renovating their buildings, and then to contact a professional to provide in detail renovation suggestions and steps with a specific cost analysis. Any guidance that the project or others may develop for the enhanced EPC template on combining recommendations into a step-by-step renovation roadmap could also be implemented in the tool, if technically possible.

1.The master tool is based on the Greek Home Energy Check tool – http://www.cres.gr/energyhubforall/HEC.html.

Creating Deep Renovation Network Platforms

OBJECTIVES FOR DEVELOPING CONCEPTS FOR DEEP RENOVATION NETWORK PLATFORMS

Deep Renovation Network Platforms would serve as a tool to building owners and all actors in the market for deep energy renovation. They include the emerging concepts of one-stop-shops (OSS) for deep energy renovation, the task of which is to relieve the customer of research, design, or bureaucratic processes. In extended cases, the One-Stop-Shop may coach the investor through the renovation process, or perform the implementation on behalf of the customer, or even provide the financing. In the Deep Renovation Network Platforms, the OSS will be linked to EPCs, including all necessary information to building owners and active marketing of deep renovation and EPCs. In addition to OSS, the Deep Renovation Network Platforms would coordinate supply-side actors and support their marketing, training, and quality.

The concepts for Deep Renovation Network Platforms developed by QualDeEPC can be adapted to the circumstances in a project partner's country and the partner's possibilities. Two versions were developed – a basic and an extended one, defined by the type of services offered. They could be organised as a nation-wide online platform or a local/regional physical hub, depending on the version and the services offered.

DEEP RENOVATION NETWORK PLATFORMS: VERSIONS AND SUBTYPES

Basic platform

The basic platform will be a web platform that provides a one-stop-shop including all relevant information. This will also either include an adaptation of the online tool presented above or of similar existing tools, which will offer our improved recommendations for residential buildings matching nZEB standards, as a tool for EPC assessors, building owners, and potential buyers and tenants. If such a tool already exists in a country, it will be checked whether it can be extended to the full functionality that is required for the basic platform.

The basic platform consists of seven services/products shown and described in Table 2. All services will be offered by the provider of the platform itself, but probably often in co-operation with partners, particularly for the last four services or an existing tool. The services 1 to 5 address building owners, prospective buyers or tenants, citizens, public authorities and possibly EPC assessors; service 4 also addresses building contractors/technicians/installers. Services 6 and 7, in addition, would involve building contractors/technicians/installers, city/municipality, local housing companies, social credit agencies, professional buildings managers and developers, and architects.

Extended platform

The operators of a Deep Renovation Network Platform could further enhance the basic platform to appropriate further services listed in Table 3, depending on the current national situation, country needs, and available resources. To the extent that partners can't implement services in the course of the QualDeEPC project, this extended concept can be understood as a policy proposal, as outlined below.

QualDeEPC policy recommendations

Physical hubs involve higher costs than online-only solutions. Both types may need funding from the national or regional government to local/regional agencies implementing the hub, and support and coordination from the national or regional energy agency. Therefore, QualDeEPC recommends the following to national and/or regional governments competent

Table 2. Basic part of the Deep Renovation Network Platform.

Services/products
1.1 General information on renovation actions, their benefits and costs, QualDeEPC recommendations
1.2 Information on potential savings and costs
1.3 Linking with renovation calculation tools
2.1 Linking with Energy Performance Certificates and database of assessors
2.2 Linking with a building's deep energy renovation roadmap / Building Renovation Passport
3. Information on building contractors/ technicians and energy efficiency experts: Lists, support with funding
4. Information on material or product manufacturers/ suppliers
5. Information on financing opportunities for deep renovation
6. Active marketing of deep renovation and its benefits and costs
7. Network (platform) for learning, exchange and cooperation (local/regional/ national)

Table 3. Extended part of the Deep Renovation Network Platform.

Services/products
8. Network (platform) for learning, exchange and cooperation (interregional/ transnational)
9. Capacity building and training
10. Step-by-step guidance for renovation project from start to end
11. Monitoring the implementation of the renovation project(s)
12. Operating a physical network hub and information centre
13. Carrying out renovation project(s)
14. Initiation and coordination of deep renovation demonstration project(s)
15. Aggregation of building renovation projects

for implementing energy efficiency policies for buildings and particularly EPC schemes:

Each EU Member State should operate a combination of two types of Deep Renovation Network Platforms:

1. *An online platform at the national level*, including a One-Stop Shop at least for information, i.e. all information services of the basic version (see 1. to 5. in Table 2). It should also be endowed with sufficient resources to perform the two further services of the basic version: 6. Active marketing and 7. Network (platform) for learning, exchange and cooperation. The networking could be expanded to interregional or international networking (service 8. of the extended concept). Out of the extended concept, services 9. Capacity building and training, 11. Monitoring the implementation of project(s), and 14. Carrying out demonstration project(s) could also be linked to this platform or be implemented by the platform operator, particularly if this is a national energy agency or similar.
2. *A network of local or regional physical hubs* with combined core funding from the national level and income from some of the services. These hubs could offer most of the services of an extended platform, including coordination of renovation projects (guiding/coaching through implementation, service 10.), or even implementation (service 13.). They would be part of a national network within the central platform (see above) and receive technical and financial support from the national level for their information, active marketing, training, and other agreed activities.

FEEDBACK FROM STAKEHOLDER WORKSHOPS

The concept of a Deep Renovation Network Platform received very positive feedback in all partner countries. In most countries, the stakeholders are already aware of existing platforms, which contain part of the suggested content. One repeatedly mentioned concern was the maintenance and durability of such a powerful platform. Moreover, the stakeholders had different opinions on how and if manufacturers and suppliers of building components and technologies should be included in the platform. The suggestions of the stakeholders include, on the one hand, the provision of links to manufacturer or material distributors associations and, on the other hand, the connection to databases for funding programs as well as databases for EPC issuers and EPCs. Also, different options for giving feedback on contractors or realized energy efficient building projects were mentioned. Additional useful information that was suggested included results of convincing demonstration projects/good practices, and the multiple benefits of deep energy renovation.

Improving the user-friendliness of the EPC template

EPC forms are implemented to meet the requirements set by the EPBD. On one hand, the EPCs have to include all technical aspects to show the energy performance of a building. On the other hand, the "user" of the EPC, i.e. building owners or representatives, potential buyers, and tenants, need to understand the information given on the EPC forms. Moreover, third parties such as financial advisors or real estate agents may also require specific information on the energy efficiency of a building. Hence, the EPC forms need to be highly user-friendly to successfully convey the given information to all users. In this objective, QualDeEPC once again puts a special focus on the renovation recommendations and the energy savings that could be achieved.

To achieve a user-friendly EPC form, QualDeEPC firstly analysed the current forms by interviewing building owners and representatives as well as professional stakeholders. Also, the current forms were screened for best practice examples. Secondly, a long list of potential improvements was analysed considering, amongst others, the availability of the specific information, implementation possibilities, and importance for different groups of users. Thirdly, an enhanced general template for the EPC form was developed as a policy proposal.

PROPOSAL FOR AN ENHANCED TEMPLATE FOR THE EPC FORM

Based on our analysis, a template for an enhanced and more user-friendly EPC form has been developed. This form contains the following elements:

1. General data and building specification (standard requirement)
2. Energy performance and classification (standard requirement)
3. Past metered or modelled yearly total energy consumption
4. Details on building envelope and building HVAC system
5. Display of improved classifications and energy performance
6. Potential energy savings (in kWh/yr)
7. Detailed renovation recommendations by component
8. Useful combination of renovations and stepwise implementation
9. Link to Deep Renovation Network Platform including:
   - General information about EPC
   - Glossary of most important terms
   - Link/ information on funding programs

This proposal for a more user-friendly EPC form was developed to include both the data required by the EPBD (nos. 1 and 2) and the additional data that we selected in our analysis (nos. 3 to 9). It is thus meant to be universally applicable. However, in stage 3 of the project, further adaptations will be recommended based on country-specific requirements and needs. The information that either needs to be adjusted to the country-specific requirements or needs further input by the EPC issuer is marked with writing in italics on the EPC form template (see, e.g., *Additional specification of building* in Figure 2).

For lack of space, we can only present the first page here (Figure 2), plus a section of the second page (Figure 3). The top of the second page provides details on the current energy performance of the building. An innovative feature is the "traffic light" scheme for rating the energy efficiency of the current status of building components and installed systems, also included on page 2 of the template (Figure 3 presents a

part of this section). The same energy rating "traffic light" scheme will be used for the renovation recommendations (page 3 of the template). Of course, these recommendations should be based on the improved recommendations towards deep energy renovation developed by QualDeEPC and presented above. The EPC issuer can suggest a 'Main option' combining several of the recommended actions that together would achieve deep energy renovation at reasonable cost. The number and specific recommendations that are combined to form a "Main option" are highly dependable on the building and are, therefore, left to the issuer, as long as they achieve the desired result of "deep energy renovation at reasonable cost". It is assumed that the definition and levels for "deep energy renovation at reasonable cost" will be provided by the national EPC authorities. Page 3 will indicate, which of the recommendations are included in the 'Main option', and the resulting total potential energy savings in kWh/yr, which are also provided prominently on p. 1 (Figure 2). Page 1 will also show the resulting improved energy class after implementing the 'Main option'.

Page 4 contains guidance on how to combine the recommendations for a step-by-step renovation, so that the EPC becomes a first step towards a Building Renovation Passport, and lock-in effects are avoided. In addition, where an official Deep Renovation Network Platform or One-Stop Shop exists, links to this would be provided on page 4. Where such tools do not exist, there would be links to existing official websites on energy efficiency in buildings and financial incentive programmes.

FEEDBACK FROM STAKEHOLDER WORKSHOPS AND FIELD TESTS

Stakeholder Workshops

Most stakeholders of the partner countries stated that a universal EPC across the EU, which can be adjusted to national requirements, would be a positive development. However, there were several suggestions for improving the current draft for an enhanced EPC form from most countries. In addition, there is a discussion if the proposed traffic light system could be implemented in the current regulations in some partner countries. Even though this energy rating would prove helpful for the recipients of the EPCs, it might mean much more work for the EPC issuers, which would increase the cost of EPCs. Most suggestions concern additional types of information that are missing on the form proposed in the Green paper. These options include, for example, CO_2 emissions and savings, check marks for nZEB-standard (in existing buildings), validity statement or date, and economic numbers, e.g. that the total economic result of the 'main option' should be displayed along with total energy savings. Moreover, the need for forms where calculated numbers are filled in automatically was expressed.

Field Tests

Field testing of the enhanced EPC template showed that the main improvement for a "regular" EPC end user is the introduction of an energy rating system (traffic light system). It seems that the use of a traffic light principle has ensured that "regular" users (non-experts) of the EPCs can easily distinguish between good and bad parts of the building envelope and the technical systems. The actual improvements in the enhanced EPC template in each of the countries are different, because in each of the countries the existing EPC templates are very different. For countries like Bulgaria and Latvia, the enhanced EPC template even contains less information than existing EPC templates in these countries, while for countries like Sweden and Greece, there is more information in the enhanced EPC than in the existing EPC template. For instance, in Bulgaria, the EPC and annexes of the EPC in the existing situation can exceed 70 pages (30 pages in Latvia), while in Greece the existing EPC consists of only 2 pages. From the field testing, we can see that the enhanced EPC template has managed to condense the information regarding the existing situation and potential energy efficiency improvement measures in the building in as short a way as possible for a "regular" non expert EPC user. The first analysis of the enhanced EPC template shows that the enhanced EPC template is still missing some information, which could help the homeowners to decide if they should implement energy efficiency measures in their buildings or not.

The field testing of the enhanced EPC template is still ongoing.

Discussion, Conclusions, and Outlook to further work

The analysis performed by the QualDeEPC project and its sister Horizon2020 projects (notably X-tendo and U-Cert, which also started in 2019) so far indicates that EPCs can either be harnessed as the starting point for implementing energy renovation, and in particular deep renovation, or they can be a lost opportunity for it. EPCs are not issued for all buildings, but for special occasions only: for renting or sale of buildings, for new buildings, and in some countries – such as Bulgaria or Latvia – for applications for financial incentives for energy renovation. In many cases, they are perceived as a burden rather than an opportunity, issued and used for formal reasons in real estate lettings and sales, and the renovation recommendations they hold have little effect. Yet, as we have seen, EPCs and their recommendations have potential for deep energy renovation, if (1) the recommendations are consistent with deep energy renovation standards, (2) the information on the recommendations and the savings that can be made are provided in a user-friendly way, and (3) the EPCs are connected to further energy advice and financial and technical support for renovation. This is exactly what QualDeEPC is aiming to achieve with the four of its seven development priorities presented in this paper.

In its Communication on the Renovation Wave, the European Commission has proposed to introduce Building Renovation Passports (BRP) as a new tool to support deep energy renovation. These Passports would be based on a detailed energy audit and guide the building owner towards achieving deep energy renovation as the final result, but allowing for stepwise implementation that may be appropriate for the building and more easily feasible for the owner than a one-step full renovation. Certainly, this tool would be more targeted to the objective of deep energy renovation than an enhanced EPC that also still serves other information purposes on the current status of a building. And if the BRP is introduced, it will be more appropriate to aim for all buildings to obtain this as soon as possible, than to increase the

Qual DeEPC

EPC form *for residential buildings*

in accordance with *Building Energy ACT XZY*

Registry no.: *123456789*	Valid until: *DD/MM/YYYY*	EPC type: *e.g. asset rating*
other requirement(s), e.g nZEB standard, calculation method		

Building data		
Type of building	*e.g. multi-family home,*	*Picture of building*
Address		
Additional specification of building	*e.g. nine apartments;*	
Year of construction		
Area		
Additional value		

Energy classification and performance

min*Value* [kWh/m²yr]	max*Value* [kWh/m²yr]	Energy class	*1st value, e.g. Primary energy [kWh/m²yr]*	*2nd value, e.g. final energy [kWh/m²yr]*	*"improved value" of Main Option* [kWh/m²yr]*
		A+			
		A			A yyy
		B			
		C			
		D			
		E	XXX	ZZZ	
		F			
		G			
		H			

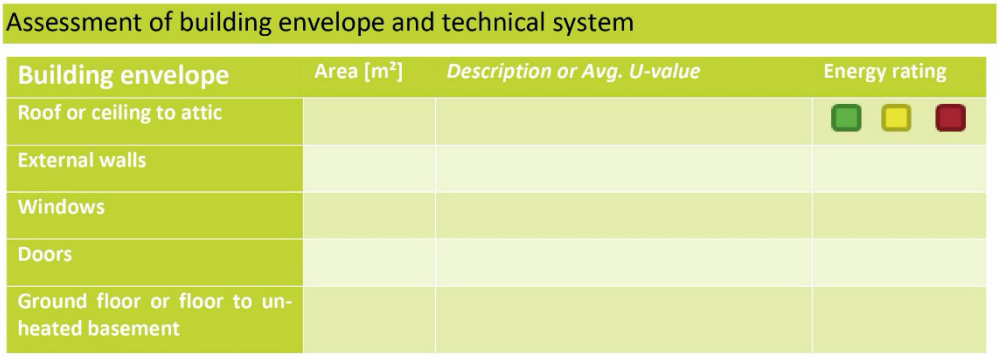
Potential final energy savings for renovation according to the Main Option (see p. 3 and 4):

XYZ kWh/yr

* The underlain renovation recommendations and implementation scheme for Option 1 are given on p. 3 & 4.

Issuer	Date
e.g. address, telephone no., registry no.	Signature

Figure 2. First page of the enhanced EPC form template.



Assessment of building envelope and technical system

Building envelope	Area [m²]	*Description or Avg. U-value*	Energy rating
Roof or ceiling to attic			
External walls			
Windows			
Doors			
Ground floor or floor to un-heated basement			

Figure 3. Excerpt from second page of the enhanced EPC form template: Assessment of building envelope.

number of trigger points for issuing an EPC. If all or many buildings have a BRP, and if the current status of a building is tracked in digital building Logbooks that are also proposed, EPCs could be issued from these data right away. However, while the European Commission is set to propose an upgrade of the EPCs in 2021 as part of the revision of the EU Directive on the overall energy performance of buildings, the BRP would be introduced in 2023 only, and even if it is introduced, it will certainly take the Member States a couple of years to determine the details and put it in practice. In the meantime, at least the enhanced EPCs could serve as a first step towards BRPs, and even if the latter are introduced in 2023, the enhanced EPCs and their renovation recommendations should be consistent with the BRPs.

Certainly, the implementation of the tools and policy proposals developed by QualDeEPC for enhanced EPCs and EPC schemes will face its own challenges. Policy-makers will need to be convinced to change the laws and regulations to require the use of the enhanced deep energy renovation recommendations, and to amend the EPC form template, as well as to provide continued funding for Deep Renovation Network Platforms and an online tool as developed by the project. The extensive information provided on the enhanced EPC form template and in the tool – particularly on costs and benefits – is easier to develop in countries that already require an on-site visit and a calculation of the energy demand for issuing an EPC than for EPCs based on past energy consumption without a calculation of the energy demand.

These are further challenges that the project team will now address in each of its seven countries of national dialogue and implementation. First, the concepts, tools, and policy proposals will be adapted to the national situation and needs. Based on this, the partners will hold two further rounds of national workshops and implement the consensus that is feasible by themselves or in collaboration with external partners. Depending on the results and what can or cannot be achieved in the seven Member States during the remaining project duration, the project will develop national Roadmaps for the further revision and convergence process, and Sustainability Strategy Plans. It will also prepare a Guidebook for improved EPCs and EPC schemes that can also be used by other EU Member States and beyond, and a Conclusive Policy Recommendations Guide for the national and EU level. All of these results will be extensively discussed and communicated.

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