D2.1 Report on local EPC situation and cross-country comparison matrix

QualDeEPC H2020 project

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Qual DeEPC

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ABBREVIATIONS

PROJECT PARTNERS

WI: Wuppertal Institut für KLIMA, UMWELT, ENERGIE gGMBH

CRES: Centre for renewable energy sources and saving foundation

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

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CIT ENERGY MANAGEMENT AB

PUBLISHABLE SUMMARY

Considering that 40% of the European Union's energy consumption can be traced back to its buildings, 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. Energy Performance Certificates (EPC), regulated by the EU's Energy Performance of Buildings Directive (EPBD) are an important instrument to enhance the market uptake of energy-efficient new buildings and the energy-efficient renovation of existing buildings.

In this background, Horizon2020 funded project QualDeEPC will work on EU-wide convergence of the building assessment and the issuance, design, and use of quality-enhanced EPCs as well as their recommendations for building renovation. The aim is to make these recommendations coherent with deep energy renovation towards a nearly-zero energy building stock by 2050.

Work package 2 of the project aims to develop the priorities for elements of EPC schemes that should be improved, and for which the project will develop proposals. The first step in developing these priorities is taking stock of the existing EPC schemes. Based on the input from all national consortium partners, the Wuppertal Institute prepared this detailed overview of the country-specific EPC assessment and certification procedures and their links to other policies and programmes, existing initiatives, and projects.

The aim of this deliverable is to present this stock-taking by a detailed analysis on which EPC element is already implemented in which form in which country, covering all 28 countries that were EU member states until 31 January 2020. All partners conducted bilateral interviews with the major actors in the EPC procedures, including executive bodies on EPC on regional and/or national level. For countries not represented in the Consortium, Wuppertal Institut and EAP conducted specific literature research, e.g. from the Concerted Action EPBD, and aimed to obtain contributions from other member states.

The information collected allows a detailed cross-country comparison in this report, which outlines the current EPC practices across the EU regarding the elements of a good practice scheme or innovative improvement options, their comparability, compliance with EU legislation, and to which extent they differ or converge. The results show, once more, the high diversity in EPC schemes across the EU. They also provide useful information in at least two directions: 1) which improvement options are not yet implemented at all or in sufficient quality in most QualDeEPC partner countries as well as other EU member states, and could therefore be interesting candidates for the further work of the QualDeEPC project in development, testing, discussion, and possibly implementation of elements for enhanced and converging EPC schemes; and 2) which countries, within or beyond the QualDeEPC project, offer good practice examples for the implementation of these options that could serve to guide the development and implementation in other countries. This deliverable will thus serve as a basis for the upcoming tasks to develop priorities and actual proposals for improvement of EPC schemes.

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1 INTRODUCTION

Considering that 40% of the European Union's energy consumption can be traced back to its buildings, 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. Energy Performance Certificates (EPC), regulated by the EU's Energy Performance of Buildings Directive (EPBD) are an important instrument to enhance the market uptake of energy-efficient new buildings and the energy-efficient renovation of existing buildings.

In this background, Horizon2020 funded project QualDeEPC will work on EU-wide convergence of the building assessment and the issuance, design, and use of quality-enhanced EPCs as well as their recommendations for building renovation. The aim is to make these recommendations coherent with deep energy renovation towards a nearly-zero energy building stock by 2050. Under the coordination of the Wuppertal Institute, the project partners will work to create consensus in the participating countries and beyond, and to implement as many improvements as possible during the project period, involving certification bodies, energy agencies, building sector and certification stakeholders, and other relevant organisations. Specifically, QualDeEPC aims to enhance:

1. **The quality and cross-EU convergence of Energy Performance Certificate (EPC) schemes, and**
2. **The link between EPCs and deep renovation.**

Work package 2 of the project aims to develop the priorities for elements of EPC schemes that should be improved, and for which the project will develop proposals. The first step in developing these priorities is taking stock of the existing EPC schemes. Based on the input from all national consortium partners, the Wuppertal Institute prepared this detailed overview of the country-specific EPC assessment and certification procedures and their links to other policies and programmes, existing initiatives, and projects.

To ensure homogenous data retrieval, a specialized questionnaire to assess the local situation in the participating countries was developed. It included 1) an overview of the current situation in the seven partner countries and 2) a list of specific questions addressing almost 50 potential options for enhancing the existing EPC schemes. These were based on the elements of a preliminary vision on good practice assessment and certification schemes. Many of these are already implemented in a number of EU member states but not in all of them. So the aim of this deliverable is to present a detailed analysis on which element is already implemented in which form in which country, covering all 28 countries that were EU member states until 31 January 2020. All partners conducted bilateral interviews with the major actors in the EPC procedures, including executive bodies on EPC on regional and/or national level. For countries not represented in the Consortium, Wuppertal Institut and EAP conducted specific literature research, e.g. from the Concerted Action EPBD, and aimed to obtain contributions from other member states.

The results allow a detailed cross-country comparison in this report, which outlines the current EPC practices across the EU regarding these elements of a good practice scheme or innovative improvement options, their comparability, compliance with EU legislation, and to which extend they differ or converge. It will thus serve as a basis for the upcoming Tasks to develop priorities and actual proposals for improvement of EPC schemes. This report is structured as follows:

- Section 2 presents the overview of current EPC situation in the seven QualDeEPC partner countries – Bulgaria, Germany, Greece, Hungary, Latvia, Spain, and Sweden.

- Sections 3 to 7 summarize the current status of EPC processes and implementation across EU Member States in five key sections, addressing the various potential elements of an enhanced and converging EPC scheme. The sections are:
    - Section 3: Assessment and certification
    - Section 4: Requirements for qualified experts
    - Section 5: Independent control systems
    - Section 6: Use of EPC data, including in wider building-related databases
    - Section 7: How are EPCs embedded in wider policies and public activities to stimulate deep renovation?
- Section 8 presents the conclusions of the study.

2 OVERVIEW OF PARTNER COUNTRIES' EPC SITUATION

Before analysing the current situation regarding the improvement options considered for enhancing EPCs and processes and uses, it is useful to gain an overview of the current situation in each country, for which QualDeEPC will develop enhancement proposals for their EPC schemes. As a first part of the country questionnaires, country partners received a list of 7 questions. This chapter is based on the responses of country partners. The amount of information received varies a lot between countries, but is considered very useful in any case. The following sub-sections presents the information received from the country partners.

2.1 Bulgaria

2.1.1 How are EPCs are implemented in your country/region (also as a part of national politics and regulations) (EPBD 2010/31 EU) ?

The implementation of EPC in Bulgaria is under the following National legislation documents:

- Energy Efficiency Act
- Ordinance № E-Рд-04-1 Of 22 January 2016 On The Energy Efficiency Survey, Certification And Evaluation Of Buildings
- Ordinance № E-Rd-04-1 Of 3 January 2018 Of Circumstances To Be Entered In The Registers Under The Energy Efficiency Act, Listing And Obtaining Information From These Records Terms And Conditions For Acquisition Of Qualification Of Consultants In Energy Efficiency
- Ordinance № 7 For Energy Efficiency
- Ordinance No. E-Рд-04-2 Of 22 January 2016 On The Energy Performance Indicators And The Energy Characteristics Of Buildings

The energy performance certificate could be issued for new buildings and for buildings in operation.

- **For new buildings:**

The Certificate of Design Energy Characteristics certifies the energy performance of a new building prior to its commissioning, including the level of energy consumption and its corresponding class on the scale of the energy consumption classes of the ordinance under the Energy Efficiency Act, complying with the requirements for new buildings. The certificate of design energy performance is issued only to a new building after the completion of the building before its commissioning. A certificate of design energy performance is issued when the new building is constructed in accordance with the design parameters for energy efficiency, the achieved energy performance of the building in the course of construction is equal to or better than the design and the building meets the statutory minimum energy consumption class for new buildings. The certificate of design energy performance may be issued on the basis of the assessment of compliance of the investment project with the requirements for energy efficiency before applying for a building permit at the assignment of the contracting authority / owner. In this case, the energy performance certificate shall be presented to the contracting entity together with the conformity assessment report.

- **For buildings in operation:**

The building owner assigns a contract to perform energy audits and certification of the building to a qualified energy auditor, registered in SEDA. The energy efficiency audit shall include the following main stages:

1. Preparatory phase, which includes inspection of the building; the collection and processing of primary building information and energy consumption by fuel type and energy and financial cost of energy for a representative prior period, but not less than three calendar years prior to the survey;
2. Establishing the energy performance of the building, which includes analysis of the existing state and energy consumption; calculations of energy balances, energy baseline; calculating the energy performance of the building and determining the potential for its improvement;
3. Identifying energy efficiency improvement measures,
4. Preparation of a comprehensive report and summary to reflect the results of the survey; submission of the report and the summary of the building owner.

An energy performance certificate for a building in operation is issued after the energy audit has been performed based on the results of the audit. The certificate of energy performance of a building in operation has a validity of 3 to 10 years, determined in the Ordinance on the energy efficiency audits, certification and evaluation of buildings.

2.1.2 What are possible purposes for issuing EPCs?

- If obliged by the Energy Efficiency Act
- When required for application for funding

2.1.3 Who is allowed to issue EPCs?

Energy efficiency audits, certification of buildings, preparing an assessment of conformity of development-project designs and preparing energy savings evaluations shall be performed by persons entered in the register referred to in Article 44 (1) of the Energy Efficiency Act, herein, who or which:

1. Are merchants within the meaning given by the Commerce Act or under the legislation of another Member State of the European Union, or of another State which is a Contracting Party to the Agreement on the European Economic Area, or of the Swiss Confederation;
2. Have at their disposal the requisite technical devices, specified in the ordinance referred to in Article 44 (9) herein;
3. Have at their disposal the requisite staff: energy efficiency consultants who meet the requirements of the ordinance referred to in Article 44 (9) herein;
4. Have secondary technical education, higher education or an acquired academic degree in field of Technical Sciences completed or recognized in the Republic of Bulgaria or secondary technical education, higher education or an acquired academic degree in the equivalent field of higher education in another member state of the European Union or in another state which is a party to the European Economic Area Agreements or in the Confederation of Switzerland;
5. Have acquired a length of service in the speciality after completion of the education - of not less than 6 years for holders of secondary technical education, not less than three years for holders of an educational qualification degree of Bachelor, and not less than two years for persons holding an educational qualification degree of Master or holding a science degree;
6. Hold a certificate of successfully passed exam for raising their qualification for performing the activities under this paragraph in higher education institutions teaching their students in specialities in the field of Technical Sciences, professional profiles of Energy, Electrical Equipment, Electronic Equipment and Automation and Architecture, Construction and Geodesy accredited under the Higher Education Act or in specialities in equivalent fields of higher education and professional profiles accredited under the applicable legislation in another member state of the European Union, in a state which is a party to the European Economic Area Agreement or in Switzerland.
7. Certified companies must have at least three energy experts (architect, civil engineer, HVAC engineer or electrical engineer) and all of them must be certified to conduct energy inspections.

2.1.4 For whom are EPCs relevant and interesting?

- Obliged by the Energy Efficiency Act
- Building owners who will sell their property (higher Energy class – higher price)

2.1.5 Who are the key market actors?

Energy auditors, Energy consultants, Consultant for applying for funding schemes, Investors; Clients

2.1.6 What are the key success factors?

- Comprehensive and well structured procedure for implementation of EPC at national level
- Existing approved software based on the national Methodology for calculation of the energy performance of buildings

2.1.7 What are key barriers?

- Building owners do not have a good understanding of their building and its energy performance, or how it can be improved.
- Low level of interest for EPC – the end users only purchase EPC if they are obliged to do it
- Energy Certificates consist a lot of information that is not understandable for the end users
- Trainings for energy auditors are not conducted frequently, resulting in poor quality of EPC

2.2 Germany

2.2.1 How are EPCs are implemented in your country/region (also as a part of national politics and regulations) (EPBD 2010/31 EU)?

The legal basis for energy performance certificates is given in chapter 5 ("Energieausweise und Empfehlungen für die Verbesserung der Energieeffizienz") of the Energy Saving Ordinance (EnEV). The regulations concern i.e., the different occasions when energy performance certificates become compulsory, the use and principles of energy performance certificates, the layout and structure of forms, the requirements for the recommendations to be included in the certificates and the skills needed to be an issuer for existing buildings. (Source BBSR)

2.2.2 What are possible purposes for issuing EPCs?

According to § 16 EnEV, energy performance certificates are necessary:

- After the completion of a new building
- If - in correspondence with refurbishment measures or a larger extension - an energetic balance for the entire building is calculated
- With sale or renting of buildings or parts of buildings (e.g. apartments)
- for display on certain buildings of public service frequently visited by the public

2.2.3 Who is allowed to issue EPCs?

To act as assessor and issuer of energy performance certificates, an education and professional experience is needed. This is fully regulated by § 21 EnEV. A certification of assessors is not foreseen.

2.2.4 For whom are EPCs relevant and interesting?

- Authorities
- Tenants
- Building owners
- Communities (of building owner or municipalities)
- Building users

- Building operators
- Investor, banks, financial service providers
- Municipality, municipal operators
- Government, Ministries (Requirements from Climate Cabinet), Institutions
- Energy consultants

2.2.5 *Who are the key market actors?*

- Energy consultants
- Tenants
- Building owners
- Communities
- Building users
- Building operators

2.2.6 *What are the key success factors?*

- Quality assurance (for process and content)
- Education, further education of the EPC issuer
- Better focus on needs and information depth for the different stakeholder groups
- understandable information for non-technicians
- link to other instruments concerning energy performance and renovation issues (e.g. energy consultancy, renovation strategy, grants,…)

2.2.7 *What are key barriers?*

- Costs
- Effort
- Lack of quality and therefore not enough trust in the information for relevant stakeholders
- Lack of understanding of the information
- Lack of linking the information to the renovation process

2.3 Greece

2.3.1 *How are EPCs are implemented in your country/region (also as a part of national politics and regulations) (EPBD 2010/31 EU)?*

- PCS are issued in Greece since 2011, when full implementation of the EPBD started. EPCs are issued for purposes of building permits (new buildings or major renovations), for real estate transactions (sale or rent) and for public buildings over 250 m^2.
- The methodological approach for defining the energy class is the 'asset rating' approach (comparison with a reference building). Energy class is defined based on the calculated primary energy consumption.
- EPCs are produced automatically by a web based national registry platform (www.buildingcert.gr), after uploading the building data and calculations of energy performance by the auditor. Auditors having access to the platform are also registered.
- Energy performance on EPCs is calculated with the use of official national software integrated in the platform and also available to the auditors.

2.4 Hungary

2.4.1 *How are EPCs are implemented in your country/region (also as a part of national politics and regulations) (EPBD 2010/31 EU)?*

- The regulation basis of EPCs is the Government Regulation No. 176/2008

- EPC's are registered in a central database. Some data of the database (address of the building and energy category) is available publicly online, but it is not possible to get any detailed information and calculations from the system.
- On-site visits are mandatory by law, there has to be photos included in the EPC, but in practice, some EPC issuers do it without site visits, based on building papers and data.
- 2.5% of EPCs are checked. If faults are detected, assessors are required to correct them. When the energy class is determined wrongly, and the difference is 2 classes or more, the assessor license is withdrawn.
- It is not necessary to use the certified software, but most assessors use one of the available tools.
- Recommendations are a compulsory part of the EPCs, but they are not necessarily on the first pages. They usually don't contain very specific information.
- The cost is determined in the EPC regulation: it is the maximum of 5500 HUF/hour (about 17 EUR) plus reasonable additional costs (e.g. travel).
- It is regulated in a decree who can be assessors. They must have a relevant expert background (listed by profession in the regulation) and they must fulfil training for accreditation. Further regular trainings are available, but not compulsory, it is not a condition to remain an assessor

2.5 Latvia

2.5.1 How are EPCs are implemented in your country/region (also as a part of national politics and regulations) (EPBD 2010/31 EU)?

- Based on Latvian legislation EPCs have to be issued when building is:
    1. Put into operation after building a new building or renovating an existing building;
    2. Sold or rented;
    3. A public building owned by the state;
    4. Is going for renovation and receiving financial incentives (co-financing)
- In real life, when a building is being sold or rented the EPCs are not issued, as nobody is asking them (it seems that nobody actually knows that EPC in this case should be issued).
- EPCs can be issued only by certified energy auditors (around 100 energy auditors in Latvia).
- It seems that EPCs are issued only in cases when it is mandated by law. Therefore the EPCs are seen as something that has no value and costs money. Most of the issued EPCs are issued for renovation of apartment buildings where the renovation process of the building is co-financed (grants) by EU. Therefore the key actors are the apartment building managing companies and the inhabitants of the buildings.
- The main barrier could be that EPCs are viewed as a document that has to be made in certain cases but no one (expect energy auditors) actually looks at the EPCs. There is lack of information in general public about EPCs.
- The Ministry of Economics also seems to be implementing the legislation about EPCs only because EU dictates so.

2.6 Spain

2.6.1 How are EPCs are implemented in your country/region (also as a part of national politics and regulations) (EPBD 2010/31 EU)?

The energy performance certificate or energy certificate is an official document drawn up by a competent technician that includes objective information about the energy characteristics.

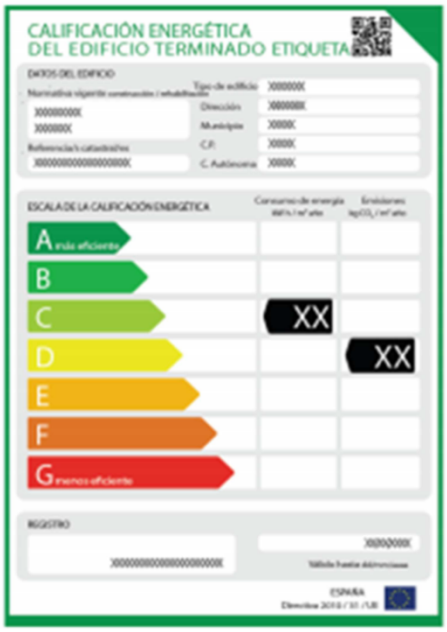

Figure 1: Sample EPC in Spain

In this sense, the energy certification qualifies a building by calculating the annual energy consumption necessary to meet the energy demand of a building under normal conditions of occupation and operation, including the production of hot water, heating, lighting, cooling and ventilation. The energy certification process concludes with the issuance of an energy performance certificate and the assignment of an energy label. The energy rating scale is seven letters and varies between the letters A (most energy efficient building) and G (least efficient building). The number of buildings registered in Spain in 2017 is estimated at 9,730,999 and the number of homes of 25,645,100. The number of buildings and parts of buildings with energy certificate and registration has been 3,637,688 as of December 2018 (Source: IDAE).

Legislation on Energy Certification in Spain is explained below:

- The Technical Building Code, CTE approved according to RD 314/2006 defines the limitation of consumption, demand, performance of thermal installations, and efficiency of lighting installations, minimum solar contributions both photovoltaic and thermal. It is modified according to Order 1635/2013, which contains all the information necessary to meet the minimum energy efficiency requirements of new buildings, as well as the energy rehabilitation of existing buildings. Later in 2018, a proposal of RD included modifications of the Technical Building Code on energy savings.
- Royal Decree 235/2013, “recast”, which approves the basic procedure for the certification of the energy efficiency of existing buildings, and incorporating new buildings that are built to be almost zero energy consumption, in the terms established by regulation in due course through the Technical Building Code, a term that in the case of public buildings, is advanced two years. This document included references to the established methodology in Spain, published as Recognised Documents in the Official Website of Certification. The methodology was adapted to European Standards in 2014, thereby also addressing the problems, which were detected through previous experience. In 2016, part of these documents was further adapted to improve processes, make the methodology more transparent, and eliminate barriers to new technological systems. One of the main changes that occurred was the inclusion of a second indicator for energy performance, complementing the CO_2 emissions indicator with one for non-renewable primary energy consumption (CA EPBD, Spain, 2016). The Royal Decree establishes the obligation to make available to buyers or users of buildings a certificate of energy efficiency that must include objective information on the energy efficiency of a building and ref-

erence values such as minimum energy efficiency requirements in order to that the owners or lessees of the building or a unit of the building can compare and evaluate their energy efficiency. In addition, this Royal Decree contributes to the reporting of CO_2 emissions using energy from emitting sources in the residential sector, which will facilitate the adoption of measures to reduce emissions and improve the energy rating of buildings. The 17 Regional Governments are responsible for the management of certificates and each of them control a registry of energy certificates.
    - The use of the common label is also regulated throughout the national territory, guaranteeing the specificities that are required in the different Regional Governments. In the case of buildings >250m^2 that provide public services to a significant number of people and that are therefore usually frequented by them, the display of this distinctive in a prominent way is mandatory.
- Royal Decree 564/2017 modifies RD 235/2013 and defines buildings with nearly zero energy consumption and buildings excluded from the Certification.
    - New buildings that are built as of December 31, 2020 will be buildings with nearly zero energy consumption. The minimum requirements that these buildings must satisfy will be those determined at the time in the Technical Building Code.
    - New buildings that will be occupied and that are publicly owned as of December 31, 2018 will be buildings with nearly zero energy consumption.
- The Ministry of Ecological Transition has made a proposal and a public consultation (in 2019) for the modification of RD 235/2013 and adapts it to Directive 2018/844/EU; the consultation raises questions such as the factors to consider improving the procedure for the Certification of Energy Efficiency of Buildings. In addition, it includes questions about the information procedure on the energy efficiency of a home or the requirements for certification technicians.
- Order 588/2017 FOM. Define the "nearly zero energy consumption building".
- Proposal (year 2018) to modify the R.D. 314/2006 (CTE) adapting it to Directive 2010/31 / EU.
- R.D. 238/2013 on Thermal Installations of Building (RITE). The energy performance requirements for heating, cooling and domestic hot water generation systems are regulated through the RITE.

European Directives	Transposition in Spain
2002/91/CE, concerning the energy certification of buildings. (Repealed since February 2012).	R.D. 47/2007, basic procedure for the energy certification of new buildings.
2010/31/UE, “recast”, include new buildings and existing buildings.	R.D. 235/2013, “recast”, also includes the procedure for existing buildings. R.D. 564/2017, corrections to R.D. 235/2013.
2018/844/UE, amendments to the Directive 2010/31/UE.	Proposal by R.D. (2019) to modify the R.D. 235/2013, adapting it to Directive 2018/844/EU.

Table 2: European Directives and their transposition in Spain

Certification procedure

In general, Spain’s calculation methodology is included in six (6) official computer software programs, which are mandatory for energy certification, and are a very useful tool for compliance with the CTE. The steps to be followed by this calculation methodology, and therefore by the computer software, are firstly, to calculate the energy demand, both thermal and for domestic hot water and lighting; then, to calculate the energy consumption of the systems necessary to cover the demand. These calculations are made by integrating the building's needs on an hourly basis, and by a transitory time-

scale regime. With the above, the final energy consumption is calculated and extrapolated to non-renewable primary energy consumption and CO_2 emissions; these two indicators are finally evaluated and established by regulations. Since the energy simulation software in Spain calculates the final energy consumption, it is necessary to have adequate conversion factors to obtain the non-renewable primary energy consumption and CO_2 emissions. Source: CAEPBD, Spain 2016. The certificate is generated by the software and used for **10 years**, after this time an updated has to be implemented. The next table shows several official software that calculates and generates the certificate:

Procedure	Type of building	Use of the building	Tools recognized
GENERAL	New construction and existing buildings	Households and tertiary sector	HULC CYPETHERM HE Plus SG Save
SIMPLIFY	New construction and existing buildings	Households and tertiary sector	CE3X (small tertiary)
		Households	CERMA
	Existing buildings	Households and tertiary sector	CE3

Table 3: EPC software in Spain

Currently these programs can be downloaded on the website of the Ministry of Ecological Transition.

Quality Assurance of EPCs

In addition to incorporating EPC information into their databases and issuing the registered energy performance label, the aforementioned Regional Governments registries are also responsible for control and inspection works. Control and inspection of EPCs have been established in a different manner in each region, while maintaining basic requirements, such as establishing a statistical control based on the obtained qualifications, as well as establishing mechanisms to prioritize some controls and carrying out inspections in several stages with several degrees of depth. The current situation is that 100% of the certificates are automatically controlled, thanks to computer mechanisms that evaluate all the certificate data, and generate automatic notices about certificates that do not correspond with reasonable average parameters. Additionally, a document control is carried out on nearly 50% of the certificates using complementary information. There are also specific inspection mechanism that reach 0,5% of the certificates in terms of information review and improvement measures, and a deep inspection system, with a visit to the building, which occurs 0.05% of the time. The number of inspections and controls as of 2017 are given in Table (CA EPBD, Spain 2016). .

Document Control	Visits to the property	Verification of Competent Technicians	Inspection and Control of Advertising	Completed Inspections	Sanctions
1,392,880	15,140	27,029	9,084	1,211	545

Table 4: EPC quality control statistics in Spain

2.6.2 What are possible purposes for issuing EPCs?

It is an administrative procedure that is mandatory in cases of:

- New construction projects

- Buildings finish
- Buy
- Sale
- Rent

It should be an information tool on the energy consumption and CO_2 emissions of the building, in addition this shows it in 4 uses (heating, cooling, DHW and lighting), the latter only for buildings of the tertiary sector. In general, consumer awareness is aimed at focusing on energy savings and the mitigation of CO_2 emissions in the field of building. The cost of the certificate varies by type of house or building, there is no fixed price, it is a market, in an approximate range of € 45-350.

2.6.3 Who is allowed to issue EPCs?

The quality and accuracy of the certificate, and by extension, the reliability of the entire EPC scheme depend to a large extent on the certifier skills. Only Spain (and Austria, Germany and most of the Italian regions) does not require the mandatory accreditation procedure. The EPC certifiers operate under their trade license and have a personal responsibility to comply with the minimum qualification requirements specified in the national legislation. (Source: BPIE FACTSHEET, 2015). In Spain, lists of experts are published by some Regional Governments. The following table presents an overview of the minimum requirements:

Minimum education requirements	Engineering degree and architects
Professional experience	Not required
Additional training	Voluntary
Verification of expert's competence (i.e. mandatory exam)	No exam
Accreditation of the certifiers	Based on trade license
Renewal of license	No renewal of accreditation
Public availability of lists	Lists of certifiers provided by region

Table 5: Minimum qualifications for EPC Assessors in Spain

2.6.4 For whom are the certificates relevant?

- Promoters and real estate agencies
- Companies selling online buildings
- Owners who are going to sell or rent a home or building
- People who are going to buy a flat or building
- Public or private building managers

2.6.5 Who are the market players?

Mainly they will be responsible for the fulfilment of the obligations established for the following markets players:

- The promoters and owners of buildings or parts thereof, regarding compliance with the obligations required of their respective buildings or parts thereof.
- The competent technical personnel in the field of energy efficiency certification of buildings, subscribers of the Energy Performance Certificates, regarding the accuracy and veracity of the data contained therein, as well as compliance with the technical procedure for energy certification, in accordance with the provisions of Chapter II of Royal Decree 235/2013.
- The agents accredited for the external control of the Energy Performance Certificates, regarding the realization of the Report, in accordance with the established procedure, as well as the

result of the actions to verify the validity and veracity of the data contained in the respective Energy Performance Certificates of buildings.

- Those who exercise functions of offering, promotion or advertising of sale or lease of buildings or part of buildings, with respect to the obligations established by current regulations regarding the offer, promotion or advertising of the sale or lease of building or building units.

The responsible agents must keep the documentation concerning the building's energy certification for any inspection or requirement during the term of the Certificate.

2.6.6 What are the key success factors?

- Ensure that each of the 17 Regional Governments have regulated and managed the organization and registration of Energy Certificates of new buildings and existing buildings. In most Regional Governments there is also a Registry of Certifiers. The registration procedure is done electronically.
- Some Regional Governments propose regulatory improvements. It is important to emphasize that these Regional Governments are of different political sign, so it is a "strong point" that consensus has been achieved in this area. For example, the Basque Country has published Decree 25/2019 of February 26, with a unique text that incorporates and improves the existing regulation on the subject.
- The Ministry for Ecological Transition has made a proposal and public consultation in 2019 to modify RD 235/2013 (recast) to adapt it to Directive 2018/844/EU.
- There is another proposal of the year 2018 to modify the Technical Building Code regarding the minimum energy efficiency requirements of buildings, which will improve the process of certification and implementation of improvements.
- Match the energy certification before and after performing the action on the building envelope. The demand decrease for heating and cooling must be at least 30% to obtain public assistance (State Urban Regeneration and Renovation Plan 2013-2017).
- The PAREER aid program consists of a base and an additional aid for actions that raise up to class "A" or "B" rate or increasing two 2 classes the initial energy certificate. The program is managed by the IDAE.
- Green mortgage. It aims to apply interest rates linked to several parameters, among which one of them is the energy rating. The interest rates are lower as the more efficient is the building. It applies to the acquisition / construction / renovation of residential buildings. Sometimes it is applied to buildings with almost zero energy consumption.
- There is no single recognized (official) software but several (official) software that can be used for certification. Therefore, the certifier chooses one of them to certify. And they are of two types: simplified and general. All give the report (report) of the certificate with the same information (but different calculation methodologies are used).

2.6.7 What are key barriers?

- With an estimate of 9,730,999 buildings and 25,645,100 homes censored in 2017, until 2018 only 3,637,688 energy performance certificates have been registered that may correspond to buildings or units that have been independently certified (IDAE). It's a weak percentage.
- The rating scale has a very high range, in each letter, of CO_2 emissions, it would be necessary to update it.
- There should be a number of m2 in the reforms, from which it would be mandatory to issue the certificate (e.g. from 2000 m2), it seems that this point is not contemplated in current legislation.
- The certification of public buildings can be carried out by the officials themselves; this creates discrimination in the so-called free market, and the opportunities for certifiers can be reduced.
- There is no mandatory procedure for the accreditation of certifiers, nor a specific period to perform the work of being a certifier. (See point 3).

- Slow process of transposition of some European Directives, which has several implications.
- Certification system managed by Regional Governments (positive or negative), may be what has involved using many resources. Create and manage 17 Certificate Registries and some Certifier Registries and with different levels of control (some regulations are more advanced than others).
- Weak promotion by organizations and institutions to boost certification.
- Failure to show the Energy Label in numerous public buildings and those frequented regularly.

2.7 Sweden

2.7.1 How are EPCs are implemented in your country/region (also as a part of national politics and regulations) (EPBD 2010/31 EU)?

The implementation of EPCs in Sweden are regulated by:

- Lag (2006:985) om energideklaration för byggnader, ändrad t.o.m. SFS 2018:314.
- SFS nr: 2006:1592. Förordning (2006:1592) om energideklaration för byggnader, ändrad t.o.m. SFS 2016:178.
- BBR 28. Boverkets byggregler (BFS 2011:6) – föreskrifter och allmänna råd - Boverkets byggregler BBR 9:2. Ändrad t.o.m. BFS 2019:2
- BED 10. Boverkets föreskrifter och allmänna råd (BFS 2007:4) om energideklaration för byggnader BED. Ändrad t.o.m. BFS 2018:11.
- BEN 3. Boverkets föreskrifter om ändring av verkets föreskrifter och allmänna råd (BFS 2016:12) om fastställande av byggnadens energianvändning vid normalt brukande och ett normalår. Ändrad t.o.m. BFS 2018:5.
- CEX 5. Boverkets föreskrifter och allmänna råd (2007:5) för certifiering av energiexpert. Ändrad t.o.m. BFS 2016:15.

2.7.2 What are possible purposes for issuing EPCs?

It is mandatory to always have a valid EPC for:

- Buildings with a floor area larger than 250 squaremeters, that is often visited by the public.
- Buildings where a private person or organisation, other than the building owner, have the right to use the property. Examples of such properties are multi-dwelling blocks and non-residential premises for lease.
- It is also mandatory to issue EPCs for:
- Newly built buildings prior to sale or within two years after completion
- Existing building (or part of building) prior to sale

Some buildings are exempt from the EPC obligation, e.g. buildings with industrial operations, holiday houses and buildings with a floor area smaller than 50 m^2. It is compulsory to base the EPCs on measured energy performance, if such values are available. For new buildings, an asset rating is performed before the construction and it is then compulsory to validate the energy performance based on measured values for a full year (however, it is not compulsory that this measurement is an EPC). Validation must be done within 24 months after the building has been built/start of use. Buildings in the first two categories listed above, or prior to sale, need to have a valid EPC from start and this is then based on calculations, since no measured values exist. For other new buildings, it is mandatory to assess an EPC based on measured values within 24 months. EPCs are valid for 10 years. On-site visits are compulsory for all buildings.

The purpose of the law of energy performance certificates is to promote efficient energy use and good indoor environment in buildings. Building owners are often obligated by law to issue an EPC (see bullet point above).

2.7.3 Who is allowed to issue EPCs?

Only certified energy experts are allowed to issue EPCs. Today, only two certification bodies in Sweden accredited for certification of energy experts (EPC experts). The Swedish Board in turn accredits the certification bodies for Accreditation and Conformity Assessment (SWEDAC). It orders to qualify for becoming a certified energy expert; a list of requirements regarding experience and training needs to be met. There are two certification levels: one for simple buildings and one for more complex buildings.

2.7.4 For whom are EPCs relevant and interesting?

- Building owners
- Potential buyers of a building.
- Researchers

2.7.5 Who are the key market actors?

- Regularity authority: The National Board of Housing, Building and Planning (Boverket)
- Supervisory authority: Each municipality
- The certification bodies Kiwa and RISE
- Consultant firms
- Individual energy experts
- Building and housing associations
- Contractors

2.7.6 What are the key success factors?

- Focus on measures that are cost-effective from the building owner's perspective.
- Using metered values for assessment of the energy performance.
- Compulsory on-site visits
- Certification of energy experts. This has replaced a former system based on accreditation of companies assessing EPCs. Advantages are decreased transaction costs for the building owner as well as reassurance of individual competence.
- Recertification for energy experts after 5 years.

2.7.7 What are key barriers?

- The system has received criticism for being costly in relation to the resulting benefits.
- Improving the quality of recommendations of renovation (cost effective energy measures).
- Less transparent, and thereby less useful, since December 2016 when regulations regarding BEN were introduced. Before BEN, metered values were presented in the EPCs. With BEN, metered values in the EPC have been corrected to normal use of energy. This means that today, the values displayed in the EPC are a mix of metered and calculated data.

3 ASSESSMENT AND CERTIFICATION OF EPCS IN EU MEMBER STATES

This section analyses the current state of implementation with respect to elements of the EPC assessment and certification procedures required, implemented, or available in EU Member States and the UK. The sub-topics for analysis include various EPC elements, such as availability of assessment tools, user friendliness of EPC and availability of online tools, especially with their relation to renovation recommendations provided on the EPC so that they become the first step towards individual buildings deep renovation passports/roadmaps. In the following, each sub-section presents the current status of an individual element of an EPC scheme.

3.1 Official or certified private EPC Software to ensure quality and comparability of assessments

When assessment is carried out by different EPC assessors and in similar buildings, EPC results should be comparable for energy rating across the buildings; however, they should provide specific energy efficiency recommendations for each building. A single mandatory, or at least an official (not mandatory) software, or certification mechanism when multiple private vendors provide software solutions for EPC assessment and recommendations could help in achieving comparability. The latter may also enable easy linkage between EPC and an investment-grade energy audit, if the certified part for the EPC assessment is embedded on a more comprehensive software for the energy audit. The following figure shows the status of availability of EPC software in various Member States. Either official or private EPC software are available in all Member States and the UK. The one exception is Sweden, where EPCs for existing buildings are based on actual energy consumption instead of a calculation.

In few countries, such as Luxembourg and Slovakia, the EPC procedure is organized online and controlled by a backend software. Some of the private software are able to produce final EPCs on their own (pending validation and assignment of identification number), while few other software are integrated with the national EPC database, or produce output in formats such as xml, which are then used by the database to produce a valid EPC.

Most often, there is an official certification mechanism for private software. Member States have adopted different certification mechanisms, such as validation of calculation results from the private software against the results from an official tool, adopting the certified algorithms into private software programmes. Estonia uses a more open certification approach where the commercial software could be validated as per the applicable European (EVS-EN), ISO, ASHRAE and CIBSE standards and the IEA BESTEST method, or an equivalent generally recognised methods.

Among QualDeEPC project partner countries, Sweden does not have an EPC software, while the rest of the countries (except Hungary and Latvia) have either official software or a certification mechanism for commercial software. Hungary and Latvia do not have an official software and use uncertified private software.

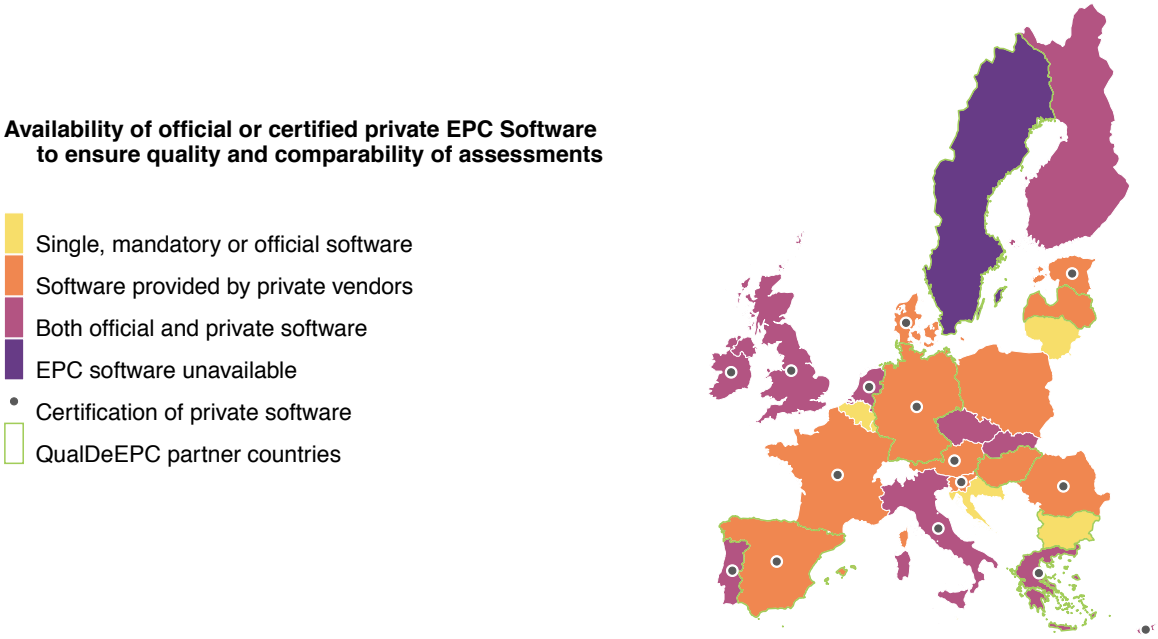

Figure 2: Availability of official or certified EPC software to ensure quality and comparability of assessments

The following table shows in brief the status of availability of EPC software in the different Member States and the UK.

	Single, mandatory software or at least an official software is available	Software solutions provided by private vendors are available	Certification mechanism for software provided by private vendors is available
Austria	No. Official software is not available.	Yes. Several private software are available (Austrian Energy Agency, n.d.)	Yes. Relevant standards of the Austrian Institute of Construction Engineering (OIB), are used to develop an excel tool that serves as a basis for validation of private software products that are used in the implementation of official EPC databases by means of XML-interfaces (Maul & Wohlschak, 2016).
Belgium	Yes. Regional governments, such as Flemish government and Walloon government provide ECP software (De Meulenaer & Triest, 2018 & Wallonie energie SPW, n.d.).	No. Only official software are used for EPC purposes.	No. See columns 1 and 2
Bulgaria	Yes. Official software is available.	No. Commercial software are unavailable.	No. See columns 1 and 2
Croatia	Yes. The national calculation tool has been developed and is in a test phase (Škoro, 2018).	No. Commercial tools appear to be unavailable (Škoro, 2018).	No. See columns 1 and 2
Cyprus	Energy Service, Ministry of Energy, Commerce and Industry, releases the SBEMcy software, which is validated as per the prescribed methodology and is available free of charge (Energy Service, n.d.).	Private software approved by the Energy Service are available, e.g., (MODECSOFT Ltd, 2020)	The Ministerial Order for the 'Methodology for Calculating the Energy Performance of Buildings of 2009' defines the calculation methodology used

	Single, mandatory software or at least an official software is available	Software solutions provided by private vendors are available	Certification mechanism for software provided by private vendors is available
			for the production of EPCs. Energy Service examines the compatibility of software with the calculation methodology and provide its approval for issuing EPCs, upon justified request (Energy Service, n.d.).
Czech Republic	Yes. National Calculation Tool - NKN II, a free to use software, is available for calculation and production of EPC (Department of Building Services, CTU, n.d.).	Yes. Private software is available EPC purposes (Arcipowska et al., 2014).	There appears to be no validation mechanism (Arcipowska et al., 2014).
Denmark	No. Official software are not available.	Yes. Private software approved by the Danish Energy Agency are available (Brand et al., 2018).	Yes. Private software approved by the Danish Energy Agency are available (Brand et al., 2018).
Estonia	No. Official software is not available. (Kurnitski, 2019).	Yes. Commercial software for calculating the building energy performance and issuing EPCs are available (e.g., EQUA, n.d.).	Yes. Applicable European (EVS-EN), ISO, ASHRAE and CIBSE standards and the IEA BESTEST method, or an equivalent generally recognised method can be used for validation of the software (Kurnitski, 2019 & Minimum requirements for energy performance, 2012)
Finland	Yes. Calculation methodology and spreadsheet based tools are available for the calculation of Energy Efficiency Reference (E-number), based on which EPC class is determined (Motiva - Energiatodistusten laskentaohjeet 2018, n.d.).	Yes. E.g., one such tool is made available by the insulation industry for the calculation of E-number (Eristeteollisuus, n.d.).	It is unclear whether there is any certification mechanism available.
France	No. The public authorities do not provide software. However, a software code has been developed, under free software licenses, and is available for software vendors for use in EPC calculation tools (Ministry of the Ecological and Inclusive Transition, n.d.).	Yes. Commercial software are available (Ministry of the Ecological and Inclusive Transition, n.d.)	Yes. Commercial software have to be validated as per any one of the three prescribed calculation methodologies (Ministry of the Ecological and Inclusive Transition, n.d.).
Germany	No.	Yes.	Yes.
Greece	Yes. Official software is available.	Yes. Possibility exists for the development of private software.	Yes. Commercial software tools need to be based on the prescribed calculation algorithms, be checked, be compatible and integrated with the national platform and get accreditation by the competent authority.
Hungary	No. Official software is not available.	Yes. It is not necessary to use the certified software, but most assessors use one of the available tools.	No. There appears to be no validation mechanism.
Ireland	Yes. Official methodology for calculating Building Energy Rating (BER) for domestic (Dwelling Energy Assessment Procedure) and non-domestic buildings (Non-domestic Energy Assessment Procedure) and their corresponding tools are available (SEAI, n.d.).	Yes. Commercial software are available, e.g., IES-VE, n.d.	Yes. Certification mechanism is in place (SEAI, n.d.).

	Single, mandatory software or at least an official software is available	Software solutions provided by private vendors are available	Certification mechanism for software provided by private vendors is available
Italy	Yes. Software called 'Energy Diagnosis and Certification Software of existing residential buildings' is available for existing residential buildings (ITC_CNR, n.d.).	Yes. A list of software validated by the authorised body, the Italian Thermotechnical Committee, is available on their website (The Italian Thermotechnical Committee, n.d.).	Yes. The Italian Thermotechnical Committee carries out validation of commercial software tools (The Italian Thermotechnical Committee, n.d.).
Latvia	No. Official software is not available.	Yes. There are some tools made by energy auditors but they are not certified or mandated by law.	No. Certification mechanism appears to be unavailable.
Lithuania	Yes. Official software is available (Arcipowska et al., 2014).	No. Software solutions by private vendors appear to be unavailable (Arcipowska et al., 2014).	No. See columns 1 and 2
Luxembourg	Yes. National software exists and is included in the national EPC database. Only the public software can be used for the calculation of the energy indicators (Reding et al., n.d.).	No. Commercial software appears to be unavailable.	No. See columns 1 and 2.
Malta	Yes. Official software, EPRDM Software, is available (BRO, 2020).	No. Commercial software appears to be unavailable (Arcipowska et al., 2014).	No. See columns 1 and 2
Netherlands	Yes. Although not a stand-alone software, private homeowners receive a provisional EPC (based on information the authorities have about the house) automatically and can convert it online into a definite EPC (low cost). This can be done digitally through Energielabelvoorwoningen.nl. A remote, certified expert will verify the entered data and a final energy label is generated and sent.	Yes. For new buildings, a different measure of energy efficiency is required, called Energy Performance Coefficient (EPC) (RVO, n.d. & Arcipowska et al., 2014)	Yes. There appears to be a certification mechanism (Arcipowska et al., 2014).
Poland	No. There appears to be no official software (Arcipowska et al., 2014).	Yes. Commercial software are available, for example, the Audytor OZC, the ArCADia Thermo and the BuildDesk Energy Certificate (BPIE & KAPE, 2017, & Graitec, n.d.).	No. There appears to be no validation mechanism (Arcipowska et al., 2014).
Portugal	Yes. Official software is available (Arcipowska et al., 2014).	Yes. Commercial software are available (Arcipowska et al., 2014).	Yes. Certification mechanism is in place (Arcipowska et al., 2014).
Romania	No. There appears to be no official software (BPIE et al., 2017).	Yes. Commercial software for applicable to all building types, are available. E.g., AllEnergy, Certificat-energetic.com, Doset–PEC, ALLPLAN, Matrix Energ and TermoExpert (BPIE et al., 2017).	Yes. However, certification mechanism is available only for the software for issuing EPCs in collective apartments (BPIE et al., 2017).
Slovakia	Yes. For individual apartments, the entire EPC procedure is organized online and is controlled by the backend software (Sternova & Magyar, 2018).	Yes. Commercial software appear to be available (Arcipowska et al., 2014) - BPIE ref.	No. There appears to be no certification mechanism (Arcipowska et al., 2014) - BPIE ref.
Slovenia	No. There appears to be no official software (Arcipowska et al., 2014)	Yes. Commercial software are available (Arcipowska et al., 2014).	Yes. Validation mechanism is in place (Arcipowska et al., 2014).
Spain	No. There is no official software.	Yes. There are 6 free software and few of them require paid updates. That software can be improved, one of them HULC is	Yes. Certification mechanism is in place.

	Single, mandatory software or at least an official software is available	Software solutions provided by private vendors are available	Certification mechanism for software provided by private vendors is available
		complex and others are excellent based in Energy Plus. There are opinions in favour of one single mandatory software, but it is not easy for legal and market reasons.	
Sweden	No. Because the Swedish EPC is based on metered values when such values exist, no software for calculation of energy performance is only in the assessment of EPCs for new buildings. However, for giving good advice on renovation measures such tool will be useful also for existing buildings. Also, EPCs for new buildings are initially based on the calculations made to prove compliance with minimum energy performance requirements.	No. Commercial software are unavailable.	No. There is no certification mechanism.
UK	Yes. For non-residential buildings, a tool based on National Calculation Methodology, called Simplified Building Energy Model, with its user interface, iSBEM, is used to calculate energy performance of buildings and generate EPCs (BRE, n.d.).	Yes. For new and existing dwellings, Standard Assessment Procedure software and Reduced data SAP software approved by BRE is used for calculating Building Energy Performance and generating EPCs (BRE, n.d.). For non-residential buildings National Calculation Methodology allows the calculation to be carried out by approved simulation software, besides SBEM (BRE, n.d.).	Yes. Private software are available and are subject to validation by BRE (BRE, n.d. & BRE, n.d.)

Table 6: Availability of official or certified EPC software to ensure quality and comparability of assessments

3.2 EPC Software: default values or validity ranges for input parameters

When assessment is carried out by different EPC assessors and in similar buildings, EPC results should be comparable for energy rating across the buildings. Comparability can be increased by providing practical or realistic default values for input data that come close enough to real data of a building or the local climate; or in other cases, rather than exact default values, certain validity ranges for input data.

The following figure shows the status of availability of input data for EPC software in different Member States and the UK. In most countries, default values are often available as a part of the reference standards, or regulations or legislation governing the building energy performance calculation methods for the purposes of EPCs (see table below). Often, EPC calculation software also provide default values. Default values are usually available for various inputs, such as weather data, usage schedules, transmission values of the building envelope, and efficiencies of building technical systems. In addition, in countries, such as Ireland and Denmark, when on-site visits are mandatory for the collection of input data, guidelines, handbooks and flowcharts are available on how to determine the input values. In Austria, an online public database, called baubook that provides characteristics of construction products, such as walls, floors, roofs, and of some building systems, such as wood heating appliances, heat pumps, ventilation fans, ducts and pipes is available.

Among QualDeEPC project partner countries, Bulgaria and Latvia do not have any guidance on default values for input data.

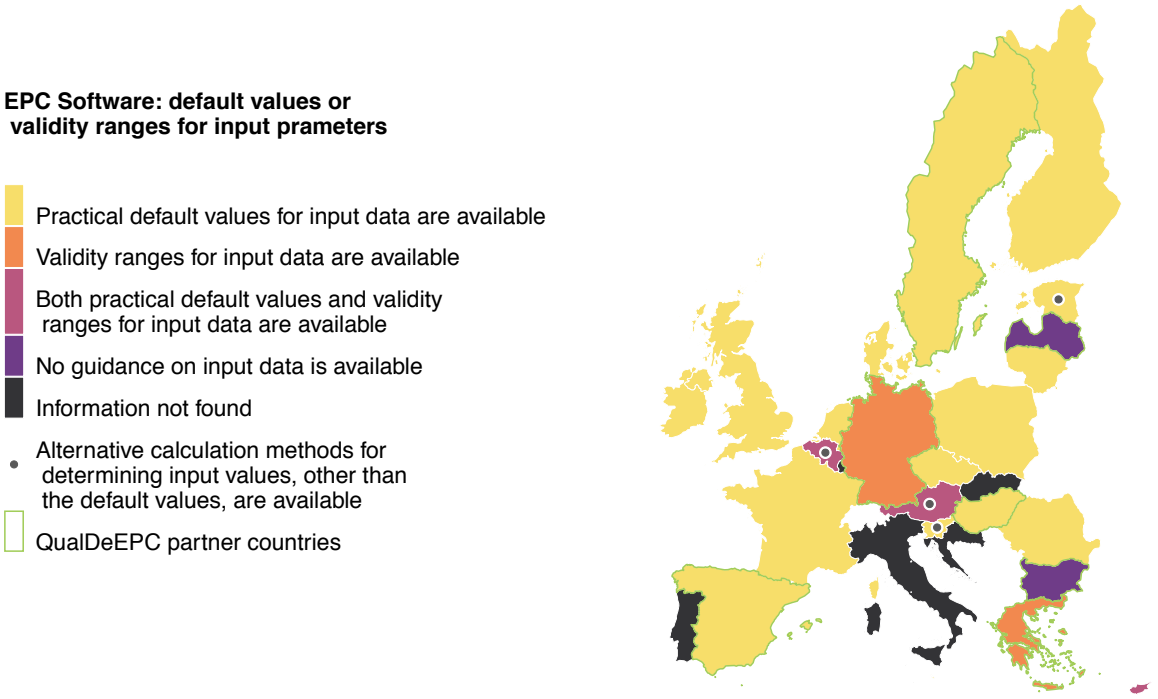

Figure 3: EPC software: default values or validity ranges for input parameters

The following table shows in brief the status of availability of input data for EPC software in various Member States.

	Practical default values for input data are available	Validity ranges for input data are available (or multiple values can be chosen from the available default values)	Alternative calculation methods for determining input values, other than the default values, are available
Austria	Yes. Default values are available from prescribed standards. In addition, an online public database, called baubook that provides characteristics of construction products, such as walls, floors, roofs, and of some building systems, such as wood heating appliances, heat pumps, ventilation fans, ducts and pipes is available. baubook GmbH is owned by the Energy Institute of Vorarlberg and IBO (Austrian Institute for Healthy and Ecological Building) and is financed by fees from product and system manufacturers that uses the platform (baubook GmbH, n.d. & Sutter & Geissler, 2016).	Yes. EPC assessor can choose from several equally compliant options for determining the input data necessary for performing EPC calculations (Geissler & Wallisch, 2016).	Yes. Complex and dynamic calculations can be performed to calculate the input values in place of the available default values (Geissler & Wallisch, 2016).
Belgium	Yes. In general, default values exist as per the applicable regulations. In addition, 'Walloon on-site input data collection protocol' of the Walloon region provides detailed guidelines for obtaining necessary input data for existing buildings, with an option to reverting to default values when other means of obtaining default values are unavailable (Loncour et al., 2016).	Yes. EPC assessor can choose from several equally compliant options for determining the input data necessary for performing EPC calculations (Loncour et al., 2016).	Yes. Possibility exists for EPC assessor to use alternate means of calculations, upon providing a justification (Loncour et al., 2016).

	Practical default values for input data are available	Validity ranges for input data are available (or multiple values can be chosen from the available default values)	Alternative calculation methods for determining input values, other than the default values, are available
Bulgaria	No. Guidance on default values for input data are unavailable.	No.	No.
Croatia	Information not found.	Information not found.	Information not found.
Cyprus	Yes. "Methodology for Calculation of Energy Efficiency of Buildings" and "building insulation guide (2nd Version)" are used for calculation of ECPs. In addition, "Guide to Certifying Existing Residential Energy Performance" is used as a guide for collecting and evaluating input data for existing residential buildings (Dracou, Kyprianou, 2016). Private software includes default values for input data, such as construction elements (MODECSOFT Ltd, 2020).	Yes. It appears to be the case, because U-Values are usually declared by the energy assessors to the building authorities (as per law) and are used in the official software (Dracou, Kyprianou, 2016).	Information not found.
Czech Republic	Yes. Czech standard 'CSN 730331-1: Energy performance of buildings - Typical values for calculation - Part 1: General part and monthly calculation data' provides the default values and general input data required for calculation in the national calculation tool (NKN, n.d.).	No. It does not appear to the case as per CSN 730331-1.	Information not found.
Denmark	Yes. Danish Energy Agency has provided a Handbook for Energy Consultants (HB2019) that is used as a reference guide for obtaining input information for EPC labelling of new and existing buildings. In addition, indicative default values for heat transmission values for building elements are provided in an website dedicated for HB2019 (Danish Energy Agency, n.d.).	No. It does not appear to be the case. Destructive and non-destructive tests could be performed to determine the input data. Then, relevant standards could be used to determine or calculate the required input data (Danish Energy Agency, n.d.).	Information not found.
Estonia	Yes. Guidance for obtaining and calculating the required input data from relevant standards, and alternate calculation procedures. Default values for some input parameters are available in the regulation "Methodology for calculating the energy performance of the building" (Methodology for calculation of energy performance of a building - Riigi Teataja, 2019).	No. It does not appear to be the case from the available information.	Yes. The regulation allows for multiple calculation procedures to determine the values for input data (Methodology for calculation of energy performance of a building - Riigi Teataja, 2019).
Finland	Yes. Default values for existing buildings are available (Motiva - Energiatodistusten laskentaohjeet 2018, n.d.).	Information not found.	Information not found.
France	Yes. Default values for typical input data as well as guidance for on-site inspection are provided in guidebooks dedicated for each topic (Roger et al., n.d.).	No. Default values are available.	Information not found.
Germany	No. Guidance on default values for input data are unavailable.	Yes. It is possible to use reliable empirical values for the energetic quality of existing building components by using publication of detailed building typologies at regional level – for asset rating EPCs	Information not found.
Greece	No. Guidance on default values for input data are unavailable.	Yes. Validity ranges for input data are available.	No. Such a provision is unavailable.

	Practical default values for input data are available	Validity ranges for input data are available (or multiple values can be chosen from the available default values)	Alternative calculation methods for determining input values, other than the default values, are available
Hungary	Yes. Practical default values for input data are available.	No. Validity ranges for input data are unavailable.	No. Such a provision is unavailable.
Ireland	Yes. Detailed procedures for carrying out survey in residential and non-residential buildings are available. When information from survey, or other sources, such as manufacturer data are unavailable, default values given in the software should be used (SEAI, 2019 & SEAI, 2019).	No. When input data from primary sources is unavailable, default values should be used (SEAI, 2019 & SEAI, 2019).	Information not found.
Italy	Information not found.	Information not found.	Information not found.
Latvia	No. Guidance on default values for input data are unavailable.	No. Validity ranges for input data are unavailable.	No. Such a provision is unavailable.
Lithuania	Yes. Calculation methodology and default input values are provided in the national regulation on 'Energy performance of buildings. Energy Performance Certification.' (Energy performance of buildings. Energy Performance Certification, 2005)	No. It does not appear to the case.	No. It does not appear to the case.
Luxembourg	Information not found	Information not found.	Information not found.
Malta	Yes. Guidance on default values for input data are available. (Building Regulation Office, 2015)	Information not found.	Information not found.
Netherlands	Yes. The energy quality is determined on the basis of a predetermined limited number of housing characteristic values. These relate to general housing characteristics (type of dwelling, year of construction) and energetic housing characteristics (degree of insulation, type of glass and installation and PV) (Berben & Ieke, 2014).	No. It does not appear to be the case.	Information not found.
Poland	Yes. Default values for some of the calculation fields are available (Regulation Of The Minister Of Infrastructure And Development on the methodology for determining the energy performance of a building or part of a building, and energy performance certificates, n.d.).	No. It does not appear to be the case.	Information not found.
Portugal	It is unclear whether guidance on default values is available.	Information not found.	Information not found.
Romania	Yes. Calculation methodology and default values are available in the regulation MC 001-2006 (Petran, n.d.)	Information not found.	Information not found.
Slovakia	It is unclear whether guidance on default values is available.	Information not found.	Information not found.
Slovenia	Yes. Default values are available (Official Gazette, 2014).	Information not found.	Yes For non-residential buildings also a metered EPC is possible (Official Gazette, 2014).
Spain	Yes. Commercially available software provide for a default value, one data as input parameter.	No. Validity ranges for input data are unavailable.	No. Such a provision is unavailable.
Sweden	Yes. Default values for different types of buildings (domestic, office, educational) are available for the calculations made for new buildings in order to assess energy performance before the building is built. There are also default values related to normal use of a building, in order to normalized measured data to normal use. For existing buildings, the EPCs are based on measured energy use.	No. It does not appear to be the case.	No. It does not appear to be the case.

	Practical default values for input data are available	Validity ranges for input data are available (or multiple values can be chosen from the available default values)	Alternative calculation methods for determining input values, other than the default values, are available
UK	Yes. Calculation methodology and default values for various input data are available in SAP, RSAP and NCM.	No. It does not appear to be the case.	No. It does not appear to be the case.

Table 7: EPC software: default values or validity ranges for input parameters

3.3 Online tool for comparing EPC recommendations to deep energy renovation recommendations

An online tool that allows building owners to compare the energy consumption data and the recommendations for energy efficient renovation as per the EPC they received with market average/typical buildings and provides specific deep energy renovation recommendations, which are consistent with typical elements of an individual "deep renovation passport/roadmap", will promote deep renovation. During or even before an energy audit, the tool also acts as a decision support mechanism for building owners to focus on specific measures while choosing between different deep energy efficiency renovation recommendations.

In several MS, an online decision support tool/mechanism for building owners to focus on specific measures while choosing between different energy renovation recommendations is available (see figure below). The Request2Action project, co-funded by the European Commission, has enabled enhancing existing tools and bringing together online resources for homeowners in its project partner countries. Similarly, another European Commission funded project, called RentCal has developed a profitability calculation tool that provides an open and objective comparison of the retrofit opportunities available to investors in the residential rental market. Another project co-financed by the European Regional Development Fund, called 'Prioritise Energy Efficiency (EE) Measures In Public Buildings: A Decision Support Tool For Regional And Local Public Authorities', developed a web-based application, called Decision Support Tool. The tool helps local and regional authorities to quickly evaluate the possibility for energy (and financial) savings by applying various energy efficiency measures in public buildings.

Among QualDeEPC project partner countries, an online decision support tool/mechanism on energy efficiency renovations for residential buildings is available in Germany and Greece. In two other partner countries, Sweden and Bulgaria, an online tool is available that compares energy consumption as per EPC with market average/typical buildings. No Member State or the UK has a tool that offers both features. However, in Italy, the EPC presents a comparison of the building's energy class with similar buildings (Ministry of Economic Development, n.d.).

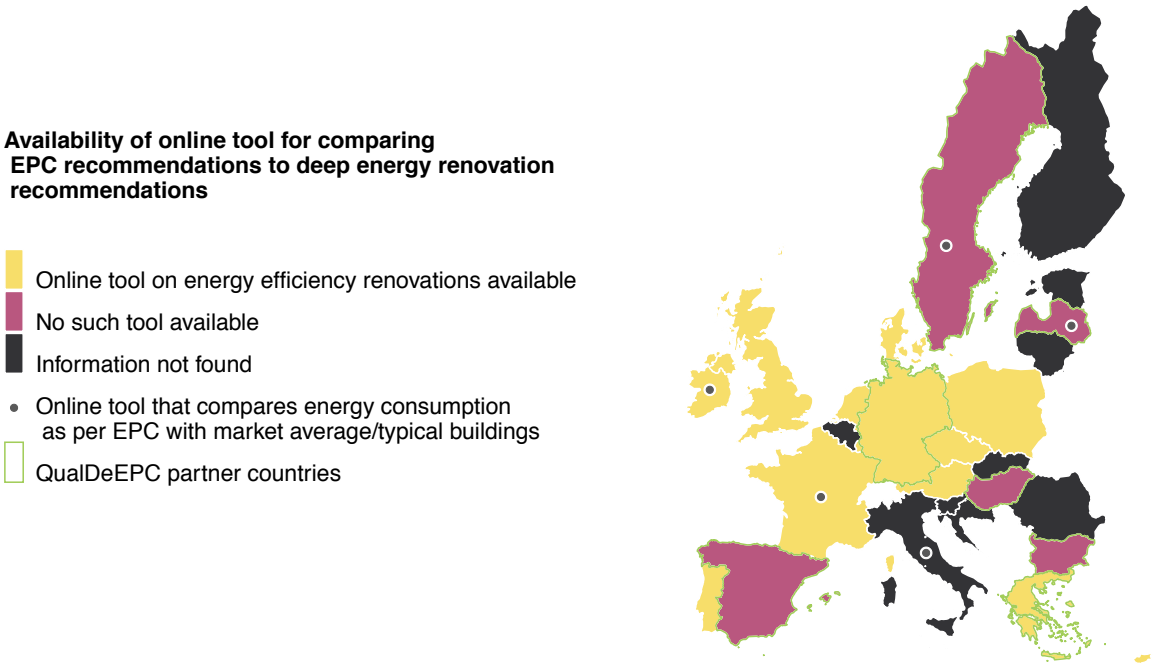

Figure 4: Availability of online tool for comparing EPC recommendations to deep energy renovation recommendations

The following table shows in brief the status of availability of online tools in various Member States.

	Online tool that compares energy consumption as per EPC with market average/typical buildings is available	Online decision support tool/mechanism for building owners to focus on specific measures while choosing between different energy renovation recommendations is available
Austria	Yes. Information not found. EPC only carries reference values as per of minimum energy performance requirements (Energie Tirol, n.d.)	Yes. A suite of online decision support tools for building owners to choose the profitability of various energy efficiency measures is available (Klimaaktiv, n.d.).
Belgium	No. An online tool is available, but compares the energy performance of a given building based on user inputs and compares to market average/typical buildings. It might not compare EPC of a building with market average/typical buildings (VITO, n.d.).	No. However, the development of such tools is envisaged under BEreel project (BEreel, n.d.).
Bulgaria	No. Online tool is unavailable.	No. Online tool is unavailable.
Croatia	Information not found.	Information not found.
Cyprus	Information not found.	Yes. An online tool is available that provides recommendations and cost-comfort analysis. However, it does not appear to be connected to EPC or EPC rating (Energy Saving Tools, n.d.).
Czech Republic	Information not found.	Yes. Czech Republic is a partner in the RentCal project and has dedicated national pages on the rental market and a translated RentCal tool in Czech (RentalCal, n.d.).
Denmark	No. However, one can compare EPCs of different buildings on a publicly accessible database of EPCs (SparEnergi.dk, 2015).	Yes. Energy efficient building solutions, their tentative costs and along with the details of vendors and handworkers is available on SparEnergi.dk. IT tools for cost-benefit analysis of energy efficient renovations is available from National Building Research Institute (SBi, n.d.). Denmark is a partner in the RentCal project and has dedi-

	Online tool that compares energy consumption as per EPC with market average/typical buildings is available	Online decision support tool/mechanism for building owners to focus on specific measures while choosing between different energy renovation recommendations is available
		cated national pages on the rental market and a translated RentCal tool in Danish (RentalCal, n.d.).
Estonia	Information not found.	Information not found.
Finland	Information not found.	Information not found.
France	Yes. This feature is available on the public EPC database (ADEME - Web DPE, n.d.)	Yes. France is a partner in the RentCal project and has dedicated national pages on the rental market and a translated RentCal tool in French (RentalCal, n.d.).
Germany	No. Online tool is unavailable.	Yes. A tool from the Ministry for Economic Affairs and Energy is available (BMWi, 2015). Germany is also a partner in the RentCal project and has dedicated national pages on the rental market and and a translated RentCal tool in German (RentalCal, n.d.).
Greece	No. Online tool is unavailable.	Yes. One-stop-shop for building renovation, called EnergyHUB for ALL, is available online (CRES, 2017)
Hungary	No. Online tool is unavailable.	No. Online tool is unavailable.
Ireland	Yes. National BER Research tool provides for searching dwelling based on their BER (EPC) rating, location, area, year of construction. The results show main space heating fuel and efficiency, thermal transmission values of building envelope etc. for buildings with similar search criteria (SEAI, n.d.).	Yes. SEAI provides various tools for assessing energy savings by opting for efficient lighting and heating systems etc. However, most of the tools are available for download a spreadsheets (SEAI, n.d.).
Italy	Yes. However, its is a mobile application that compares the real consumption of the property with the reference energy requirement for condominium-type buildings, assigning each building a class of merit (good / sufficient / insufficient) for both heating and electrical consumption. It also includes a list of interventions to optimize its performance (Department of Energy Efficiency Units, 2020).	Information not found.
Latvia	Yes. However, it is not actually a tool but each year for 3 types of buildings the value of space heating consumption is given (this value then goes into EPC)	No. Online tool is unavailable.
Lithuania	Information not found.	Information not found.
Luxembourg	Information not found.	Yes. An online tool, called Energy Pass Simulator by myenergy Luxembourg, is available. It evaluates the energy efficiency of buildings based on inputs (and not based on EPCs) and provides recommendations for improving energy performance of buildings (myenergy Luxembourg, n.d.).
Malta	Information not found.	Information not found.
Netherlands	Information not found.	Yes. An online tool that provides recommendations for energy efficient improvements for dwellings as well as cost benefit analysis is available (Verbeterjehuis.nl, n.d.). Netherlands is a partner in the RentCal project and has dedicated national pages on the rental market and a translated RentCal tool in Dutch (RentalCal, n.d.).
Poland	Information not found.	Yes. Poland is a partner in the RentCal project and has dedicated national pages on the rental market and a translated RentCal tool in Polish (RentalCal, n.d.).
Portugal	Information not found.	Yes. An online tool is available as a part of one-stop-shop (Casa Eficiente 2020, 2020).
Romania	Information not found.	Information not found.

	Online tool that compares energy consumption as per EPC with market average/typical buildings is available	Online decision support tool/mechanism for building owners to focus on specific measures while choosing between different energy renovation recommendations is available
Slovakia	Information not found.	Information not found.
Slovenia	Information not found.	Information not found.
Spain	No. Online tool is unavailable.	No. There are six tools, but they are not online. One of them, CE3X offers the possibility the EPC assessor writes recommendations. Having an online tool is interesting and should be impartial. According to the results of the questionnaires it is a good idea that the tool will provide specific recommendations for deep energy renovation. However, Spain is a regional partners for the programme RentCall and an adaptation of that tool for Spain is available.
Sweden	Yes.	No. There are commercial programs for sale that are adapted to Swedish EPC.
UK	Information not found	Yes. Service of the Energy Saving Trust: Home Energy Check Home Energy Check Scotland includes lot of detailed information, tools and calculators, Financial Support, lists of registered handcrafts, database of energy efficient products (Energy Saving Trust, n.d. & Energy Saving Trust, n.d.). UK is a partner in the RentCal project and has dedicated national pages on the rental market and and a translated RentCal tool in English (RentalCal, n.d.).

Table 8: Availability of online tool for comparing EPC recommendations to deep energy renovation recommendations

3.4 On-site inspection during EPC assessment

During EPC assessment, an on-site inspection (including interview/consultation with the owner) is very useful. It has the advantages of reducing the input errors to a minimum, but it entails an additional cost. Furthermore, in some countries, EPC software does not provide recommendations automatically (e.g., based on a database of building typology and renovation measures), and the assessor chooses recommendations from a given list of measures or provides their recommendations. In such cases, it is even more important to conduct an on-site visit to provide building-specific recommendations.

In most Member States, an on-site visit is either mandatory for all buildings or mandatory for some category of buildings (e.g., existing/residential/non-residential/public).

Among QualDeEPC partner countries, Spain and Germany have no requirements or guidelines for an on-site inspection, while on-site inspection is mandatory for all buildings in Sweden, Greece, Bulgaria, and Latvia. In Hungary, on-site inspection appears to be voluntary, subject to interpretation.

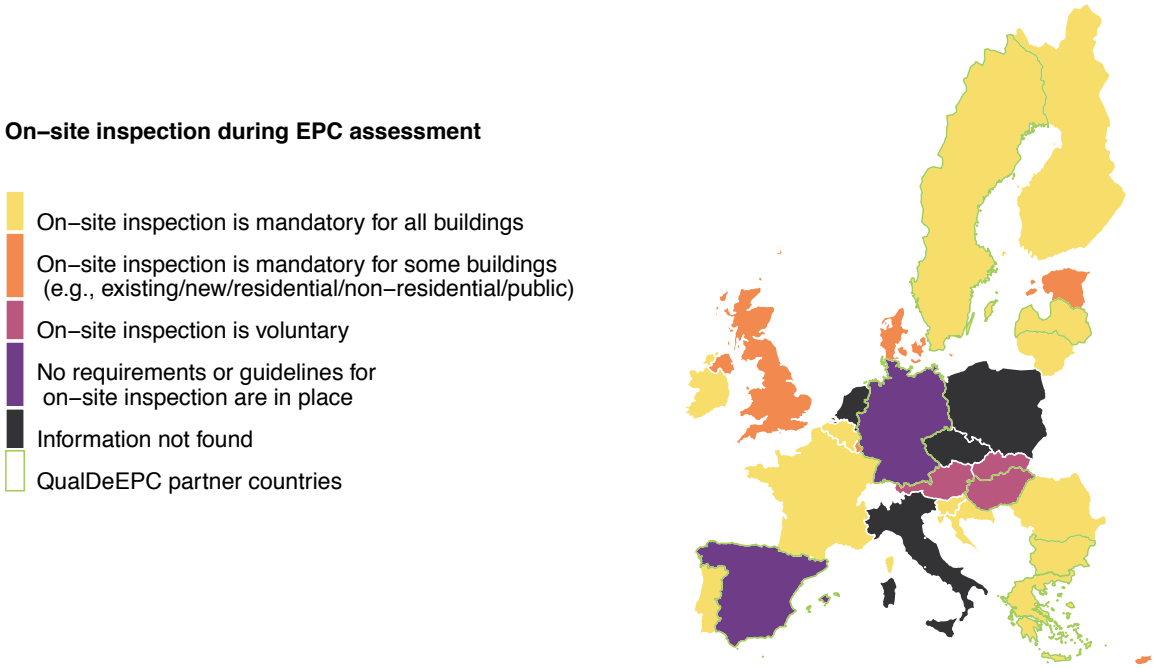

Figure 5: On-site inspection during EPC assessment

The following table shows in brief the status of requirement for on-site inspection during EPC assessment in various Member States.

	On-site inspection is mandatory for all buildings	On-site inspection is mandatory for some buildings (e.g., existing/new/residential/non-residential/public)	On-site inspection is voluntary
Austria	No. On-site inspection is not required (Arcipowska et al., 2014).	No. See column 1	Yes. It is recommended especially for old buildings (Austrian Energy Agency, n.d.).
Belgium	Yes. On-site inspection is mandatory for all buildings (Loncour et al., 2016)	No. See column 1	No. See column 1
Bulgaria	Yes. It is mandatory, but not ever implemented.	No. See column 1	No. See column 1
Croatia	Yes. An on-site visit and energy audit is mandatory for the issuance of EPC (Ordinance on energy auditing of buildings and energy certification, 2017).	No. See column 1.	No. See column 1.
Cyprus	No. On-site inspection is not required for all buildings (Dracou, Kyprianou, 2016).	Yes. It appears that on-site inspections are required only for existing buildings (Dracou, Kyprianou, 2016).	No. See column 1 and 2
Czech Republic	No. On-site inspection is not required (Arcipowska et al., 2014).	No. See column 1	No. See column 1
Denmark	No. On-site inspection is not required for all buildings (Bekendtgørelse om Håndbog for Energikonsulenter (HB2019), 2019).	Yes. On-site inspection is required only for few categories of buildings, such as detached single-family houses, row houses (Bekendtgørelse om Håndbog for Energikonsulenter (HB2019), 2019).	No. See column 1 and 2.
Estonia	No. On-site inspection is not required for	Yes. On-site inspections are required	No. See column 1 and 2.

	On-site inspection is mandatory for all buildings	On-site inspection is mandatory for some buildings (e.g., existing/new/residential/non-residential/public)	On-site inspection is voluntary
	all buildings (Arcipowska et al., 2014)	only in exceptional circumstances (Arcipowska et al., 2014).	
Finland	Yes. On-site inspection if mandatory for all buildings (FINLEX ® - Säädökset alkuperäisinä, n.d.)	No. See column 1.	No. See column 1.
France	Yes. On-site inspection is required for all buildings (Ministry of the Ecological and Inclusive Transition, n.d.).	No. See column 1.	No. See column 1.
Germany	No. See column 3	No. See column 3	It has to be differentiated to which occasion the EPC is issued, but there are alternatives allowed
Greece	Yes. On-site inspection is required for all buildings.	No. See column 1.	No. See column 1.
Hungary	No. It is an interesting situation in Hungary: the related regulation about the EPCs does not explicitly state that an on-site inspection is required. It is only in the annex of the regulation, describing the required content of the EPC, saying that it is mandatory to include a photo of the building's specific structures (such as each of the facades, the most characteristic window) and the engineering's (such as heat generators). Based on this, it is a general concern among assessors that it is compulsory, although they are well aware that in many cases (especially when a real estate is purchased or rented, so the EPC is needed "just for the record") on-site visit does not happen.	No. See column 1.	Yes. Based on the remarks regarding the requirements of photographs, it can be assumed that there are no clear requirements for a site-visit. Because, photographs can be acquired electronically from a source even without a site visit.
Ireland	Yes. On-site inspection is required for all buildings. The BER Assessor is required to visit premises being assessed (SEAI, 2019 & SEAI, 2019).	No. See column 1	No. See column 1
Italy	No. On-site inspection is not required for all buildings (Arcipowska et al., 2014)	No. See column 1.	No. See column 1.
Latvia	Yes. It is hard to say whether it is mandatory but it is common practice that the buildings get inspected	No. See column 1.	No. See column 1.
Lithuania	Yes. On-site in spection is required for all buildings (Arcipowska et al., 2014).	No. See column 1.	No. See column 1.
Luxembourg	No. On-site in spection is not required for all buildings (guichet.public.lu, n.d.).	Yes. On-site inspection is mandatory for existing buildings (guichet.public.lu, n.d.).	No. See column 1 and 2.
Malta	Yes. On-site in spection is required for all buildings (Arcipowska et al., 2014).	No. See column 1.	No. See column 1.
Netherlands	No. On-site visit is not required (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2015).	No. See column 1.	No. See column 1.
Poland	No. On-site visit is not required (Arcipowska et al., 2014).	No. See column 1.	No. See column 1.
Portugal	Yes. On-site in spection is required for all buildings (Arcipowska et al., 2014).	No. See column 1.	No. See column 1.

	On-site inspection is mandatory for all buildings	On-site inspection is mandatory for some buildings (e.g., existing/new/residential/non-residential/public)	On-site inspection is voluntary
Romania	Yes. On-site inspection is required for all buildings	No. See column 1.	No. See column 1.
Slovakia	No. EPCs can be issued online. An on-site inspection is not necessary (e.g. www.sse.sk).	No. See column 1.	Yes An on-site inspection is possible, but more expensive (e.g. www.sse.sk).
Slovenia	Yes. The EPC issuance includes the inspection of the building and installations, analysis of building and energy use data and the calculation of the necessary energy indicators. On-site inspection is not obligatory for dwellings and new buildings (Official Gazette, 2014).	No. See column 1.	No. See column 1.
Spain	No. On-site visit is not mandatory, but there is a proposal for RD235/2013 modifications that will include the mandatory visit.	No. See column 1.	No. See column 1.
Sweden	Yes. On-site visit is mandatory for all buildings.	No. See column 1.	No. See column 1.
UK	No. On-site visit is not required for all buildings (Department for Communities and Local Government, 2017).	Yes, On-site visit is mandatory for existing buildings, but not for new buildings. (Department for Communities and Local Government, 2017)	No. See column 1 and 2.

Table 9: On-site inspection during EPC assessment

3.5 High user-friendliness of the EPC

For its effectiveness and market acceptance, very high user-friendliness of various aspects of EPCs, such as presentation of energy consumption and rating, and recommendations for renovation, potential energy (and cost) savings and other benefits is essential. It would be optimal if it was the first step to the development of an individual deep renovation passport/roadmap for a building.

In all Member States, energy rating on EPC is presented in classes, except in Malta and Poland, where a sliding scale is used to represent the energy performance of the building; and in Slovenia, where both classes and sliding scale are used for new buildings, and only a sliding scale is used for existing buildings. EPCs also often provide detailed information on the existing construction and building systems, and describe the calculation methodology.

The following figure shows the status of three aspects of user-friendliness of the EPC in different Member States. Recommendations are usually based on their potential of technical and economic feasibility for implementation and are presented in EPCs of all Member States, in compliance with the EPBD. A list of possible recommendations is often available to the EPC assessors, from which they are able to choose the ones that are cost effective to implement. However, in most cases they are free to suggest other recommendations, based on justification. In some EPCs recommendations are classified and bundled under categories, such as:

- Improvements in building components and technologies, e.g., building envelope, technical systems etc.

- Short-term improvements and long-term improvements, i.e., improvements that are immediately required and improvements that could take place when the building components or systems are repaired or replaced in the near future.
- Major and minor improvements, based on the amount of their energy and cost savings.

A clear presentation of potential energy (and cost) savings and benefits (e.g., increased comfort levels) that could be obtained by implementing the recommendations are provided in 17 countries. In few countries such as Italy and Luxembourg, recommendations are presented along with clear evidence of payback periods, and class achievable through implementing the renovations either individually or cumulatively.

Among QualDeEPC project partners, EPC rating and recommendations are provided in Spain and Hungary, while in the other countries, potential energy and cost savings and benefits by implementing the recommendations are also presented (in Germany, this is voluntary).

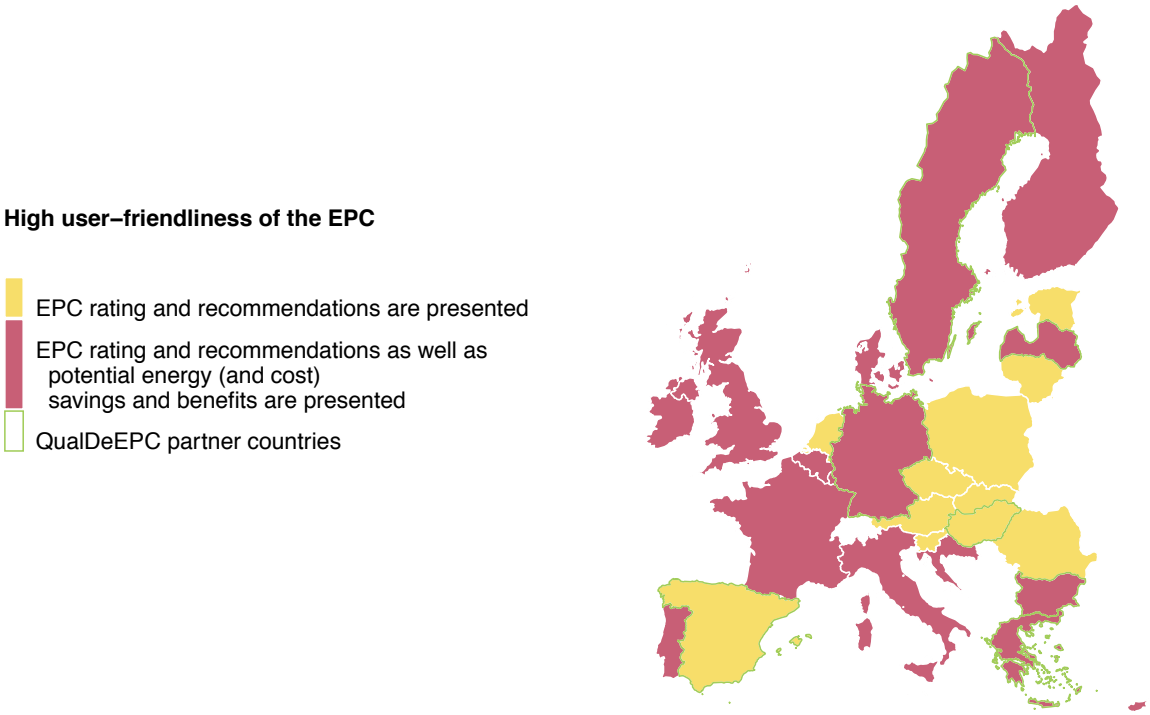

Figure 6: High user-friendliness of the EPC

	EPC rating is presented (classes or sliding scale)	EPC rating and recommendations for renovation are presented	EPC rating and recommendations as well as potential energy (and cost) savings and benefits are presented
Austria	Yes. EPC rating is presented in classes (Energie Tirol, n.d.).	Yes. Recommendations for renovation are presented in the Annex (Energie Tirol, n.d.)	No. Potential energy and cost savings and benefits are not presented.
Belgium	Yes. EPC rating is presented in classes (environnement.brussels, n.d., Energiesparen.be, n.d., & Wallonie energie SPW, n.d.).	Yes. However, presentation might vary regionally (environnement.brussels, n.d., Energiesparen.be, n.d., & Wallonie energie SPW, n.d.).	Yes. Recommendations are presented based on their profitability (cost-effectiveness) and technical feasibility. Presentation might vary regionally (environnement.brussels, n.d.).
Bulgaria	Yes. EPC rating is presented in classes.	Yes. See column 3.	Yes. EPC rating and recommendations as well as potential energy (and cost)

	EPC rating is presented (classes or sliding scale)	EPC rating and recommendations for renovation are presented	EPC rating and recommendations as well as potential energy (and cost) savings and benefits are presented
			savings and benefits are presented
Croatia	Yes. EPC rating is presented in classes. (Ordinance on energy auditing of buildings and energy certification, 2017).	Yes. A list of cost effective recommendations are presented (Ordinance on energy auditing of buildings and energy certification, 2017).	Yes. A simple payback period is provided (Ordinance on energy auditing of buildings and energy certification, 2017).
Cyprus	Yes. EPC rating is presented in classes (Xichilos & Hadjinicolaou, n.d.).	Yes. See column 3.	Yes. Recommendations report is presented along with EPC, which consists of information on recommendations and payback periods (Xichilos & Hadjinicolaou, n.d.).
Czech Republic	Yes. EPC rating is presented in classes (Šance pro budovy, n.d.).	Yes. Recommendations for improvement are presented. (Šance pro budovy, n.d.)	No. Potential energy and cost savings and benefits are not presented.
Denmark	Yes. EPC rating is presented in classes (SparEnergi.dk, 2016).	Yes. See column 3.	Yes. Recommendations as well as potential tonnes of CO_2 emission and cost savings and benefits are presented. In addition, a list of energy savings that are estimated to be profitable to implement in short-term and long-term are presented (SparEnergi.dk, 2016).
Estonia	Yes. EPC rating is presented in classes (Format and procedure of issuance of energy performance certificates – Riigi Teataja, 2014).	Yes. A list of energy saving measures for existing buildings, which are technically and economically reasonable, is presented (Format and procedure of issuance of energy performance certificates – Riigi Teataja, 2014).	No. Not required as per the regulation (Format and procedure of issuance of energy performance certificates – Riigi Teataja, 2014).
Finland	Yes. EPC rating is presented in classes (Motiva, n.d.).	Yes. See column 3.	Yes. Recommendations as well as potential energy savings are presented (Motiva, n.d.).
France	Yes. EPC rating is presented in classes (Ministry of the Ecological and Inclusive Transition, n.d.).	Yes. See column 3.	Yes. Recommendations as well as potential investment, savings, payback period and tax credits are presented (Roger et al., n.d.).
Germany	Yes. EPC rating is presented in classes on a sliding scale. However, for general public, the system is difficult to understand, e.g. demand and consumption based EPCs are not comparable.	Yes. See column 3.	Yes. Data on payback times or cost of kWh saved are presented. However, this is voluntary.
Greece	Yes. EPC rating is presented in classes.	Yes. See column 3.	Yes. EPC rating and recommendations as well as potential energy (and cost) savings and benefits are presented.
Hungary	Yes. EPCs in Hungary contain the calculations, with lots of formulae and numbers, which is usually non-comprehendible by the user. They usually don't understand anything apart from the energy class, but it doesn't mean much to them.	Yes. However, the recommendations part is although compulsory, it is not very well developed, it usually includes only broad suggestions of measures (such as: heat insulation of the facades is recommended). The current practice does not motivate homeowners to use EPCs, they only find it a burden.	No. Potential energy (and cost) savings and benefits are not presented
Ireland	Yes. EPC rating is presented in classes. (SEAI, 2019).	Yes. See column 3.	Yes. An advisory report is accompanied to the BER certificate, identifying potential improvements that could lead

	EPC rating is presented (classes or sliding scale)	EPC rating and recommendations for renovation are presented	EPC rating and recommendations as well as potential energy (and cost) savings and benefits are presented
			to better comfort levels, reduced energy use and costs. This advisory report shows in detail for each building component possible improvement measures. These measures are rated with Costs: low to high, and with Impact: low to high (Commercial Energy Ratings, 2017 & SEAI, 2017).
Italy	Yes. EPC rating is presented in classes. Classes (Ministry of Economic Development, n.d.)	Yes. See Column 3.	Yes. Recommendations have to be mandatorily presented along with the evidence of payback periods, and class achievable through implementing the major renovations (Ministry of Economic Development, n.d.)
Latvia	Yes. EPC rating is presented in classes.	Yes. See Column 3.	Yes. EPC rating and recommendations as well as potential energy (and cost) savings and benefits are presented.
Lithuania	Yes. EPC rating is presented in classes (Encius & Baranauskas, 2018).	Yes. Recommendations for improvement are provided (Encius & Baranauskas, 2018).	No. Potential energy (and cost) savings and benefits are not presented
Luxembourg	Yes. EPC rating is presented in classes (guichet.public.lu, n.d.).	Yes. See column 3.	Yes. A list of measures for improvement as well as their potential energy and cost savings and benefits are presented, along with the new achievable energy class, when the renovation measure is implemented individually or cumulatively (guichet.public.lu, n.d.).
Malta	Yes. EPC rating is presented in sliding scale (draft specimen) (DeBold & Barbara, n.d.).	Yes. EPC rating and recommendations for renovation are presented (Building Regulation Office, 2020)	No. Potential energy (and cost) savings and benefits are not presented.
Netherlands	Yes. EPC rating is presented in classes (Milieu Centraal, n.d.).	Yes. The energy label contains tips on making dwellings more energy efficient (Milieu Centraal, n.d.).	No. Potential energy (and cost) savings and benefits are not presented. (Milieu Centraal, n.d.).
Poland	Yes. Linear continuous scale ranging from 0 to 500 (the lower the number, the more energy efficient) (Regulation on the methodology for determining the energy performance of a building or part of a building, and energy performance certificates, n.d.).	Yes. Recommendations for cost-effective and feasible technical improvement are presented (Regulation on the methodology for determining the energy performance of a building or part of a building, and energy performance certificates, n.d.).	No. Potential energy (and cost) savings and benefits are not presented (Regulation on the methodology for determining the energy performance of a building or part of a building, and energy performance certificates, n.d.).
Portugal	Yes. EPC rating is presented in classes (ADENE, 2019).	Yes. See Column 3.	Yes. Recommendations are presented with cost benefit analysis as well as the potential class achievable by implementing those recommendations, individually and cumulatively (ADENE, 2019).
Romania	Yes. EPC rating is presented in classes (BPIE et al., 2017).	Yes. Recommendations are provided (BPIE et al., 2017).	No. Information on potential energy and cost savings is not often provided (BPIE et al., 2017)
Slovakia	Yes. EPC rating is presented in classes (energeticky-certifikat.sk, n.d.).	Yes. Recommendations are presented (energeticky-certifikat.sk, n.d.).	No. Potential energy (and cost) savings and benefits are not presented.
Slovenia	Yes. Both classes and sliding scale for new buildings and only sliding scale for existing buildings (Offi-	Yes. A list of recommendations is provided. Recommendations should be state of the art and	No. Potential energy savings and benefits are not presented (Official Gazette, 2014).

	EPC rating is presented (classes or sliding scale)	EPC rating and recommendations for renovation are presented	EPC rating and recommendations as well as potential energy (and cost) savings and benefits are presented
	cial Gazette, 2014).	technically feasible. Recommendations target the building shell, energy efficiency, use of renewable energy and organizational measures (Official Gazette, 2014). (Official Gazette, 2014).	
Spain	Yes. EPC rating is presented in classes	Yes. However, the EPC assessor may write or not the recommendations and these are included in another file.	No. Potential energy (and cost) savings and benefits are not presented.
Sweden	Yes. EPC rating is presented in classes.	Yes. See column 3.	Yes. Recommendations and potential energy savings should be reported if they are cost-effective. This means that only a few recommendations are actually given.
UK	Yes. EPC rating is presented in classes (Energy Saving Trust, n.d.).	Yes. See Column 3.	Yes. Recommendations for renovation as well as potential energy and cost savings and benefits are presented (Energy Saving Trust, n.d.).

Table 10: High user-friendliness of the EPC

3.6 Improving the renovation recommendations

Improving the renovation recommendations provided on the EPC is important so that it becomes the first step towards an individual buildings 'deep renovation passport/roadmap'. For this purpose, the recommendations should focus on high-energy-efficiency options consistent with deep renovation. Assessment software tools should provide such high-energy-efficiency options in high quality as their output for the renovation recommendations. Furthermore, an improvement would be that the first pages of the EPC would present an overview of such recommendations and (if possible) energy savings, together with links for further information and financial support for implementing the recommendations.

In the following figure, the potential of the EPC to become an individual buildings deep renovation passport/roadmap is analysed by various aspects on the way recommendations are presented, such as potential energy (and cost) savings, benefits for comfort and wellbeing, payback periods, prominent display and explanation of recommendations and links to financial support. Among non-QualDeEPC project partner countries, when most of these features are present in an EPC, then it is regarded as "requirements in force/guidance available to produce the renovation recommendations in a way to become the first step towards individual buildings deep renovation passports/roadmaps". Belgium, Denmark, Ireland, Portugal and UK, along with QualDeEPC project partners Germany, Greece, and Latvia, have progressive EPCs, to motivate and facilitate the building owners towards deep renovation, and with the potential of becoming deep renovation passports/roadmaps.

In most Member States, EPCs provide links to financial support, such as incentives or subsidy schemes that are helpful in carryout the renovations. The quality of EPC software and input data also plays a crucial role for conducting detailed analysis required for deep renovation passports/roadmaps, such as investments costs, savings and payback periods, for example, EPC in UK.

Among QualDeEPC project partner countries, Hungary, Spain and Sweden do not have any of the features that improve the renovation recommendations towards deep renovation. In Germany, rec-

ommendations are presented in the first few pages of EPC (not necessarily the front page). Germany, Greece, and Latvia also indicate that there are requirements/guidance available to produce the renovation recommendations that lead to individual buildings deep renovation passports/roadmaps. Except for Bulgaria, none of the partner countries have EPC software tools that include high quality and high-energy efficiency options for renovation recommendations.

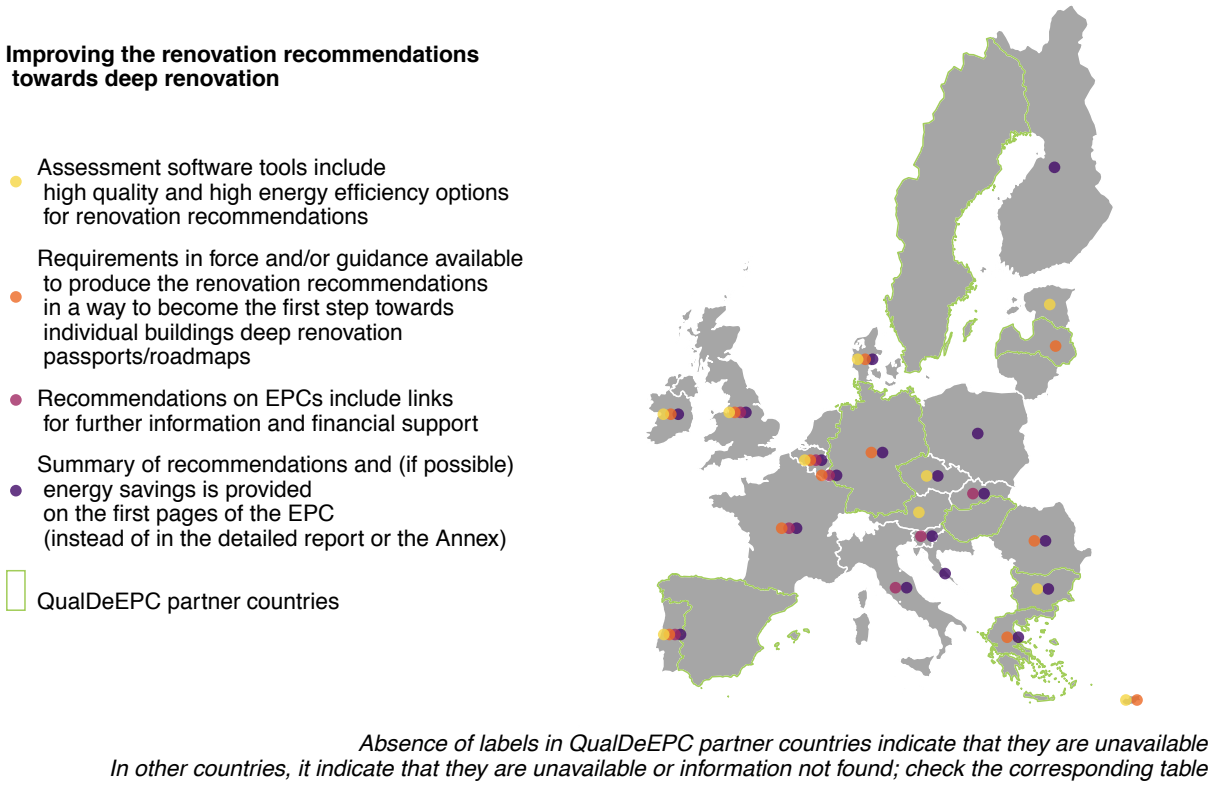

Figure 7: Improving the renovation recommendations towards deep renovation

The following table provides more information regarding improving the renovation recommendations towards deep renovation in various Member States.

	Requirements in force and/or guidance available to produce the renovation recommendations in a way to become the first step towards individual buildings deep renovation passports/roadmaps	Assessment software tools include high quality and high energy efficiency options for renovation recommendations	Summary of recommendations and (if possible) energy savings is provided on the first pages of the EPC (instead of in the detailed report or the Annex)	Recommendations on EPCs include links for further information and financial support
Austria	Information not found.	Yes. EPC software GEQ provides high quality and high-energy efficiency options (GEQ, n.d.). However, this could potentially be tool specific and not all available tools may have this feature (Energie Tirol, n.d.).	No. Recommendations are presented in the Annex (OIB, 2015).	No. Such recommendations are not provided in the guidelines and may be absent from the EPC (OIB, 2015 & Energie Tirol, n.d.).
Belgium	Yes. Recommendations are presented in a way to improve the energy class	Yes. Recommendations are presented in various categories, such as build-	Yes. Recommendations are provided in 2nd and 3rd pages of the EPC report (envi-	Yes. Links to further information and financial information are

	Requirements in force and/or guidance available to produce the renovation recommendations in a way to become the first step towards individual buildings deep renovation passports/roadmaps	Assessment software tools include high quality and high energy efficiency options for renovation recommendations	Summary of recommendations and (if possible) energy savings is provided on the first pages of the EPC (instead of in the detailed report or the Annex)	Recommendations on EPCs include links for further information and financial support
	of the building. Information and benefits for further pursuing a detailed energy audit and acting on the recommendations are presented (Energiesparen.be, n.d.).	ing envelope, heating and hot water installations, ventilation system and renewables (Energiesparen.be, n.d.).	ronnement.brussels, n.d., Energiesparen.be, n.d., & Wallonie energie SPW, n.d.).	provided (Wallonie energie SPW, n.d.).
Bulgaria	No. No such requirements or guidance are in place.	Yes. High quality and high energy efficiency options are presented.	Yes. Summary of recommendations are provided on the first pages of the EPC.	No. Links to financial support are not provided.
Croatia	No. Recommendations are only listed with a simple payback period.	No. The national calculation tool is still in test phase and there are no commercial tools.	Yes. A list of cost-effective recommendations is presented on the third page of EPC (Ordinance on energy auditing of buildings and energy certification, 2017).	No. It does not appear to be the case in the prescribed format of the EPC (Ordinance on energy auditing of buildings and energy certification, 2017).
Cyprus	Yes. Renovation recommendations are provided along with their costs for their implementation. Three set of recommendations are provided, short, medium and long payback period recommendations. Further, their impact on energy savings has also to be evaluated as low, medium or high (Xichilos & Hadjinicolaou, n.d.)..	Yes. EPC software presents some recommendations, and the assessor can choose from this list and/or can create their own set of recommendations (Xichilos & Hadjinicolaou, n.d.).	No. Recommendations are provided as supplementary document to the EPC. However, EPC is only 2 pages long.	No. Links to financial support are not provided.
Czech Republic	Only a summary of the improvements is provided on the first pages of EPC (Šance pro budovy, n.d.).	Recommendations are presented in various categories, such as building envelope, heating and hot water installations, ventilation system (Šance pro budovy, n.d.)	Summary of recommendations is provided in the second page and their impact on energy performance is provided on the first page of the EPC certificate. Detailed description of the recommendations are provided separately (Šance pro budovy, n.d.)	Information not found.
Denmark	Yes. The Danish government launched a comprehensive strategy for energy renovation of the existing building stock in May 2014, which includes various activities and programmes, including steps to making the EPCs more robust and ensure further support of the	Yes. Private software appear to include high quality and high energy efficiency options for renovation recommendations (SparEnergi.dk, 2016).	Yes. Best choice of recommendations is provided on the second page and a detailed description of recommendations is also provided in the pages following that (SparEnergi.dk, 2016).	Information not found.

	Requirements in force and/or guidance available to produce the renovation recommendations in a way to become the first step towards individual buildings deep renovation passports/roadmaps	Assessment software tools include high quality and high energy efficiency options for renovation recommendations	Summary of recommendations and (if possible) energy savings is provided on the first pages of the EPC (instead of in the detailed report or the Annex)	Recommendations on EPCs include links for further information and financial support
	energy renovation of buildings (Thomsen et al., 2016).			
Estonia	Information not found.	Yes. Recommendations are usually provided by the EPC issuer from the list provided in the electronic environment for drafting energy performance certificates in the national register of construction works and entered into the registry. Recommendations are presented in various categories, such as building envelope, heating and hot water installations, ventilation system (Format and procedure of issuance of energy performance certificates – Riigi Teataja, 2014).	No. It does not appear to be the case (Format and procedure of issuance of energy performance certificates – Riigi Teataja, 2014).	No. It does not appear to be the case (Format and procedure of issuance of energy performance certificates – Riigi Teataja, 2014).
Finland	Information not found	No. Assessment software appears to be used only to calculate building energy performance and the corresponding EPC class. Recommendations are provided by the assessor based on the on-site visit.	Yes. Summary of recommendations is provided on the second page and details are provided few pages later (Motiva, n.d.).	No. Links to financial support are not mandatorily provided.
France	Yes, renovation recommendations are provided in sufficient detail to be able to become the first step towards individual buildings deep renovation passport/roadmaps.	No. Assessor has to provide recommendations based on the site inspection. A 'recommendations guide' is available for guidance on how to provide cost-effective recommendations (Roger et al., n.d.)..	Yes. Recommendations are summarized on page 4 of EPC (Roger et al., n.d.).	Yes. Links for further information and financial support are provided (Roger et al., n.d.).
Germany	Yes.	No. Assessment tools do not include high quality and high energy efficiency options for renovation.	Yes. Recommendations focus on cost-effective measures and are shown on page 4 of the EPC	No. Links to financial support are not provided.
Greece	Yes.	No.	Yes. Auditors provide the recommendations on the 2nd page of the EPC (up to 3). Technical Guides include an extensive list, to assist auditors in the selection of improve-	No. Links for further information and financial support are not provided.

	Requirements in force and/or guidance available to produce the renovation recommendations in a way to become the first step towards individual buildings deep renovation passports/roadmaps	Assessment software tools include high quality and high energy efficiency options for renovation recommendations	Summary of recommendations and (if possible) energy savings is provided on the first pages of the EPC (instead of in the detailed report or the Annex)	Recommendations on EPCs include links for further information and financial support
			ment scenario.	
Hungary	No. Recommendations usually don't contain very specific information.	No.	Yes. Recommendations are a compulsory part of the EPCs, but they are not necessarily on the first pages.	No. See column 1.
Ireland	Yes. Grants are linked to some of the potential renovation recommendations (SEAI (grants), n.d.).	Yes. SBEMie software generates a detailed advisory report listing potential renovation recommendations for cost effective improvement to the energy performance of the building.	Yes. A detailed advisory report listing potential renovation recommendations has to be added to the BER. Although it is technically an Anex, as the EPC is only one page, this is the next piece of information that is available as a part of the EPC (Commercial Energy Ratings, 2017 & SEAI, 2017).	No. BER rating includes only the current energy efficiency rating and does not provide a potential rating based upon modifications that could be made.
Italy	No. Recommendations are only listed with a simple payback period.	Information not found	Yes. The section on recommendations is on the second page. It reports the recommended interventions and the estimate of the results achievable, with the single intervention or with the realization of all of them, expressing a rough assessment of the potential for improvement of the building or property subject to the energy performance certificate (Ministry of Economic Development, n.d.).	Yes. Page 4 of EPC provides information on opportunities; also in terms of national or local support tools, related to the execution of energy audits and energy redevelopment interventions, including major renovations.
Latvia	Yes.	No.	No.	No. EPC has a mandatory annex with calculation of energy efficiency measures.
Lithuania	Information not found	Information not found	Information not found	Information not found
Luxembourg	Yes, renovation recommendations are provided in sufficient detail to be able to become the first step towards individual buildings deep renovation passport/roadmaps.	No. Renovation recommendations are provided by the Assessor based on the site visit (Reding & Flies, n.d.).	Yes. A list of measures for improvement as well as their potential energy and cost savings and benefits are presented in page five of the EPC (guichet.public.lu, n.d.).	YES Links are provided below the recommendations measures (guichet.public.lu, n.d.).
Malta	Information not found	Information not found.	Information not found.	Information not found.
Netherlands	No. The building owners themselves via online portal generate EPC. There does not appear to be any mechanism for presenting renovation recommendations (Milieu Centraal, n.d.).	See column 1.	See column 1.	See column 1.

	Requirements in force and/or guidance available to produce the renovation recommendations in a way to become the first step towards individual buildings deep renovation passports/roadmaps	Assessment software tools include high quality and high energy efficiency options for renovation recommendations	Summary of recommendations and (if possible) energy savings is provided on the first pages of the EPC (instead of in the detailed report or the Annex)	Recommendations on EPCs include links for further information and financial support
Poland	No. Cost-effective and feasible recommendations are provided, without further information for making informed choice on renovation recommendations.	Information not found.	Yes. Recommendations are provided in the third page of the EPC report (Regulation on the methodology for determining the energy performance of a building or part of a building, and energy performance certificates, n.d.).	No. No links are provided (Regulation on the methodology for determining the energy performance of a building or part of a building, and energy performance certificates, n.d.).
Portugal	Yes. Funding schemes for energy efficient renovation are designed using the information available in EPC database. EPC is provided in sufficient detail to be able to become the first step towards individual buildings deep renovation passport/roadmap (EPBC-CA, 2018).	Yes. At least one of the available software tools has the capability to conduct and present techno economic feasibility of renovation recommendations (Itecons, n.d.).	Yes. Summary of recommendations are presented on page 2 and 3 (ADENE, 2019).	Yes. Links to financial incentive schemes are provided immediately after presenting the recommendations (ADENE, 2019).
Romania	Yes. EPC data is used to map energy renovation opportunities and could also be used to monitor and showcase implemented renovation projects for European Commission's Horizon 2020 programme, the ENERFUND online app (Tenea et al., 2018).	Information not found	Yes. Summary of recommendations are provided on page 2 (Construction21.org, n.d.).	No. Links are not available as per the prescribed format.
Slovakia	No. Only generic recommendations are provided (energeticky-certifikat.sk, n.d.).	Information not found	Yes. Recommendations are presented on the first page itself (energeticky-certifikat.sk, n.d.).	Yes. Links to financial incentives are presented beside the recommendations (energeticky-certifikat.sk, n.d.).
Slovenia	No. Only generic recommendations are provided (Official Gazette, 2014).	No. See column 1 (Official Gazette, 2014).	Yes. Recommendations are provided on page 3 of the EPC report (Official Gazette, 2014).	Yes. The energy performance certificate lists sources for more detailed information on the cost-effectiveness of the recommendations. It also provides information on the measures to be taken to implement the recommendations, as well as information on energy audits and other incentives and funding options (Official Gazette, 2014).

	Requirements in force and/or guidance available to produce the renovation recommendations in a way to become the first step towards individual buildings deep renovation passports/roadmaps	Assessment software tools include high quality and high energy efficiency options for renovation recommendations	Summary of recommendations and (if possible) energy savings is provided on the first pages of the EPC (instead of in the detailed report or the Annex)	Recommendations on EPCs include links for further information and financial support
Spain	No.	No.	No. The EPC assessor may write or not the recommendations and these are included in another file.	No.
Sweden	No.	No.	No.	No.
UK	Yes. Renovation recommendations and the associated information are presented in a way to become first step towards individual deep renovation passports (Energy Saving Trust, n.d.).	Yes. As per requirements in SAP (BRE, n.d.).	Yes. Current and potential of energy use, CO_2 emissions, lighting costs, heating costs and hot water costs are presented on the 1st page. Further recommendations (lower cost measures plus further measures) are presented on page 3 (Energy Saving Trust, n.d.).	Yes. Links and eligibility for an individual recommendation to be financed under Green Deal are presented in the table of recommendations along with capital cost, typical savings per year, rating after implementing the recommendation (Energy Saving Trust, n.d.).

Table 11: Improving the renovation recommendations towards deep renovation

3.7 Compliance between EPC rating and operational rating

In all Member States, except in Sweden, EPC rating for new buildings is based on asset rating and not revised to reflect operational rating. In Sweden, new buildings must have an EPC based on metered energy use two years after they have been built, at the latest; however, some buildings need an EPC from the start, which means that there are no measured values yet. In such cases, it can then be based on calculations (valid for 10 years). In existing buildings, it has been observed that some of the countries base the EPC rating on an operational rating. Sometimes, different EPCs based on asset and operational ratings are issued for different building typologies, such as residential and non-residential buildings.

3.8 EPC scheme for new buildings compatible with NZEB requirements

Article 9 of the EPBD directs that by 2019 and 2021, all new buildings owned by public authorities and all new buildings, respectively, are nearly zero-energy buildings (NZEB) (based on country specific definitions of NZEB). Furthermore, countries are required to draw national plans for increasing the number of nearly zero-energy buildings. This section examines whether the existing EPC schemes already include and display NZEB-equivalent benchmarks (country specific definitions) along with the corresponding energy rating on the EPC label. For example, if existing energy rating class 'B' for a category of buildings correspond to national NZEB definitions, then the EPC label clearly indicates that energy rating class 'B' as NZEB or this is clearly indicated in the corresponding policy document, such as the national plan for NZEB. In EPCs, this highlights whether the buildings already meet the NZEB 2019/2021 requirements. However, once Article 2 of the EPBD is implemented and enforced by

the countries from 2021, EPC energy rating class/scale for new buildings needs to be compatible with country specific definitions of NZEB requirements. Furthermore, most of the countries have already enforced NZEB requirements for public buildings from 2019 (a few countries from even before that), and it is unclear whether the EPCs already reflect a new scale for energy class for these buildings, which meet NZEB requirements.

The following figure shows whether and how current EPC schemes reflect NZEB in various Member States. In about 10 countries EPCs already clearly indicate when the buildings meet NZEB requirements. In some countries this is indicated on the existing energy scale, as an add-on to the best class, which is A, for example, as A++ in Lithuania, A2020 in Denmark, A2 in Ireland etc. In other countries, it is displayed as a check box, for example, in Italy.

Among QualDeEPC countries, EPCs in Bulgaria, Hungary, Spain and Sweden are compatible with NZEB requirements.

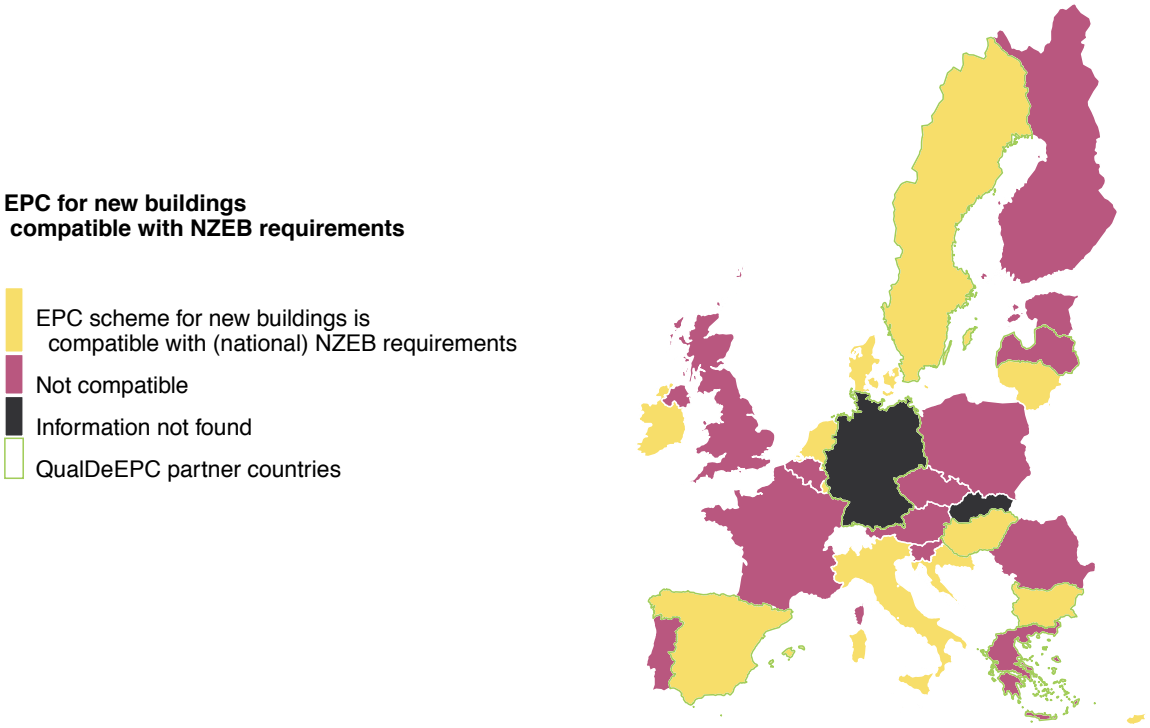

Figure 8: Compatibility of EPCs with NZEB requirements

The following table shows in brief whether and how current EPC schemes reflect NZEB in various Member States.

	EPC scheme for new buildings is compatible with (national) NZEB requirements
Austria	No. After 31 December 2020, all new buildings shall be NZEB within the meaning of Article 2(2) of Directive 2010/31/EU and as defined in OIB-330.6-014/14-012 National Plan for low energy buildings (Altmann-Mavaddat et al., 2016). However, existing EPC does not indicate energy rating class that corresponds to NZEB.
Belgium	No. Cost-optimal studies have been conducted to define NZEB based on an energy performance indicator (E-level) and a timeline has been established for enrolling it in different building typologies. However, NZEB is not reflected in EPCs (De Meulenaer & Triest, 2018).
Bulgaria	Yes.

	EPC scheme for new buildings is compatible with (national) NZEB requirements
Croatia	Yes. EPC enrols the building as NZEB if the energy performance of a building meets the requirements for zero energy buildings (Ordinance on energy auditing of buildings and energy certification, 2017).
Cyprus	Yes. 2nd national plan for increasing the number of NZEBs indicates that NZEB class as 'A'.
Czech Republic	No. NZEB definitions are in place and all new buildings must gradually meet NZEB requirements since 2016, subject to their floor area and whether the buildings are public buildings, to ensure that all new buildings completed by 31 December 2020 will be NZEBs. However, NZEB is not reflected in the existing EPCs (Svoboda et al., n.d.).
Denmark	Yes. EPC has three categories in class A, A2010, A2015, and A2020, which represent. The year refers to the building regulations that the building meets. Building which voluntarily complies with the building class 2020 (equivalent to NZEB level) energy requirements from 2020 is labeled A2020 (Thomsen et al., 2016 & SparEnergi.dk, 2016).
Estonia	No. Definitions for NZEB and the dates for their enforcement are in place, however, NZEB is not reflected on EPC. Only minimum energy performance (MEP) mark as required by the MEP regulation is shown.
Finland	No. NZEB is not displayed on the EPC.
France	No. NZEB is not displayed on the EPC.
Germany	Information not found.
Greece	No.
Hungary	Yes.
Ireland	Yes. NZEB compatible buildings will have a BER rating of A2 compared with a current rating for new builds of A3 (Rebuilding Ireland, 2019).
Italy	Yes. EPC clearly indicates whether NZEB standard has been attained (Ministry of Economic Development, n.d.).
Latvia	No.
Lithuania	Yes. NZEB is introduced as A++ class in the EPC (Encius & Baranauskas, 2018).
Luxembourg	Yes. In Luxembourg, from 2017, every new residential building will be a Nearly Zero Energy Building (NZEB). As a rule the NZEB corresponds to classes AAA. However, site-specific conditions are also taken into account, which can result in deviations from classes AAA (myenergy, 2020).
Malta	Information not found.
Netherlands	Yes. For new buildings, a different measure of energy efficiency is required, called Energy Performance Coefficient (EPC) (RVO, n.d). An NZEB will have an EPC value of 0. From 2015, building permits were only issued for homes with an EPC of 0.4, and from 2021 EPC of 0 will become mandatory for the issue of building permits (Milieu Centraal, n.d.).
Poland	No. Although, NZEB requirements are in place and are obligatory from 1st January 2021 for all non-public buildings (Bekierski et al., n.d.).
Portugal	No. NZEB is not displayed on the EPC.
Romania	No. However, the EPC format shall be reviewed to introduce diversified energy classes for residential/non-residential NZEB (Tenea et al., 2018).
Slovakia	NZEB is not displayed on the EPC. However, New public buildings must fulfill NZEB requirements from 1 January 2019 (Sternova & Magyar, 2018).
Slovenia	No. NZEB is not displayed on the EPC. (Šijanec & Potočar, 2016).
Spain	Residential buildings that are constructed after 2021 - for public buildings are 2019- must meet the NZEB parameters; These parameters (i.e. energy demand, efficiency etc.) are already included in the CTE, Technical Building Code. The parameters to meet NZEB are different in other countries
Sweden	Yes.
UK	No. NZEB is not displayed on the EPC. However, UK has a target for all new homes to meet the Zero Carbon Standard from 2016 and for all new non-residential buildings from 2019.

Table 12: Compatibility of EPCs with NZEB requirements

3.9 Treatment of innovative technologies in EPC assessment calculations

Achieving converging calculation methods, especially for innovative technologies in the EPC assessment, e.g. for heat recovery ventilation, building automation and control systems, reversible heat pumps, advanced solar shading systems, as well as for renewable energy systems (cf. CA EPBD CCT 1

report) ensures convergence in the EPC assessments between various Member States. Most of the documentation on technologies considered in EPC assessment calculation is in the governing standards or in their national language, which is not easily accessible. Therefore, technologies from few countries, where information could be easily accessible, or from the QualDeEPC partner countries are presented here.

In most Member States and the UK, typical heat generation and distribution systems, and ventilation systems along with heat recovery are considered. Solar thermal and solar PV systems are often considered, however, wind turbines are only considered in few countries. Advanced lighting controls or building automation control (BAC) systems, such as available in Sweden, are not often considered in other countries.

The following table shows in brief the status of treatment of innovative technologies in EPC assessments calculations in various Member States.

	List of innovative technologies that are available in the assessment process
Austria	Yes. OIB-Richtlinie 6, which is a guide document for EPCs, indicates that use of heat recovery systems, highly efficient alternative energy systems, such as decentralization supply system, cogeneration, heat pumps, and solar thermal and photovoltaic systems etc. should be considered. Furthermore, the calculation methodology for EPC, 'Leitfaden Energietechnisches Verhalten von Gebäuden', uses building standards that account for calculation procedures for many advanced building technologies (OIB, 2015).
Belgium	The assessment process considers various heating, cooling and ventilation technologies, and domestic hot water systems. Heating and cooling generation technologies, such as heat pump, solar water heater, cogeneration, and residual heat are considered. Electricity generation through solar PV systems is considered. Shower heat recovery is considered in energy consumption for domestic hot water calculations. Humidification and various lighting systems are also considered for non-residential units (Energiesparen.be, n.d.).
Bulgaria	Information not found.
Croatia	According to CA EPBD Implementation in Croatia, there are requirements for designing and installing heating systems in new buildings - they have to compensate the heat losses in order to maintain indoor thermal comfort. Among other requirements, heating systems must have thermally insulated pipework. For buildings equipped with heating systems with air-to-air heat pumps, the seasonal coefficient of the performance of individual heat pumps (SCOP) should be ≥ 4.0; for heating systems with air-to-water, water-to-water and soil-to-water heat pumps, the seasonal performance factor (SPF H3) of individual heat pumps should be ≥ 3.0. SCOP includes the heat pump, regulation, auxiliary heating unit and other parts of the system, such as pumps and ventilators on the side of the heat storage tank. SPF H3 is the factor which influences the calculated limit that includes the heat pump, regulation, auxiliary heater, and all parts of the system, including pumps and fans on the side of the tank's thermal sources (air, water, soil). Air-to-air systems do not contain the listed parts (they contain freon) and have no impact on the factor.
Cyprus	The inputs into SBEMcy software, which is used to generate EPCs, include the HVAC System, the DHW system, solar thermal system, photovoltaic system, wind generator, and combined heat and power systems. In addition, lighting and lighting controls, ventilation and exhaust systems are considered, as well as, thermal and photovoltaic solar systems (Abela, 2014).
Estonia	Various types of heating systems including heat pumps, district heating; ventilation systems with heat recovery, systems that utilise free cooling, heat or electricity generated from solar, wind, water and geothermal energy sources are considered (Methodology for calculation of energy performance of a building - Riigi Teataja, 2019).
Hungary	Heat recovery ventilation, heat pump, building automation, solar panels, solar collectors are considered'.'
Ireland	Different types of HVAC systems, hot water generators including solar hot water, Solar PV and wind turbines for electricity generation, combined heat and power, lighting and its control, demand controlled ventilation etc. are considered.
Sweden	Technologies/energy measures related to the following areas are listed: BAC systems (e.g. heating, cooling, lighting and ventilation on demand, pressure-controlled pumps and variable speed-controlled fans), building services systems (e.g. energy efficient lighting, heat pumps, heat recovery, solar collectors and solar cells) and building envelope (e.g. energy efficient windows and doors, additional insulation).

Table 13: Treatment of innovative technologies in EPC assessment calculations

3.10 Cost of EPCs

The cost of EPCs varies considerably across Member States. Especially in those countries where the EPCs are issued automatically via an online-tool, costs are quite low. For example, all buildings in the Netherlands automatically received a free provisional EPC. Only in case of selling or renting a definitive EPC has to be issued, which costs about 50 EUR. In Slovakia, there are several EPC assessors offering online EPCs starting at about 90 EUR (e.g. https://www.certifikatybudov.sk), depending on the type of building. In Germany, there are also some low-cost offers available: the website www.mcenergieausweis.de advertises to generate an official EPC (based on consumption) for 19 EUR. In Hungary the costs for EPCs are determined in the regulation: An EPC can be issued for a residential building at about 75 EUR, for multi-family or non-residential buildings an EPC can cost several thousand EUR. In the UK, a reliable EPC will cost about 75 to 120 GBP. In the Czech Republic, Denmark and Spain an EPC costs about 800 EUR (Atanasiu and Constantinescu, 2011).

In most countries the costs for EPCs are regulated by the market. Especially in those countries where an on-site inspection is mandatory or where the EPC also includes some elements of an energy audit, the costs are much higher. Atanasiu and Constantinescu (2011) come to the same conclusion: Usually a lower price of EPC can be related to a lower quality.

3.11 Updating of EPCs when legislation and regulations for EPC scheme changes

The comparability and, hence, the usefulness of EPCs for building markets would improve, if it was possible to generate updates of EPCs when the legislation and regulations for the EPC scheme (e.g. the labelling scale) are changed. It would be best, if this were automatically executed online, with the help of a central database. However, such a provision is available only in Greece, which is a QualDeEPC country partner country. In most other countries, EPCs once issued are valid for 10 years and are not re-issued before that.

3.12 EPC calculation procedure in adherence with new CEN OAS standard

EPC calculation may be changed to be in adherence with the new CEN OAS standard. The EU may establish an overarching standard that provides a common, modular calculation core for building energy performance calculation while leaving establishment of national user interfaces and input values to MSs; (cf EN ISO 52000-1:2018-03 Energy performance of buildings - Overarching EPB assessment). The adoption of CEN OAS standards and the corresponding calculation methodology are under consideration in Greece, which is a QualDeEPC country partner country.

4 REQUIREMENTS FOR QUALIFIED EXPERTS IN EU MEMBER STATES

In addition to concise EPC assessment and certification rules and tools, the knowledge of the experts allowed to perform the EPC assessment and issue the EPCs is another important precondition for quality and credibility of the EPCs. Several potential elements of a good practice EPC scheme were analysed in this area.

4.1 Registry of EPC assessors

An official registry of EPC assessors is useful and potentially even needed for credibility of the EPC scheme. It allows for the building owners to transparently check the credentials of available assessors, and choose an assessor based on their preference. In addition, a registry of EPC assessors is crucial for quality control purposes.

The following figure shows the availability of registry of EPC assessors in various Member States. Except for Germany, all other countries, for which we have information, have an official registry of EPC assessors. Austria and Netherlands also have unofficial registries maintained by professional bodies. In some countries, the registration is automatically done along with the qualification as an EPC assessor, and in other countries EPC assessors have to register themselves upon qualifying. The following table provides more details of EPC assessor situation in each country. Official registries are maintained by concerned Ministries, Energy Agencies, and sometimes, professional chambers. Unofficial/commercial registries are maintained by EPC assessor bodies etc.

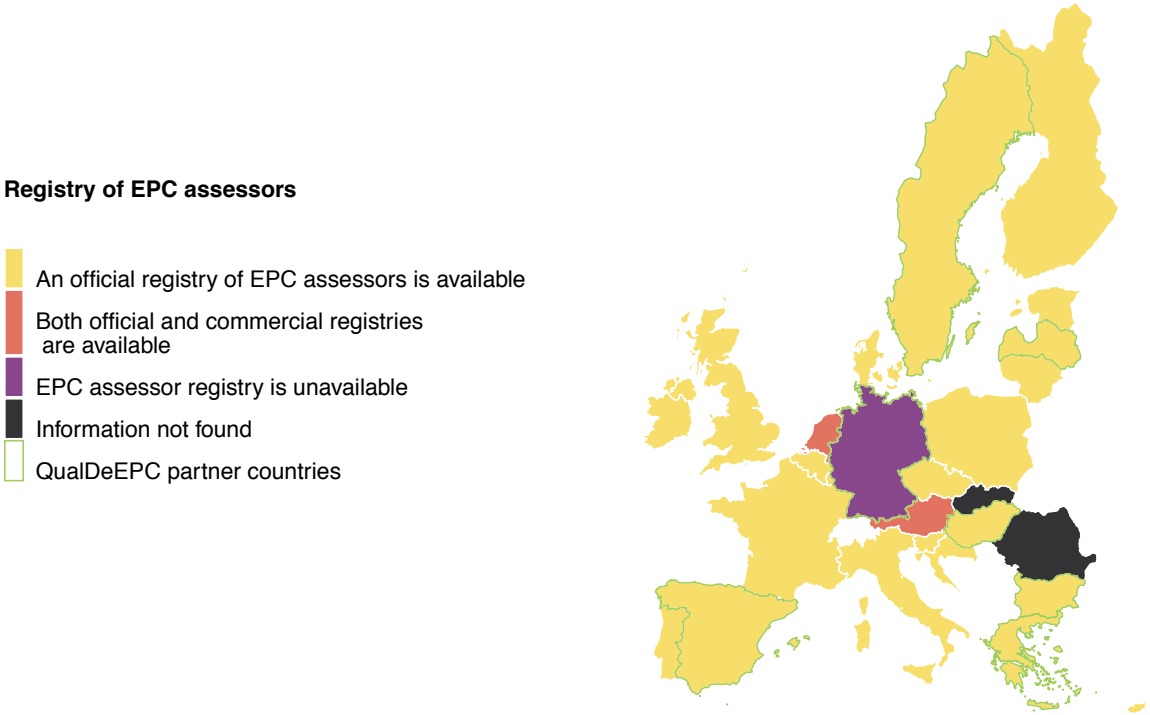

Figure 9: Registry of EPC assessors

The following table shows in brief the information on EPC assessor registers in various Member States.

	An official registry of EPC assessors is available	An unofficial and/or commercial registry of EPC assessors is available
Austria	Yes. An official registry of EPC assessors is available at federal level e.g., (Energie Tirol, 2019).	Yes. A commercial database of EPC providers is available (energieausweis.at, n.d.).
Belgium	Yes. An official registry of EPC assessors for different building typologies is available (Energiesparen.be, n.d.).	No. Unavailable.
Bulgaria	Yes. An official registry of EPC assessors is available as per the national legislation.	No. Unavailable.
Croatia	Yes. An official registry of EPC assessors is available (Ministry of Construction and Physical Planning, n.d.)	No. Unavailable.
Cyprus	Yes. An official registry of EPC assessors is available (Ministry of Energy, Commerce and Industry - Energy Service, 2020).	No. Unavailable.
Czech Republic	Yes. An official registry of EPC assessors is available (Ministry of Industry and Trade, 2018).	No. Unavailable.
Denmark	Yes. Registry of energy labelling companies is available (sparenergi.dk, 2015).	No. Unavailable.
Estonia	Yes. An official registry of EPC assessors is available (Ministry of Economic Affairs and Communications, n.d.)	No. Unavailable
Finland	Yes. An official registry of EPC assessors is available (Housing Finance and Development Center, n.d.)	No. Unavailable.
France	Yes. An official registry of EPC assessors is available (Ministry of Ecology, Energy, Sustainable Development and the Sea, n.d.)	No. Unavailable.
Germany	No. Unavailable.	No. Unavailable.
Greece	Yes. An official registry of EPC assessors is available	No. Unavailable.
Hungary	Yes. Available at the homepage of the Chamber of Architects and the Chamber of Engineers.	No. Unavailable
Ireland	Yes. The National Register of BER Assessors, maintained by SEAI, is available (Sustainable Energy Authority Ireland) (SEAI, n.d.).	No. Unavailable.
Italy	Yes. An official registry of EPC assessors is available (Moneta et al., 2016).	No. Unavailable.
Latvia	Yes. An official registry of EPC assessors is available. (State Bureau of Construction Control, n.d.)	No. Unavailable.
Lithuania	Yes. An official registry is available (SPSC, 2020).	No. Unavailable.
Luxembourg	Yes. An official registry of EPC assessors is available (Guichet.lu, n.d.).	No. Unavailable.
Malta	Yes. An official registry of EPC assessors is available. (Building Regulation Office, n.d.)	No. Unavailable
Netherlands	Yes. An official registry of EPC assessors is maintained, which is accessible by the building owners, when requesting for a definitive energy label (RVO, n.d.).	Yes. An un-official registry of EPC assessors for residential units is also available, which is maintained bz FedEC, a professional association of energy advisors (maatwerkadvies voor woningen & FEDEC, n.d.).
Poland	Yes.An official registry of EPC assessors is available (Ministry of Infrastructure and Construction, n.d.).	No. Unavailable
Portugal	Yes. ADENE maintains a central register of all EPC assessors (ADENE, n.d.).	No. Unavailable.
Romania	Information unavailable. There are about 1,760 certified energy experts (BPIE et al., 2017). However, it is unclear whether there is a registry of experts.	Information unavailable.
Slovakia	Yes. An official register of EPC assessors is available from the Slovak Chamber of Civil Engineers (www.sksi.sk, 2020).	No. Unavailable.
Slovenia	Yes. An official register of EPC assessors is maintained by the Ministry of Infrastructure (Ministry of Infrastructure, n.d.).	Yes. The website www.energeskaizkaznica.si provides

	An official registry of EPC assessors is available	An unofficial and/or commercial registry of EPC assessors is available
		a search for independent EPC assessors (Energetska Izkaznica, n.d.).
Spain	Yes. There is an official registry in most Regions, but it is not mandatory to be in the Registry to carry out an EPC.	No. Unavailable.
Sweden	Yes. Available on the webpage of the National Board of Housing, Building and Planning.	No. Unavailable.
UK	Yes. Accredited persons to undertake an EPC are officially registered. This register is publically available (Ministry of Housing, Communities and Local Government, n.d.).	No. Unavailable.

Table 14: Registry of EPC assessors

4.2 Requirements for regular mandatory EPC assessor training on assessment and recommendations as a precondition for certification and registry

EPC assessors should undergo mandatory training on EPC assessment and providing recommendations for being certified as an EPC assessor and included in the registry. Such training should also enable them to avoid common mistakes. The following figure shows the current status of training requirements for EPC assessors in various Member States. Mandatory training on assessment and recommendations is required for initial certification and registration in some countries, while in others there are no such requirements. However, in many countries without the requirements for mandatory training, there are opportunities for voluntary training, and candidates should pass an examination for certification.

The duration and contents of the course varies in different Member States. In some countries, the qualifications of the candidates and their professional experience determines the amount of training required, while in other countries all candidates must take the requisite courses. Primarily, the mandatory training covers aspects, such as obtaining input data, performing calculations, providing cost-effective recommendations, using the databases of registries for EPCs and EPC assessors, EPC assessor obligations etc. Training is provided by various organizations, such as Universities, Energy Agencies, Professional chambers, or accredited third parties.

After initial certification or accreditation (with or without mandatory training), undergoing periodic training is mandatory in some countries. This is to ensure that EPC assessors update their skills regarding technical advancements, and legislative or regulatory changes in their field.

Among QualDeEPC partner countries, in four countries, Germany, Greece, Spain and Sweden, certification or accreditation is not linked with mandatory training (in Germany, there are alternatives to it, which however may also require training). In Latvia and Hungary, mandatory training is required for obtaining certification/accreditation and registration as an EPC assessor for the first time.

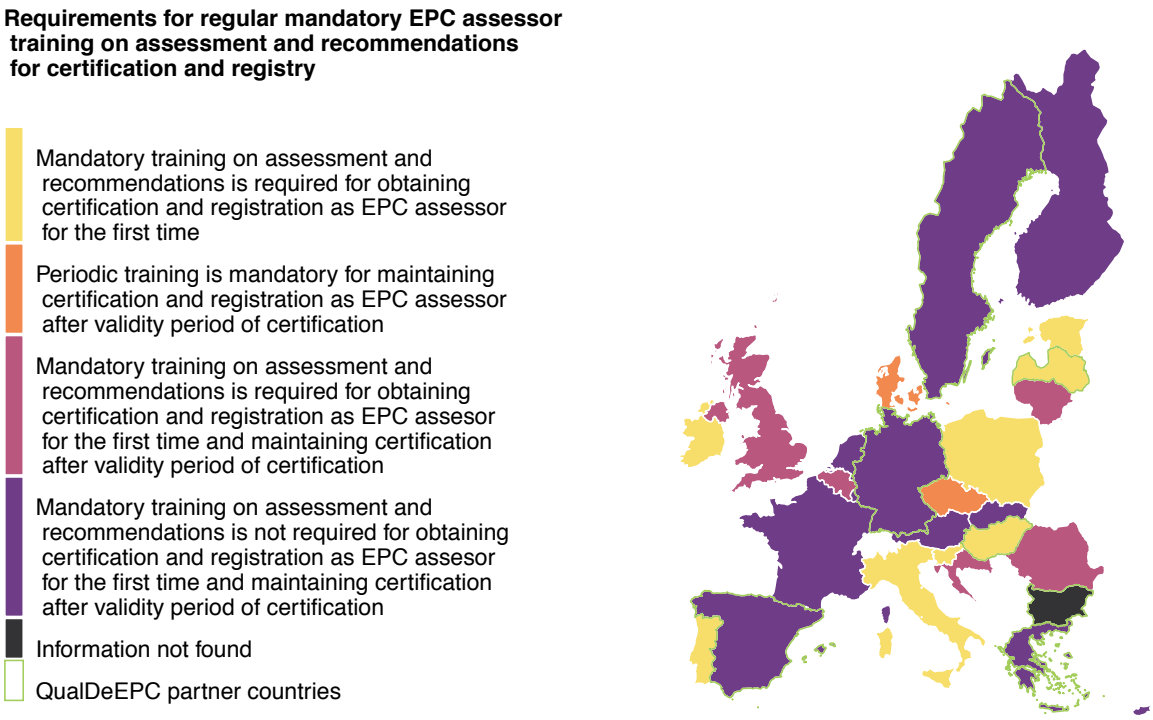

Figure 10: Requirements for regular mandatory EPC assessor training on assessment and recommendations for certification and registry

The following table shows in brief the requirements for regular mandatory EPC assessor training on assessment and recommendations for certification and registry in various Member States.

	A mandatory training on assessment and recommendations is required for initial certification and registration of EPC assessors is required	Periodic training is mandatory for maintaining EPC assessor certification
Austria	No. Professionals from the listed sectors, such as builder, electrical engineering, civil engineering, and architecture are eligibly to issue EPCs. Mandatory training is not required (Oesterreich.gv.at, n.d.).	No. See column 1.
Belgium	Yes. Mandatory training and examination are required to qualify as an EPC assessor. Separate training and exams are conducted for different building typologies, such as type A certification for residential buildings and type C certification for public buildings (Energiesparen.be, n.d.).	Yes. Continuing to receive annual training has been mandatory since 2017 in order to retain recognition as type A energy expert (Energiesparen.be, n.d.).
Bulgaria	Yes. An initial and mandatory training on assessment and recommendations is required for accreditation.	
Croatia	Yes. Mandatory training in specific modules is required (Ministry of Construction and Physical Planning, n.d.).	Yes. Authorized natural persons who carry out energy certification, energy audits of buildings and regular inspections of heating systems and cooling or air-conditioning systems in buildings are obliged to attend once a year the training programme (Ministry of Construction and Physical Planning, n.d.).
Cyprus	No. EPC assessors are required to pass a qualifying examination under the categories for residential, non-residential buildings or both. Training is not mandatory (Ministry of Energy, Commerce and Industry & Ministry of Energy, Commerce and	No. See Column 1.

	A mandatory training on assessment and recommendations is required for initial certification and registration of EPC assessors is required	Periodic training is mandatory for maintaining EPC assessor certification
	Industry, n.d.).	
Czech Republic	No. Mandatory training is not required. Taking an examination is compulsory (Energy Management Act, 2001).	Yes. Continuing professional education is required (Energy Management Act, 2001).
Denmark	No. Mandatory training is not required. However, it is mandatory to pass an examination depending on the building typology they wish to issue EPCs for (Order on energy labelling of buildings, n.d.).	Yes. Qualified energy consultants must attend mandatory courses and meetings in accordance with the Danish Energy Agency's decision (Order on energy labelling of buildings, n.d.).
Estonia	Yes. Mandatory training is provided by the Open University, of Tallinn University of Technology, and the examination is conducted by the Estonian Association of HVAC Engineers (Ministry of Economic Affairs and Communications, n.d.).	No. Periodic training is not required.
Finland	No. It appears that mandatory training is not required, however, training is provided by Finnish Association of HVAC Engineers for taking the mandatory examination for qualifying as an EPC assessor (Motiva, n.d.).	No. However, as initial accreditation is valid for 7 years, periodic training is one of the options for continuing as EPC assessor after the completion initial 7 years.
France	No. Taking an examination is mandatory, but not training (The certification criteria for technical diagnostic operators and training and accreditation bodies for certification bodies, 2018).	Yes. EPC assessors are required to keep abreast of technical, legislative and regulatory developments in the field concerned and completes training lasting at least three days (five days for certification with mention) during the certification cycle, including at least one day (two days for certification with mention) in the last eighteen months of the certification cycle (The certification criteria for technical diagnostic operators and training and accreditation bodies for certification bodies, 2018).
Germany	No. Training is not mandatory for experts certified for proving energy performance of new buildings or who are a sworn public expert.	No. See column 1.
Greece	No. Although not mandatory, training seminars are organized by vocational centers and academic institutions and attended on a voluntary basis by interested auditors.	No. See column 1.
Hungary	Yes. EPC assessors must undergo mandatory training for accreditation.	No. Further regular trainings are available, but taking part in them is not a condition to remain an assessor. They can be attended on a voluntary basis.
Ireland	Yes. Training course is mandatory for Domestic BER Assessors and recommended (nor mandatory) for Non-Domestic BER Assessors (SEAI, n.d.).	No. BER assessor registration is valid for one year. Renewal may be subject to additional educational or administrative requirements, but not definitive (SEAI, n.d.).
Italy	Yes. Regional and autonomous provinces have their own approach towards mandatory training, but usually mandated especially for people with relevant professional qualifications (Moneta et al., 2016).	No. Not necessary (Moneta et al., 2016).
Latvia	Yes. It is mandatory to train for 2 years under the guidance of a certified EPC assessor.	No. Periodic training is not required.
Lithuania	Yes. Undertaking training course organized by designated organizations and passing a qualifying examination is mandatory (SPSC, n.d.).	Yes. EPC assessor must undertake an additional 20 hours of training and pass an examination every 5 years (Meškauskienė et al., n.d.)
Luxembourg	No. Architects and consulting engineers whose profession is regulated by the Law of 13 December 1989 on the organization of the professions of architects and consulting engineers are not required to take a mandatory training. However, other experts are approved by the Ministry of	No. Periodic training is not required.

	A mandatory training on assessment and recommendations is required for initial certification and registration of EPC assessors is required	Periodic training is mandatory for maintaining EPC assessor certification
	Economic Affairs to issue EPCs after taking mandatory training (Guichet.lu, n.d.). .	
Malta	Yes. Undertaking a training that is approved by the Building Regulation Board is mandatory (Energy Performance of Buildings Regulations, 2018, n.d.).	No. It is unclear from the legislation or the available information if such training is necessary. There appears to be no requirements for mandatory periodic training.
Netherlands	No. Only a qualifying examination is required. For certification as an EPC assessor for non-residential buildings, optional voluntary training is available after clearing the qualifying examination (RVO, n.d. & RVO, n.d.).	No. Periodic training is not required.
Poland	Yes. Completion of a mandatory training course and passing an examination is required (Kasperkiewicz et al., 2014).	No.
Portugal	Yes. EPC assessors should undertake mandatory training courses. Besides mandatory courses, there are also complementary training courses (ADENE, n.d.)	No. Periodic verification is not mandatory (ADENE, n.d.).
Romania	Yes. An initial mandatory training and an examination are required (Tenea et al., 2016.).	Yes. EPC accreditation is awarded for a period of 5 years, which may be extended upon evidence of continuous training (Tenea et al., 2016.).
Slovakia	No. It is necessary to have a professional competence regarding energy consumption in buildings. Additionally, an examination at a test committee has to be done (Act no. 555/2005 Coll, 2005).	No. See column 1.
Slovenia	Yes. A one-week training with a written and oral exam is needed for accreditation (Potocar et. al, 2017).	No. Periodic training is not mandatory.
Spain	No. The only requisite to become EPC assessor is to have the academic degree of engineer, architect or technical vocational training in Spanish FP.	No. See column 1.
Sweden	No.	No. However, the EPC assessor needs to report any updating of skills and send in assessed EPCs to the national certification body once a year.
UK	Yes. Although, the exact information is unavailable, it appears that EPC assessors have to undertake level 3 and 4 assessment, depending on the building type they wish to issue EPCs for, which trains them in using approved software, conducting on-site visits and recording information on site etc.,	Yes. Assessors have to update their skills and knowledge regularly.

Table 15: Requirements for regular mandatory EPC assessor training on assessment and recommendations for certification and registry

4.3 Eligibility requirements (pre-qualifications) for EPC assessor certification

Qualified EPC experts should have relevant educational background or professional qualification for providing effective recommendations for deep renovation. Ideally, they should have undertaken/implemented a course of one or more of new building shell / heating / cooling / ventilation technologies, RES, certification software, etc. as a part of their education. Except for four countries, all other countries have eligibility requirements for EPC assessor certification (see figure below).

In most courtiers, higher education in technical disciplines, such as engineering, architecture or sciences are required, along with professional experience. However, most countries also have supplementary training programmes (see section 4.2) when the candidates do not have sufficient creden-

tials from their education or professional qualification. The following table briefly explains the eligibility requirements for EPC assessor certification in various Member States.

Among QualDeEPC members, Bulgaria and Spain do not have any eligibility requirements for EPC assessor certification.

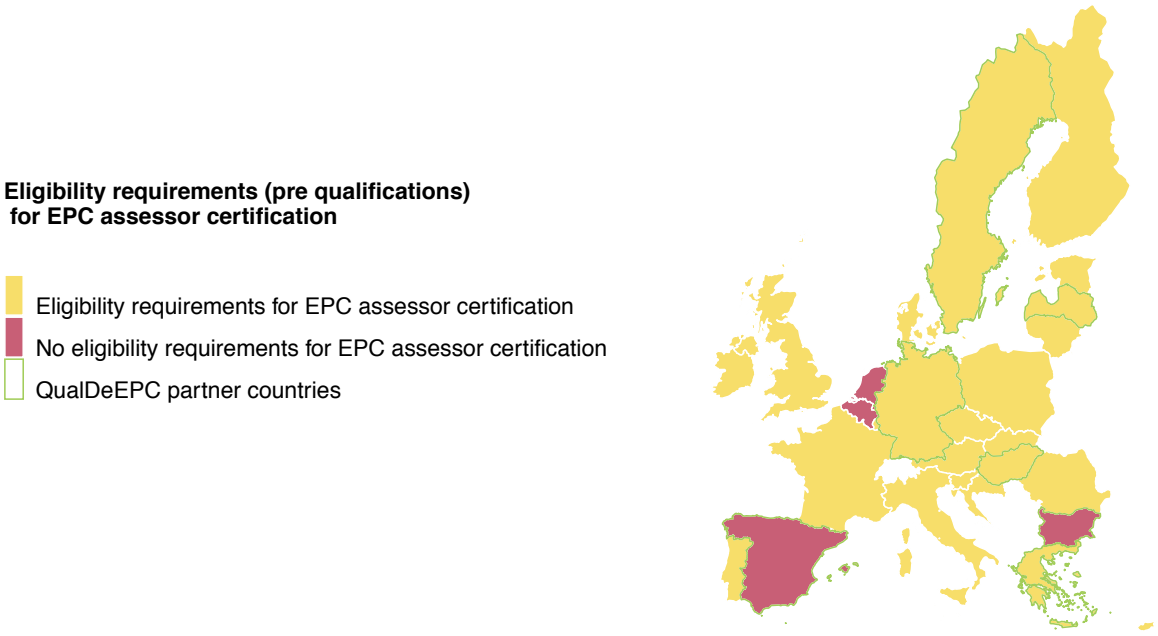

Figure 11: Eligibility requirements for EPC assessor certification

The following table shows in brief eligibility requirements (pre qualifications) for EPC assessor certification in various Member States.

	Eligibility requirements for EPC assessor certification
Austria	Yes. Professionals from the listed sectors, such as builder, electrical engineering, civil engineering, and architecture are eligibly to issue EPCs. (Oesterreich.gv.at, n.d.).
Belgium	No. No prerequisites are required. Basic secondary education diploma or similar qualifications are sufficient for taking part in training and examination for type A energy expert. There appears to be no prerequisites for type C expert as no information regarding it has been provided (Energiesparen.be, n.d.).
Bulgaria	No.
Croatia	Yes. Under graduation or graduation in professional disciplines, such as architecture or engineering is required (Ministry of Construction and Physical Planning, n.d.).
Cyprus	Yes. Previous experience in the area of building or energy or building's technical systems and membership of registration at the Cyprus Scientific and Technical Chamber in the field of Architecture or Engineering fields, such as mechanical, electrical, environmental are required to be a Qualified Expert for energy performance certification (Ministry of Energy, Commerce and Industry & Ministry of Energy, Commerce and Industry, n.d.).
Czech Republic	Yes. Higher, secondary or tertiary professional education in the certain fields engineering such as electrical, power engineering, or energy, or construction are prerequisites for qualifying as "Energy Specialist" before taking the mandatory examination (Energy Management Act, 2001).
Denmark	Yes. Relevant technical education at minimum level 4 or higher of minimum 3 years duration is a prerequisite for taking the energy consultant examination (Order on energy labelling of buildings, n.d.).
Estonia	Yes. Mandatory EPC assessor training is offered for professionals with a University degree in technology (Tailin University of Technology, n.d.)

	Eligibility requirements for EPC assessor certification
Finland	Yes. Technical qualification or equivalent professional experience that is required for performing building performance calculations and issuing EPCs is required (FINLEX ® - Säädökset alkuperäisinä, n.d.).
France	Yes. Post secondary diploma in the field of building technology or equivalent professional experience (The certification criteria for technical diagnostic operators and training and accreditation bodies for certification bodies, 2018).
Germany	Yes. University degree in relevant technical fields or German professional education entitling to own a company in the relevant fields of building works, plus either a mandatory training or other relevant qualification (cf. previous chapter, table 16).
Greece	EPC assessors should be engineers and architects with at least three years of experience (Markogiannakis & Giannakidis, n.d.).
Hungary	Yes. Only professionals with relevant expert background, as listed by profession in the regulation, can qualify as EPC assessors.
Ireland	Yes. Domestic Assessors require a NFQ Level 6 Advanced Certificate/Higher Certificate in construction studies (or similar) or a recognized equivalent. In addition, membership of one of the specified professional bodies at the specified grade is a pre-qualification (SEAI, n.d.).
Italy	Yes. Professional education and registration in the fields, such as engineering and architecture are required.
Latvia	Yes.
Lithuania	Yes. EPC assessors should have an engineering diploma, 3 years of experience in construction, and practical experience of certification of at least 3 buildings. (Meškauskienė et al., n.d.)
Luxembourg	Yes. At least 3 years university education in architecture or engineering, or equivalent field is required (Reding & Flies, n.d.).
Malta	Yes. Only professionals from the disciplines architecture, civil/structural engineering, mechanical or electrical engineering are allowed to become EPC assessors (Energy Performance of Buildings Regulations, 2018, n.d.).
Netherlands	No. Only mandatory certification of BRL 9500-01 and BRL 9500-02 ar required for residential and non-residential buildings, respectively (RVO, n.d).
Poland	Yes. EPC assessors should have a degree in fields, such as engineering, architecture or MSc in any discipline, or a licensed engineer as per Polish law, and should have undertaken 50 hours of training in post-graduation or otherwise in concerning regulatory basics, national provisions and regulations, assessment of the thermal protection of buildings, assessment of heating systems and DHW systems, ventilation and AC systems, lighting systems, calculation methods and certification methodology (BPIE & KAPE, 2017).
Portugal	Yes. Professionals from the fields of architecture or engineering, with specific qualifications and minimum experience of 5 years are required (ADENE, n.d.).
Romania	Yes. In order to be certified, the candidates should be engineers (graduates in civil or power engineering); or architects, with at least three years of professional experience for the certification of apartments and apartment buildings, and at least five years of professional experience for the certification and energy audits of all types of buildings (Tenea et al., 2016.).
Slovakia	Yes. It is necessary to have a professional competence regarding energy consumption in buildings.
Slovenia	Yes. For accreditation as EPC assessor it is necessary to have 3-year university with technical studies in major plus 2 years of experience with energy efficiency and renewable energy in buildings. Additionally, a one-week training with a written and oral exam is needed (Potocar et. al, 2017).
Spain	No.
Sweden	Yes. Detailed knowledge requirements are listed in regulation CEX. Also needed: relevant technical education and documented experience of practical work (at least 5 years, of which 2 years should be related to energy and indoor climate in the corresponding category of buildings). Comment: The later may cause a problem since we now have a generation shift in the field, with many of the certified energy experts retiring.
UK	Yes. The amount of mandatory training on assessment and certification depends on the previous experience in the field of construction and energy.

Table 16: Eligibility requirements for EPC assessor certification

4.4 Updating EPC assessor accreditation

In some Member States, EPC assessors should undergo a periodic verification, by means of an examination, for being accredited and included in the registry (see figure below). This is to ensure that EPC assessors keep abreast of latest technologies, and updates of relevant legislation and regulation; and

building upon on the training. Although most of the countries insist on continuing education and further training as a mean for being accredited and registers, only some countries also require an examination. However, this is also often criticised for its red tape tendencies.

Among QualDeEPC partner countries, a periodic verification, by means of an examination is mandatory only in Sweden.

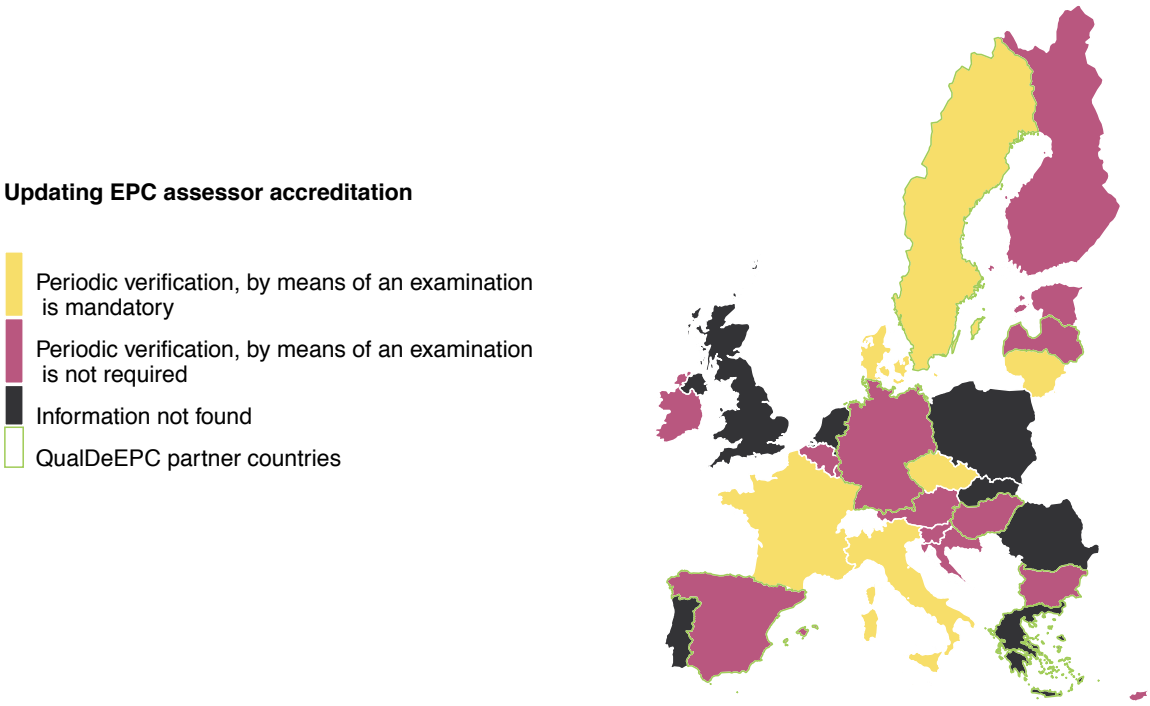

Figure 12: Updating EPC assessor accreditation

The following table briefly explains the requirements for updating EPC assessor accreditation in various Member States.

	Periodic verification is mandatory
Austria	No. Professionals from the listed sectors, such as builder, electrical engineering, civil engineering, and architecture are eligibly to issue EPCs. Separate verification is not required (Oesterreich.gv.at, n.d.).
Belgium	No. Type A experts should take part compulsory annual training for stipulated number of hours and context to retain accreditation (Energiesparen.be, n.d.).
Bulgaria	No.
Croatia	No (Ministry of Construction and Physical Planning, n.d.).
Cyprus	No. It does not appear to be the case from the available information (Ministry of Energy, Commerce and Industry & Ministry of Energy, Commerce and Industry, n.d.).
Czech Republic	Yes. Continuous education is provided by the State Energy Inspectorate to deepen and updates expertise in the field of energy management and use to ensure the operation of buildings, energy savings, energy performance of buildings and energy management, etc. Credits are awarded for such education programmes (Energy Management Act, 2001). Assessors have to undergo further education and pass an examination (Svoboda et al., n.d.).
Denmark	Yes. All energy consultants must pass a refresher course no later than every 3 years (Order on energy labeling of buildings, n.d.).
Estonia	No. Noting from the available literature or the relevant regulation mentions so.

	Periodic verification is mandatory
Finland	No. The certificate is valid for seven years. To renew the qualification after that the EPC assessor should maintain their professional skills by issuing certificates, undertaking training etc. (Act on Building Energy Certification, n.d.)
France	Yes. The certificate is renewed upon satisfactory clearance of a documentary exam and a practical exam (The certification criteria for technical diagnostic operators and training and accreditation bodies for certification bodies, 2018).
Germany	No. Proof of expertise through references in the field of energy-efficient construction and renovation or participation in further education, similar to the evidence supporting the renewal of the entry in the EEE list.
Greece	Information not found.
Hungary	No. Not required.
Ireland	No. Renewal of registrations is subject to payment of fees, in-date insurance policies, and may be subject to additional educational or administrative requirements (SEAI, n.d.). However, a BER/DEC -Assessor is required/expected from time to time to update, at his/her own cost, their skills and/or resources to meet the standards required on an on-going basis by SEAI; this may be subject to verification by SEAI or its appointed agents or contractors in order to approve renewal of registrations (SEAI, 2018).
Italy	Yes. Although varies regionally.
Latvia	No. EPC assessors are certified only once and then can issue EPCs for the rest of their life.
Lithuania	Yes. EPC assessor must undertake an additional 20 hours of training and pass an examination every 5 years (Meškauskienė et al., n.d.)
Luxembourg	No. Not required.
Malta	No. It is unclear from the legislation or the available information if such training is necessary. There appears to be no such periodic training programme.
Netherlands	Information not found.
Poland	Information not found.
Portugal	Information not found.
Romania	Information not found.
Slovakia	Information not found.
Slovenia	No. The license for EPC assessors is valid for unlimited time (Energy Act, Official Gazette, 2018).
Spain	No.
Sweden	Yes. The certificate is valid for 5 years. After that it needs to be renewed with a new theoretical test. The test for recertification is a less comprehensive than the first certification test. Also, the EPC assessor needs to report number of performed assignments and any updating of skills and send in assessed EPCs to the national certification body once a year.
UK	Information not found.

Table 17: Updating EPC assessor accreditation

4.5 Regular events and workshops on innovative solutions for deep renovation

Organisation by the national EPC body or others, such as professional chambers, of regular events and workshops for presenting innovative solutions for deep renovation and implementing more intelligent and advanced energy measures.

In countries where continuing professional education through mandatory training for being certified as an EPC assessor, such as Belgium, France, Ireland the intent behind the courses is to provide advancement in technologies including deep renovation technologies, besides updating about the changes in regulations and EPC assessment routines. Few countries have explicitly mentioned that these trainings focus on renovation recommendations, however, the content of these training and their link to deep renovation, including innovations solutions cannot be easily accessible.

Among QualDeEPC partner countries only Lativa has opportunities to attend such renovation workshops. In addition, in most countries such workshops on deep renovation are organized as a part of

various publicly funded deep renovation projects, however they are sporadic. One example of a regularprogram for deep renovation is 'BedreBolig' scheme by the Danish Energy Agency. 'BedreBolig' is a training course that has been set up with the aim of training advisers to offer comprehensive, professional advice on energy renovation of homes (Centre for Energy Efficiency, 2017).

5 INDEPENDENT CONTROL SYSTEMS FOR EPCS IN EU MEMBER STATES

The EPBD requires member states to install independent control systems for a sample of EPCs to monitor their quality and compliance with legal requirements. This appears to differ between member states too, and therefore this study analysed a number of options for enhancing EPC schemes and their convergence.

5.1 Using common quality criteria for independent control

Independent control of the quality of EPCs and EPC assessors is based on quality criteria. It would be good if these are converged between EU MS. The following table includes information on how the quality control is implemented in EU member states and the UK.

	Using common quality criteria for independent control
Austria	Control is organised at the level of provinces. For example, in the ZEUS-regions Burgenland, Kärnten, Salzburg und Steiermark the EPCs will be controlled by independent inspection bodies like Energy Agencies. The routines for control in the regions are different (ZEUS, n.d.).
Belgium	In the Flemish region, the Flemish Energy Agency executes quality check of EPCs (De Meulenaer & Triest, 2018). In the Brussels capital region, a private body has been hired for the purpose.
Bulgaria	Information not found.
Croatia	Detailed control includes checks of the content of the report on the energy audit of the building, the validity and completeness of the input data, the accuracy of the EPC and the calculated and proposed measures to improve the energy performance of the building (Skoro, 2016).
Cyprus	The Ministry of Energy, Commerce and Industry is the implementing authority on quality assurance on EPCs.
Czech Republic	The State Energy Inspection is annually required to check at least one in twenty EPCs issued in the previous calendar year (Svoboda, 2016).
Denmark	The Danish Energy Agency has set up a mandatory Quality Assurance scheme (Engelund Thomsen et. al, 2014).
Estonia	The Technical Regulatory Authority is responsible for checking compliance (Consumer Protection and Technical Regulatory Authority, n.d.).
Finland	It is regulated by law, that the Housing Finance and Development Center shall audit a number of energy certificates issued each year, with a focus on the correctness of the certificate's source data, energy quantities, and recommendations for savings (Finlex Databank, n.d.).
France	Information not found.
Germany	The Deutsches Institut für Bautechnik (DIBt) carries out random electronic 1st level controls. 2nd and 3rd level (more detailled) controls are under the sovereignity of the Federal States. These probably have different quality criteria (DIBT, n.d.).
Greece	CRES is in charge of the independent control.
Hungary	There is no particular body designated to quality control. The experts of the two chambers can perform controlling activities, but they are separately assigned and subcontracted for this purpose, they are not employees of the Chambers.
Ireland	SEAI monitors the technical performance and professional conduct of BER assessors and BER assessments via audits (SEAI, 2016).
Italy	The national legislation requires 2% of all EPCs to be annually checked starting from best class EPC (Costanzo et. al, 2016).
Latvia	There is a provision for independent control.
Lithuania	Information not found.
Luxembourg	Information not found.
Malta	To ensure a high quality of EPCs and to achieve a level of independence in the auditing process, the Independent Control System has been entrusted to the Malta Competition and Consumer Affairs Authority (MCCAA). The verification system devised by the BRO and MCCAA consists of a number of checks on a statisti-

	Using common quality criteria for independent control
	cally significant sample of certificates (DeGiorgio and Carmelo, 2016).
Netherlands	Information not found.
Poland	An indepdent body exisits and the following factors are checked during EPC control: calculation results, efficiency of technical building systems and U-values compared with requirements concerning thermal insulation of the building envelope components, energy demand indicators, energy consumption and categories of cost-effective recommendations, correctness of description, etc. (Bekierski et. al., 2016).
Portugal	There are three steps of checking: Automatic input validation, Simple quality checks, and detailed quality checks (Altmann-Mavaddat et. al, 2015).
Romania	Information not found.
Slovakia	Information not found.
Slovenia	A template for quality control is available (Official Gazette, 2014).
Spain	Information not found.
Sweden	Boverket makes yearly check of 1% of EPCs. Furthermore, individuals can give complaints to Boverket or to the certification bodies.
UK	Information not found.

Table 18: Using common quality criteria for independent control

5.2 Achieving sufficient sample size

Achieving a sufficient sample number of buildings and their EPCs and their assessors for performing verification and quality control of EPCs (cf. DG Energy guidance on sample sizes)

	Sufficient sample size for verification and quality control
Austria	In 2013, 11,039 EPCs were checked (Altmann-Mavaddat et. al, 2014).
Belgium	In Brussels Capital Region 156 EPCs were checked in 2013, 236 in 2014 (Govaert et. al, 2014). In the Walloon Region about 50% of EPCs have been selected by the web application for control in 2014 (Fourez et. al, 2015).
Bulgaria	Information not available
Croatia	So far, 324 out of about 150,000 EPCs in total were checked in detail, 50 of which were declared invalid. The future plans is to strengthen the existing quality assessment scheme and increase the number of EPCs to be controlled, which currently stands at 0.3% of issued EPCs (Skoro, 2016).
Cyprus	In the period 2010 to 2013, 10% of EPCs have been checked by desk audit, 21% of EPCs by on-site check (Hadjinicolaou, 2014).
Czech Republic	In 2016, the State Energy Inspection controlled 20% of energy specialists. These controls covered 1,305 EPCs to verify whether they were processed objectively, truthfully and completely, as the Energy Management Act requires (Svoboda, 2016).
Denmark	An electronic analysis is carried out for all EPCs. A technical revision must be carried out for 0.25% of all EPCs (Engelund Thomsen et. al, 2014).
Estonia	The size of the sample rises from year to year (Kuusk et. al, 2016).
Finland	In 2013, 120 EPCs (about 2%) have been checked (Haakana et. al, 2014).
France	In France, the focus of control lies on EPC assessors. New EPC assessors are checked 4 times during the first year, and 4 more times in the following 4 years. In 2013 this led to a check of about 11,600 EPCs (Roger et. al, 2014).
Germany	The EnEV requires that the random samples must each cover a statistically significant percentage of all newly issued energy certificates in a calendar year (EnEV, 2014).
Greece	On EPC registration platform, all EPCs are checked automatically. In addition, on-site check for 1 to 3 % of all EPCs. All EPCs used for obtaining renovation grants or finance are checked too.
Hungary	2.5% of EPCs are checked, of which 0.5% (i.e. 20% of the total sample size) should have total inspection with on-site visit.
Ireland	Every BER assessor can expect to receive at least one data review per year, at least one desk review or documentation and practice audit per year, and additional auditing on a frequency reflecting the numbers of BER published, risk profiling, complaints or other indicators (SEAI, 2016).
Italy	The national legislation requires 2% of all EPCs to be annually checked starting from best class EPC (Costanzo

	Sufficient sample size for verification and quality control
	et. al, 2016).
Latvia	Information not found regarding EPCs. Each EPC assessor has to be controlled by the EPC assessor certifying organization at least once in a 5 year period.
Lithuania	All EPCs are automatically checked by a software. About 0.5% of all issued EPCs are controlled via a detailed audit (Meškauskienė et. al, 2014).
Luxembourg	In 2013, 43 EPCs have been checked (Reding et. al, 2015).
Malta	Yes. To ensure a high quality of EPCs and to achieve a level of independence in the auditing process, the Independent Control System has been entrusted to the Malta Competition and Consumer Affairs Authority (MCCAA). The verification system devised by the BRO and MCCAA consists of a number of checks on a statistically significant sample of certificates (DeGiorgio and Carmelo, 2016).
Netherlands	In 2014, 1,429 EPCs were checked by 4 certification institutes (van Eck, 2015).
Poland	EPCs are quality controlled ex officio or by request. So far, less than 10 EPCs have been controlled upon a request. The number of EPCs controlled ex officio in the period 2015 - 2016 is 180 (Bekierski et. al, 2016).
Portugal	About 5 to 6% of EPCs receive a simple quality check, about 0.5% of EPCs are verified by a detailed quality check (Altmann-Mavaddat et. al, 2015).
Romania	10% of issued EPC have to be checked for compliance each year (Petran, 2016).
Slovakia	In 2013, 103 EPCs (0.035%) have been checked (Sternova et. al, 2014).
Slovenia	A statistically significant proportion of annual issued EPCs, set on 31 March each year, will be checked (Official Gazette, 2014).
Spain	The percentage of EPC inspections are different in the regions. In total, in 2014, 560,000 EPCs were visually controlled, 5,000 EPCs received detailed controls, and 2,000 EPCs external controls (Domíngues Martín, 2014).
Sweden	Boverket makes yearly check of 1% of EPCs.
UK	Regarding public buildings in England, the random size should be at least 2% (Delorme and Cousens, 2014).

Table 19: Sufficient sample size for verification and quality control

5.3 Quality control of both EPCs and assessors

In all Member states, quality control of EPCs or assessors are in place except for most regions in Spain, which is also a QualDeEPC partner country (see figure below). In the majority of the Member states, both EPCs and assessors are controlled. Quality checks on EPCs include accuracy of the input data and results, calculation methodology used. Quality checks on assessors include their accreditation, history of errors, and quality of recommendations. However, the basis of quality checks might vary across Member States.

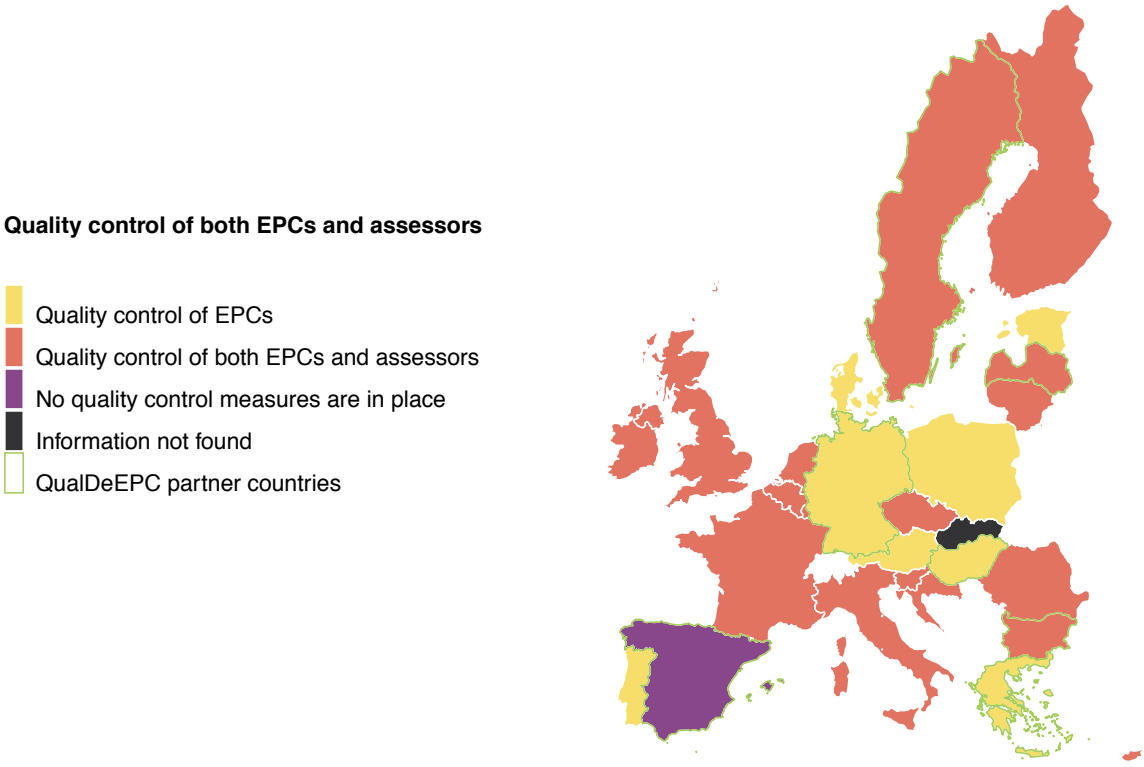

Figure 13: Quality control of both EPCs and assessors

The following table briefly explains the procedures followed for quality control of EPCs and assessors in various Member States.

	Quality control of EPCs	Quality control of assessors
Austria	Yes. For example, in the ZEUS-regions Burgenland, Kärnten, Salzburg und Steiermark the EPCs will be controlled by independent inspection bodies like Energy Agencies. The routines for control in the regions are different (ZEUS, n.d.).	No. There are no specific checks targeted at EPC assessors.
Belgium	Yes. Flanders: The Energy Agency checks randomly the correctness of EPCs (Energiesparen.be, n.d.).	Yes. Flanders: The Energy Agency checks randomly services provided and qualifications of EPC assessors (Energiesparen.be, n.d.)
Bulgaria	Yes.	Yes.
Croatia	Yes. Detailed control includes checks of the content of the report on the energy audit of the building, the validity and completeness of the input data, the accuracy of the EPC and the calculated and proposed measures to improve the energy performance of the building (Skoro, 2016).	Yes. Assessors are obligated to rectify the mistakes found in EPCs during quality check. If a number of EPCs from a particular assessor are found to be incorrect, their accreditation may be revoked (Marđetko-Škoro, 2014).
Cyprus	Yes. Desk audit from the data retrieved from the EPC database and on-site visits are performed (Hadjinicolaou, 2014).	Yes. EPC assessors are audited at their premises (Hadjinicolaou, 2014).
Czech Republic	Yes. In 2016, the State Energy Inspection controlled 20% of energy specialists. These controls covered 1,305 EPCs to verify whether they were processed objectively, truthfully and completely, as the Energy Management Act requires (Svoboda, 2016).	Yes. See Column 1.
Denmark	Yes. The Danish Energy Agency carries out quality assurances of EPCs on a regular basis and in the case of a complaint (Brand et. al, 2018).	No. Certified companies must carry out their own quality checks (Engelund Thomsen et. al, 2014).
Estonia	Yes. In 2013 0.6% of EPCs have been quality checked (Arcip-	No.

	Quality control of EPCs	Quality control of assessors
	owska, 2014).	
Finland	Yes. It is regulated by law, that the Housing Finance and Development Center shall audit a number of energy certificates issued each year, with a focus on the correctness of the certificate's source data, energy quantities, and recommendations for savings (Finlex Databank, n.d.).	Yes. Criminal liability provisions shall apply to a certifying staff member in the performance of his or her duties (Finlex Databank, n.d.).
France	Yes. The certification body has to check at least one EPC with an on-site inspection for each certification cycle (5 years) of all experts (Arcipowska et. al, 2014).	Yes. EPC assessors are checked 4 times during the first year, and 4 more times in the following 4 years. Thereafter, experts are checked 4 times every 5 years (Roger et al., 2016).
Germany	Yes. The inspection body has to randomly check EPCs (EnEV, 2014).	No.
Greece	Yes.	No.
Hungary	Yes.	No.
Ireland	Yes. Quality control of EPC assessments is carried out(SEAI, 2016).	Yes. SEAI has put in place a quality assurance system for BER assessors, and a related disciplinary procedure pursuant to its powers (SEAI, 2016).
Italy	Yes. The national legislation requires 2% of all EPCs to be annually checked starting from best class EPC (Costanzo et. al, 2016).	Yes. The tolerance of errors and penalty depends on the type and repetition rate (Costanzo et. al, 2016).
Latvia	Yes.	Yes.
Lithuania	Yes. A random sampling of EPCs is checked regarding input data and results. Detailed checks are carried out when results are out of range. On-site visits are carried out for a limited number of EPCs (Meškauskienė et al., n.d.)	Yes (Meškauskienė et al., n.d.)
Luxembourg	Yes. The Ministry of Economy controls EPCs in order to verify their compliance with legal regulations (Reding et. al, 2016).	Yes. Penalties in the form of a time-limited suspension can be imposed (Reding et. al, 2016).
Malta	Yes. To ensure a high quality of EPCs and to achieve a level of independence in the auditing process, the Independent Control System has been entrusted to the Malta Competition and Consumer Affairs Authority (MCCAA). The verification system devised by the BRO and MCCAA consists of a number of checks on a statistically significant sample of certificates (DeGiorgio and Carmelo, 2016).	No. Article 22 of the Energy Performance of Buildings Regulations, 2018 appears to suggest that only EPCs are regulated and EPC assessors are only obliged to rectify faulty EPCs (Energy Performance of Buildings Regulations, 2018).
Netherlands	Yes. Qualified experts base the quality control of EPCs on the check. It includes the check of a certain number of the EPCs issued by qualified assessors (van Eck, 2016).	Yes. The quality control of EPCs is based on the check by qualified experts. It includes the check of a certain number of the EPCs issued by qualified assessors (van Eck, 2016).
Poland	Yes. An independent control system of EPCs took place between 2013 and 2014 (iBroad, 2017).	No. The number of licensed persons issuing EPCs is too high for a quality control process (iBroad, 2017).
Portugal	Yes. Short or detailed assessments of EPCs can take place (Fragoso and Baptista, 2016).	Information not found.
Romania	Yes. The ISC control mainly focuses on the validity of EPC assessors qualification (Tenea et. al, 2018).	Yes. The ISC control mainly focuses on display of EPCs in large and public buildings, compliance with legal regulations, and the completeness of EPCs (Tenea et. al, 2018).
Slovakia	Information not found.	Information not found.
Slovenia	Yes. A 2-level approach of EPC quality control is given (Zavrl et. al, 2018).	Yes. The quality control of EPCs also includes an "expert supervision"
Spain	Not general, only in some regions.	No.
Sweden	Yes.	Yes.
UK	Yes. The accreditation schemes are responsible for monitoring	Yes. See column 1.

	Quality control of EPCs	Quality control of assessors
	the quality of the EPCs by ensuring their energy assessors are competent and possess the appropriate skills to conduct energy assessments (Department for Communities and Local Government, 2017).	

Table 20: Quality control of both EPCs and assessors

5.4 Performing automatic validity/quality check of EPC assessments

Performing an automatic validity/quality check during the assessment and/or during upload to EPC database for all EPCs, e.g., through an automatic online register to fill in the EPC characteristics and an integrated tool checking these, will considerably increase the quality of EPCs and reduce the necessities for increased quality control measures at a later stage. Some of the Member States, including QualDeEPC partner countries, Germany, Greece and Sweden, have the infrastructure to perform automatic validity/quality check of EPC assessments.

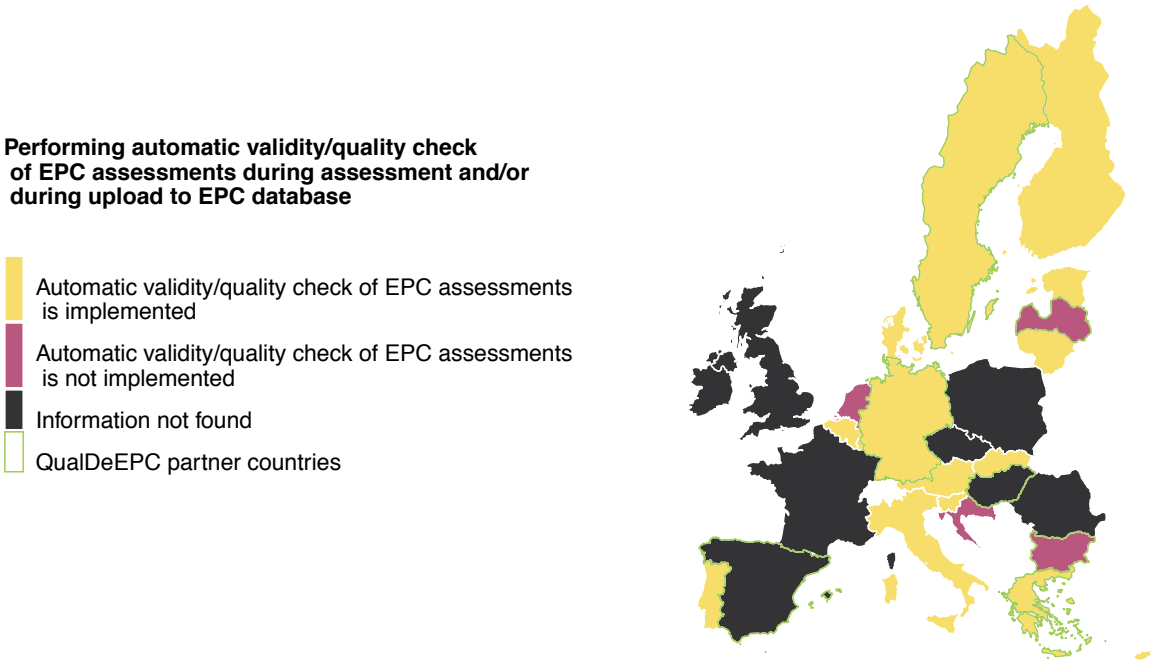

Figure 14: Performing automatic validity/quality check of EPC assessments

The following table shows in brief the availability of Automatic validity/quality check during assessment and/or during upload to EPC database for all EPCs in various Member States.

	Automatic validity/quality check during assessment and/or during upload to EPC database for all EPCs is available
Austria	Yes. In some regions automatic quality checks are implemented in the calculation software. In some regions, the EPC database is used for independent quality checks (Arcipowska et. al, 2014).
Belgium	Yes. For example in the Walloon Region all EPCs submitted to the database are automatically screened by a control web application (Fourez et. al, 2017).
Bulgaria	No.
Croatia	No.

	Automatic validity/quality check during assessment and/or during upload to EPC database for all EPCs is available
Cyprus	EPC assessors submit EPCs via mail to MECI-Energy Service, which is responsible for the maintenance of registries for EPCs and EPC assessors, and received it back within one working day with a unique number that proves its validity (Hadjinicolaou, 2014).
Czech Republic	Information not found.
Denmark	Yes. The EPC database has an automatic data validation (Brand et. al, 2018).
Estonia	Yes. An automatic validation of the data is carried out. This is necessary for the issuance of the EPC (Arcipowska et. al, 2014).
Finland	Yes. The database automatically checks the input data of all EPCs (Haakana et. al, 2016).
France	Information not found.
Germany	Yes.
Greece	Yes.
Hungary	Information not found (Unclear if Yes or No).
Ireland	Information not found.
Italy	Yes. However, it is a regional approach and may not be available in all regions (Arcipowska et. al, 2014).
Latvia	No.
Lithuania	Yes. An automatic quality check in the EPC database is implemented (Meškauskienė et al., n.d.).
Luxembourg	Yes. The EPC database as well as the national software currently checks the plausibility of the EPC automatically (Reding et. al, 2016).
Malta	Information not found.
Netherlands	No (Arcipowska et. al, 2014).
Poland	Information not found.
Portugal	Yes. The software automatically checks the input data (Fragoso and Baptista, 2016).
Romania	Information not found.
Slovakia	Yes. The online database automatically carries out quality controls (Davis et. al, 2018).
Slovenia	Yes. The electronic EPC registry runs an automatic check (Zvarl et. al, 2016).
Spain	Yes and No: Automatic check during upload to some Regional EPC databases .
Sweden	Yes.
UK	Information not found.

Table 21: Performing automatic validity/quality check of EPC assessments

5.5 Achieving C or C* level control of EPC assessments for the sample according to EPBD

The following figure shows the level of control of EPC assessments for the sample according to EPBD. The majority of the Member States have at least C level controls (see explanation on the definition in figure 19).

Among QualDeEPC partner countries, Bulgaria, Germany, Greece, and Hungary have C* level controls, while available information suggests Latvia and Spain have neither C nor C* level controls.

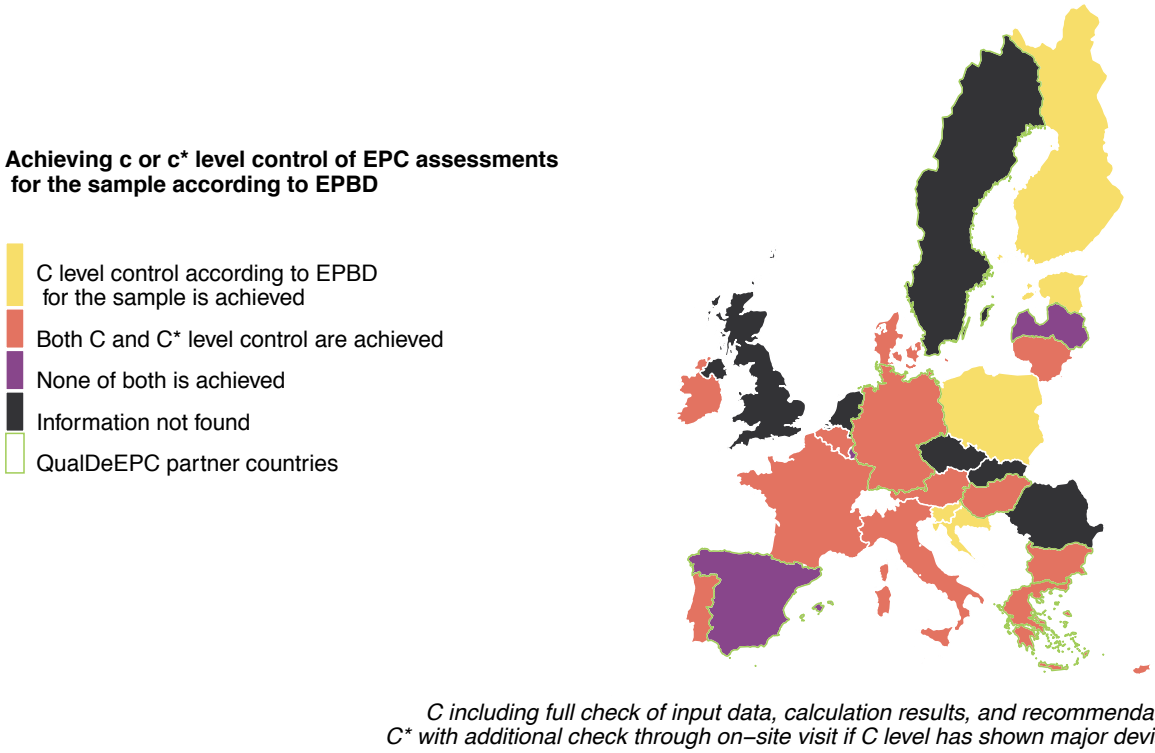

Figure 15: Achieving C or C level control of EPC assessments for the sample according to EPBD*

	C level control according to EPBD for the sample is achieved	C* level control according to EPBD for the sample is achieved	Both C and C* are achieved
Austria	Yes. For example in Kärnten, the control is based on three steps: 1) validity check on the input data, 2) verification of results including recommendations, 3) full verification of input data, full verification of recommendations, and if possible on-site inspection of the building (ZEUS, n.d.).	Yes. See column 1.	Yes. See column 1.
Belgium	Yes. In Flanders, a C level control is achieved. The Flemish Energy Agency executes a quality check on the work of a number of qualified experts, based on possible illogical inputs of data as well as at random (De Meulenaer et. al, 2016).	Yes. Site visits are also performed as a part of quality check (De Meulenaer et. al, 2016).	Yes
Bulgaria	Yes.	Yes.	Yes.
Croatia	Yes. The control included control of input data, accuracy of energy class calculations and proposed measures for improved energy performance of buildings (Marđetko-Škoro, 2014).	Information not found.	Information not found.
Cyprus	Yes. Desk audit from the data retrieved from the EPC database and on-site visits are performed (Hadjinicolaou, 2014).	Yes. See column 1.	Yes. See column 1.
Czech Republic	Level of controls is not defined in the clearly defined (Energy Management Act, 2001). .	Information not found.	Information not found.
Denmark	Yes. An electronic analysis is carried out for all EPCs. A technical revision must be carried out for 0.25% of all EPCs (Engelund Thomsen et. al, 2014).	Yes The technical revision includes a re-certification of the EPC and can also include a second on-site visit (Danish Energy Agency, n.d.).	Yes.
Estonia	Yes. The samples are fully checked (Kuusk et. al, 2016).	Information not found.	Information not found.
Finland	Yes. The Housing Finance and Development Centre	Information not found.	Information not

	C level control according to EPBD for the sample is achieved	C* level control according to EPBD for the sample is achieved	Both C and C* are achieved
	of Finland checks the sample EPCs regarding the input data, the accuracy of calculations and the appropriateness of recommendations (Haakana et. al, 2016).		found.
France	Yes. The certification body has to check at least one EPC with an on-site inspection for each certification cycle (5 years) of all experts (Arcipowska et. al, 2014). EPC assessors are checked 4 times during the first year, and 4 more times in the following 4 years. Thereafter, experts are checked 4 times every 5 years (Roger et al., 2016).	Yes. See column 1.	Yes. See column 1.
Germany	Yes. The control includes a check of input data, output data, recommendations, and in case of consent with the building owner an on-site inspection (EnEV, 2014).	Yes. See column 1.	Yes. See column 1.
Greece	Yes.	Yes.	Yes.
Hungary	Yes.	Yes.	Yes.
Ireland	Yes. All supporting drawings, documents etc. used to draw up the BER and the accompanying advisory report is audited (SEAI, 2016).	Yes. Quality control audit process could also take place on the building site (SEAI, 2016).	Yes. See column 1 and 2.
Italy	Yes. Full verification of the results and recommendations is done, although subject to the regulations by individual regions (Costanzo et. al, 2016).	Yes. On-site visits form a part of the controls, although subject to the regulation by individual regions. However, regions might choose to limit on-site visits by increasing the rate of C level control (Costanzo et. al, 2016).	Information not found.
Latvia	No.	No.	No.
Lithuania	Yes. A random sampling of EPCs is checked regarding input data and results. Detailed checks are carried out when results are out of range. On-site visits are carried out for a limited number of EPCs (Arcipowska et. al, 2014).	Yes. See column 1.	Yes. See column 1.
Luxembourg	No. (Reding et. al, 2016).	No.	No.
Malta	Yes. Schedule II (Regulation 32) of the Energy Performance of Buildings Regulations, 2018 allows for all levels of controls including c* (Energy Performance of Buildings Regulations, 2018).	Yes. See column 1.	Yes. See column 1.
Netherlands	Information not found.	Information not found.	Information not found.
Poland	Yes. Controls are in place to verify whether EPCs were processed objectively, truthfully and completely, as the Energy Management Act requires (Svoboda, 2018).	Information not found.	Information not found.
Portugal	Yes. Short quality assessments and detailed quality assessments can be carried out. A short assessment includes a check of the input data, a detailed one further includes an on-site inspection (Fragoso and Baptista, 2016).	Yes. Short quality assessments and detailed quality assessments can be carried out. A short assessment includes a check of the input data; a detailed one further includes an on-site inspection (Fragoso and Baptista, 2016).	No.
Romania	Information not found.	Information not found.	Information not found.
Slovakia	Information not found.	Information not found.	Information not found.
Slovenia	Yes. First level control is an automatic validity	No.	No.

	C level control according to EPBD for the sample is achieved	C* level control according to EPBD for the sample is achieved	Both C and C* are achieved
	check by the EPC registry. A Second level control includes a check of the EPC issued (Zarvl et. al, 2018).		
Spain	No.	No.	No.
Sweden	Information not found.	Information not found.	Information not found.
UK	Information not found.	Information not found.	Information not found.

Table 22: Achieving C or C level control of EPC assessments for the sample according to EPBD*

5.6 Availability of a central database for reporting errors or faulty procedures from EPC assessments for analysis and learning

Reporting errors or faulty procedures in a central database allows creating statistics of common mistakes, and identifying assessors with high error rates. The common mistakes can also be highlighted in the assessor trainings, so that assessors learn to avoid them in the future.

Although quality control mechanism is available in all the countries, which aims to identify errors in EPC assessments, communicate with the assessors and getting them rectified, it is unclear from the available literature, such as CA EPBD implementation status reports, whether such central database for reporting errors or faulty procedures from EPC assessments exists, except in two countries, Denmark and Portugal.

In Denmark, although it is unclear whether it is a central database or not, Denmark is currently implementing a seven-step plan that entails shortening the time from error to learning increase the overall quality of the EPC (Thomsen et al., 2018). In Portugal, all technical mistakes and other aspects must be registered in the central database on the individual record of quality assurance (Altmann-Mavaddat et. al, 2015).

5.7 Sanctions and penalisation for EPC assessors

This element aims to ensure quality control of EPCs and assessors through creating differentiated and staged sanctions for EPC issuers who produced poor quality assessments or recommendations once or repeatedly: stage 1) obligation to produce correct EPC (and controlling that it happens), stage 2) fines, and stage 3) withdrawal of certification or accreditation. The process should, however, be able to distinguish between fraud and negligence. A majority of the Member States (see figure below) levy differentiated and staged sanctions in case of poor assessment or recommendations, while few countries tend to make the distinction between negligence and fraud, which attracts the maximum fine and punishment.

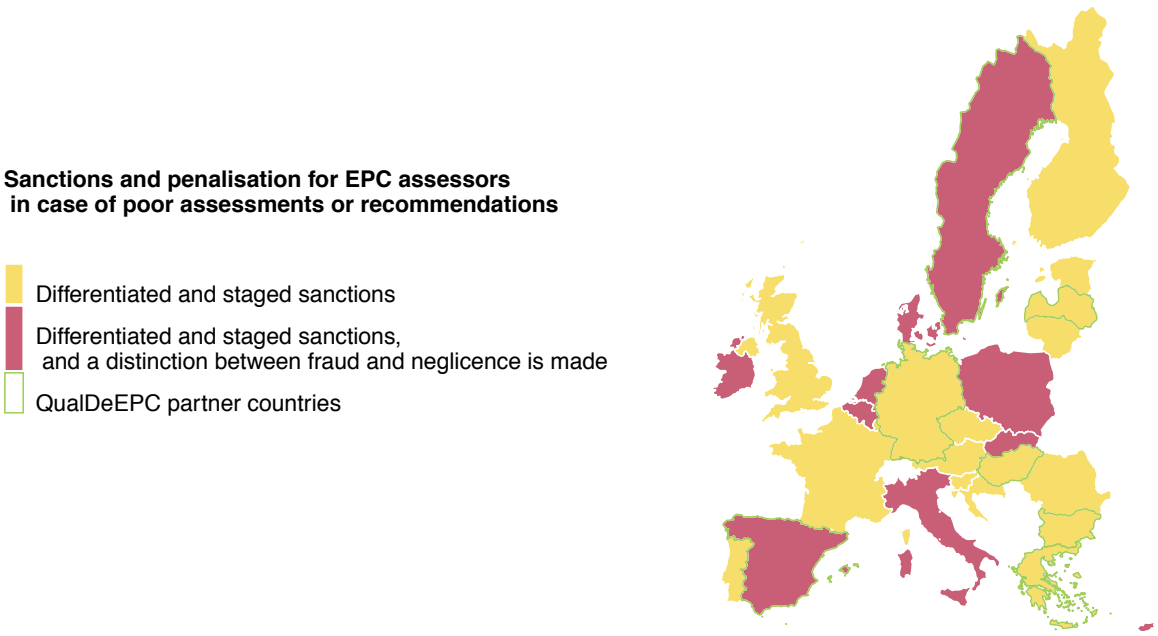

Figure 16: Sanctions and penalisation for EPC assessors in case of poor assessments or recommendations

The following table shows in brief procedures for sanctions and penalisation for EPC assessors in case of poor assessments or recommendations in various Member States.

	Differentiated and staged sanctions for EPC issuers in case of poor quality assessments or recommendations are in place	A distinction between fraud and negligence is made
Austria	Yes. EPC assessors are liable for the correctness of the contents. They are also liable within the scope of the so-called expert liability for damages that have occurred due to this incorrectly issued EPCs (Wirtschaftskammer Burgenland, 2019).	Information not found.
Belgium	Yes. Flanders: Sanctions can reach from re-issuance of the EPC to penalties from 250 to 5,000 EUR (Energiesparen.be, n.d.).	Yes. See column 1.
Bulgaria	Yes.	Information not found.
Croatia	Yes. If three or more invalid EPCs have been issued, EPC assessor can be sanctioned with a fine or loss of accreditation (Skoro, 2016).	Information not found.
Cyprus	Yes. Initially, warnings are issued, if EPC data is found incorrect. If the mistakes are not corrected in time bound manner or repeated, then the license may be suspended. The time of suspension depends on the Assessors ability to prove that they can perform correct calculations (Hadjinicolaou, 2014).	Yes. In the event that it is proven that the QE is changing data and/or manipulating calculations on purpose, the suspension might be for life (Hadjinicolaou, 2014).
Czech Republic	Yes. Several law violations have been identified, and penalties were imposed on the 178 relevant energy specialists. Penalties for wrongly processed EPCs resulted in more than 13,000 € (Svoboda, 2016).	Information not found.
Denmark	Yes. EPC assessors have to correct errors in the EPCs. In case of substantial errors, EPC assessors may receive a warning being displayed in the online register of experts. As a last	Yes. EPC assessors have to correct errors in the EPCs. In case of substantial errors, EPC assessors may receive a warning being displayed in

	Differentiated and staged sanctions for EPC issuers in case of poor quality assessments or recommendations are in place	A distinction between fraud and negligence is made
	resort, the EPC assessor can lose his license (Brand et. al, 2018).	the online register of experts. As a last resort, the EPC assessor can lose his license (Brand et. al, 2018).
Estonia	No. Usually EPC assessors are asked to correct their mistakes. In case this is not done, penalties of 64,000 EUR for companies or 6,400 EUR for individuals can be imposed (Kuusk et. al, 2016).	No. See column 1.
Finland	Yes. Criminal liability provisions can be applied for EPC assessors (Finlex Databank, 2013).	Information not found.
France	Yes. Penalties up to loss of accreditation are in place (The certification criteria for technical diagnostic operators and training and accreditation bodies for certification bodies, 2018).	Information not found.
Germany	Yes. Based on non-compliance found during random EPC controls, EPC issuers may be threatened with fines (EnEV, 2014).	Information not found.
Greece	Yes.	Information not found.
Hungary	Yes. Penalties up to withdrawal of accreditation are in place.	No.
Ireland	Yes. Sanctions are in place, levelled by severity. Penalties include suspension or termination from registration (SEAI, 2016).	Yes. The stated objective for the disciplinary process of BER/DEC Scheme is the "classification of non-compliances on the basis of the seriousness of their impact on the integrity of the scheme". In addition, sanctions are based on severity.
Italy	Yes. Penalties in the regions range from 300 € to a maximum of 10,000 €, according to the breach of the rules. Penal consequences may be awarded in case of fraud (Costanzo et. al, 2016).	Yes. See column 1.
Latvia	Yes. A penalty point system is implemented (Valsts valodas centrs, 2013). With 10 penalty points, the EPC assessor certificate is withdrawn.	No.
Lithuania	Yes. Penalties up to loss of accreditation are in place (Meškauskienė et al., n.d.)	No. Does not appear to be the case (Meškauskienė et al., n.d.).
Luxembourg	Yes. Penalties in the form of a time-limited suspension can be imposed (Reding et. al, 2016).	Information not found.
Malta	Yes. EPC assessors are obligated to rectify incorrect EPCs in stipulated time, pending which their accreditation might be suspended (Energy Performance of Buildings Regulations, 2018).	Information not found.
Netherlands	Yes. Penalties can be imposed. By repeated non-compliance, the EPC assessor can lose its license and will be excluded from activities related to EPCs (van Eck, 2016).	Yes.
Poland	Yes. Penalties are in place (Bekierski et. al, 2016).	Yes. No penalties are foreseen for minor errors (Bekierski et. al, 2016).
Portugal	Yes. Penalties are in place, up to the (limited) suspension of the EPC assessor from the national list (Diário da República, 2013).	Information not found.
Romania	Yes. Based on specific control procedure approved by MDRAP Order no. 3152/2013 (PCC 001-2013 indicative) penalties and sanctions can be imposed (Ministry of Regional Development, 2013).	Information not found.
Slovakia	Yes.	Yes.
Slovenia	Yes. The penalty depends on the mistake. If necessary, the EPC assessor has to correct the EPC as well as issue and store	No.

	Differentiated and staged sanctions for EPC issuers in case of poor quality assessments or recommendations are in place	A distinction between fraud and negligence is made
	a new one in the register (Zarvl et. al, 2018).	
Spain	Yes.	Yes.
Sweden	Yes.	Yes.
UK	Yes. Penalties can be imposed. If a non-compliance situation is repeated, the specific experts will lose their license and will be excluded from activities related to EPCs (Department for Communities and Local Government, 2017).	Information not found.

Table 23: Sanctions and penalisation for EPC assessors in case of poor assessments or recommendations

5.8 Channelling monetary gains from sanctions for enhancing EPC schemes

If there is a mechanism to set sanctions, then the finance coming from the sanctions may be spent to improve the EPC scheme – i.e. new EPC platforms, training sessions, quality monitoring team, etc. This is an innovative idea. We have not found any information if an EU member state or the UK has already implemented it. If there were any fines imposed at all, it seems the proceeds are going to the general budget and are not earmarked for improving the EPC schemes.

6 USE OF EPCS AND THEIR DATA IN EU MEMBER STATES, INCLUDING IN WIDER BUILDINGS-RELATED DATABASES

While the three previous chapters analysed potential ways of improving the quality of EPCs, this chapter looks at how their use in the building markets could be improved. This concerns the use of EPCs in building transactions (e.g., sale or rental) and advertisements, as well as the use of EPC data for other policy or market purposes, respecting data protection issues.

6.1 Public opinion about EPCs

For EPCs to achieve the expected impact of making building energy performance transparent and relevant in building markets, it is crucial that the public is aware of them and has a high opinion of them. However, we find that the current public opinion about EPCs in the EU Member States is unclear. The publication by the Horizon2020 project Enerfund found, that the interest in EPCs is poor, as the general public in the EU does not sufficiently understand the EPC itself and its importance. Additionally, the information provided by the EPCs is not easily understandable for the majority of the general public. What is understandable, however, is the classification in the energy classes from A to G. EPCs bring added value to the building in its renting or selling, but mainly have no or little impact on building renovation. This is often the case, when EPCs only provide generic recommendations based on templates with no detail assessments and costing. For a building renovation, an additional energy audit becomes necessary.

However, as can be seen in the following table, at least in some countries a more positive public opinion about EPCs could be reached.

	Public opinion about EPCs
Austria	The general public does not have a good understanding, and is not very interested (Geissler et. al, 2016).
Belgium	Information not found.
Bulgaria	Statistical information not found. The QualDeEPC country partner estimates that many people do not care about EPCs or see them as a burden.
Croatia	Information not found.
Cyprus	The general public in Cyprus is considered not to be well aware about the EPC and its importance (Geissler et. al, 2016).
Czech Republic	Information not found.
Denmark	There has been an increasing understanding of the information provided by the EPCs. Now at least the price of higher ranking of buildings is generally accepted (Geissler et. al, 2016).
Estonia	Information not found.
Finland	Information not found.
France	In general, the public has a limited understanding of what is really provided by the EPC. The consideration for the general usefulness of EPCs is limited, except for the role it can have in adding value to a property and to improve its selling or leasing potential (Geissler et. al, 2016).
Germany	Information not found.
Greece	The general public understands the energy categories provided in the EPC – A is the best etc. and the necessity to acquire an EPC. However, the general usefulness of EPCs is limited to the added value the building may have in its renting or selling potential (Geissler et. al 2016). The QualDeEPC country partner estimates that EPCs have little impact for stimulating energy efficiency renovation, due to limited number of recommensations given in EPCs.
Hungary	The QualDeEPC country partner estimates it is more seen as a burden, but opinions differ on the scale. During the sale or rental procedure, it is only a burden and homeowners usually get it in the last minute. When it is

	Public opinion about EPCs
	needed for a grant application for instance (or for financial support, or a credit assessment) for energy renovation, it is valued more, because this way people get to see where they are heading, what the state of their building/flat is, and what will it achieve after refurbishment.
Ireland	Information not found.
Italy	Information not found.
Latvia	Statistical information not found. The QualDeEPC country partner estimates that many people do not care about EPCs or see them as a burden.
Lithuania	Information not found.
Luxembourg	Information not found.
Malta	Information not found.
Netherlands	Information not found.
Poland	In order to increase the public perception, the graphic design of the EPC could be improved. Additionally, including recommendations into the EPC would be supportive (iBroad, 2017).
Portugal	Information not found.
Romania	There is lack of awareness and suspicions on the EPC quality, that hamper the effective use of the EPC on the market (Geissler et. al, 2016).
Slovakia	The general public has only limited understanding of the information provided through EPC. Understandable are the energy classes due to the similarity to the energy labelling of appliances (Geissler et. al, 2016).
Slovenia	The general public is not very well informed regarding EPC necessity. Especially owners at renting or selling are considering EPC as "necessary financial burden" which has to be obtained (Geissler et. al, 2016).
Spain	Statistical information not found. The QualDeEPC country partner estimates that many people do not care about EPCs or see them as a burden.
Sweden	Statistical information not found. The QualDeEPC country partner draws the following conlcusions: It differs a lot between different types of building owners, and it also depends on how far the building owner has come in the work of improving energy performance. **Larger building owners**: A lot thanks to the first round of EPCs, energy consumption is now high on the agenda in many of these companies. However, now that they need to have the EPCs redone (10 years have past), at least some of them see this as mainly of a burden. Energy efficiency measures are today already part of their daily work and goals. **Single-family house owners**: The general opinion among private persons selling a property seems to be that it is mainly a burden and an unnecessary cost. For private persons looking to buy a property, the opinions seem to be more of a mix.
UK	The general public does not have a good understanding of the information provided in the EPC and can misinterpret it. This is in part because the document itself is often not displayed in its entirety at the point of sale or lease (Geissler et. al, 2016).

Table 24: Public opinion about EPCs

6.2 Mandatory use of EPC during sale and rental of buildings

The EPBD requests, that in each Member State it becomes obligatory to display the EPC in the sale or rental process of a building. In all Member State the EPBD has been transposed, so that a respective national law exists. Usually, the EPCs has to be presented to the buyer or tenant. How strict this requirement is implemented, however, is different. In some countries, it is tolerated to submit the EPC a certain time after the selling, whereas in some countries the absence of an EPC at the time of sale may result in a fine for the seller.

6.3 Sanctions and penalisation for building owners failing to own or present an EPC

The use of EPCs in building markets can be improved by sanctions for building owners for missing to obtain/present an EPC. This may be combined with rewards for compliance and creating market demand/pressure for presenting an EPC (which should be of high quality), in order to improve compliance further, since the control of compliance may not be easy (cf. chapter 6.1 and 6.4). However, no

information was found on rewards for compliance. Regarding market pressure, an example from Austria was found: If no energy certificate is presented and the building does not have an overall energy efficiency corresponding to its age and type, the buyer or tenant can make warranty claims (in the case of rentals this means a reduction in rent) (Energieausweis.at, n.d.).

Regarding the sanctions for building owners for missing to obtain/present an EPC, these appear to be provided for by legislation, but the degree of control and implementation may vary between member states.

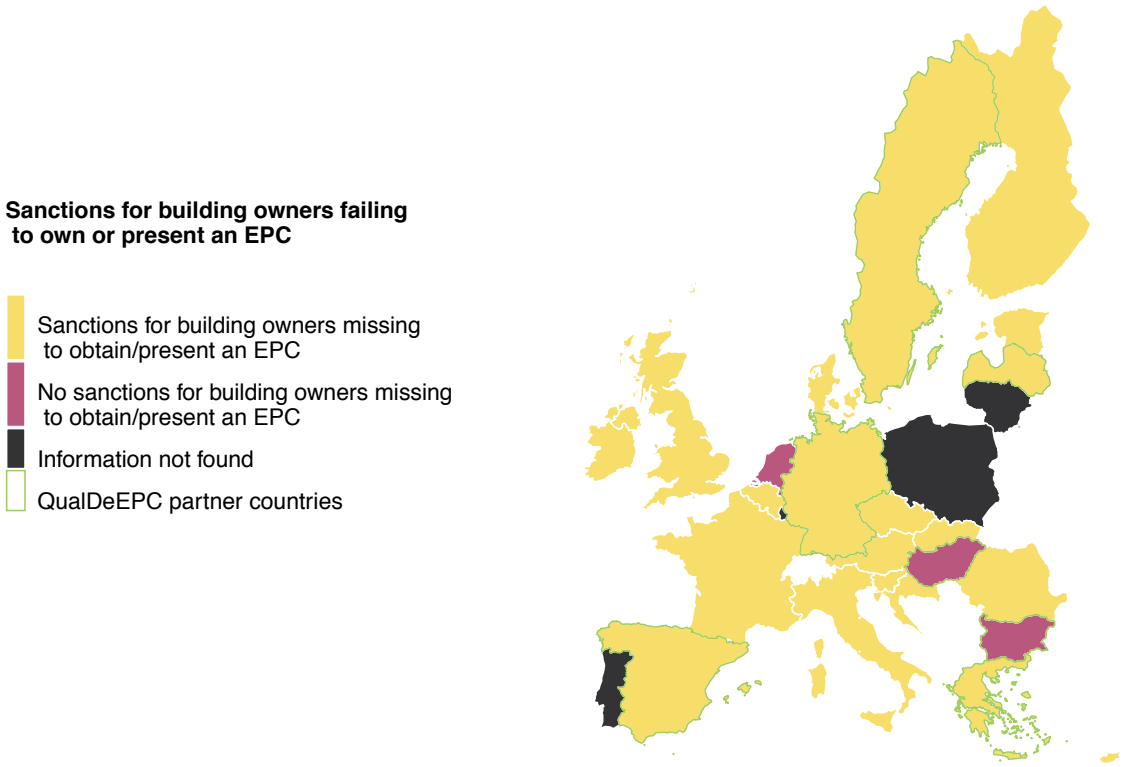

Figure 17: Sanctions for building owners failing to own or present an EPC

	Sanctions for building owners missing to obtain / present an EPC are in place
Austria	Yes. When selling a building or long-term renting, an EPC has to be provided. The buyer or renter can sue for the EPC or can reimburse the costs. From a purely legal point of view, the omission constitutes an administrative violation and can therefore be punished with up to € 1,450.00 (Energieausweis-Vorlage-Gesetz 2012).
Belgium	Yes. Flanders: If a seller of a building does not provide an EPC in time, they will be asked to give reasons. The building seller risks a fine of 500 to 5,000 EUR. A notary has to report, if an EPC is not provided during selling. The notary risks a fine of 250 to 5,000 EUR if not reporting (Energiesparen.be, n.d.).
Bulgaria	No.
Croatia	Yes. Penalties can be imposed in the case for not providing the EPC at the time of sale, rent or lease (Skoro, 2016).
Cyprus	Yes. If an EPC is not delivered to buyer or renter, the seller might expect a fine up to 8,550 EUR ("An owner, who fails to deliver the certificate to a buyer or renter, or to display it on a public building, will incur in a fine which must not exceed 8,550 € (Hadjinicolaou, 2010).
Czech Republic	Yes. The obligation to display the EPC in the case of sale or rent was randomly checked and resulted in penalties of about 30,000 EUR in total (Svoboda, 2016).
Denmark	Yes. In 2013 the Danish Energy Agency has carried out random checks on larger buildings. The owners not having an EPC were given a warning and a deadline for complying with the rules (Engelund Thomsen et. al, 2014).
Estonia	Yes. Penalties can be imposed (Kuusk et. al, 2016).

	Sanctions for building owners missing to obtain / present an EPC are in place
Finland	Yes. The owner is liable in the case of non-compliance (Finlex Databank, 2013).
France	Yes. EPC is mandatory for sale and lease of buildings. Furthermore, failure to present EPC in sale and rental advertisements is both civil and criminal offence (Ministry of Ecology, Energy, Sustainable Development and the Sea, n.d.).
Germany	Yes. The non-delivery of an EPC to the buyer or renter is an administrative offence (EnEV, 2014).
Greece	Yes.
Hungary	No.
Ireland	Yes. If the BER is not included in any advertisement for the building, it can lead to a penalty for the person found guilty can be fined with 4,000 to 5,000 EUR or imprisonment for a term not exceeding 3 months or both (Energy Rating Plus, n.d.)
Italy	Yes. In case of not providing the EPC in sale or rent, a penalty between 300 an 18,000 EUR can be imposed (Costanzo et. al, 2016).
Latvia	Yes.
Lithuania	Information not found.
Luxembourg	Information not found.
Malta	Yes. Building owners are obligated to produce EPC to the Building Regulation Office on demand, failing which is deemed to be an offence (Energy Performance of Buildings Regulations, 2018).
Netherlands	No. All buildings are give a provisional EPC. Building owners are required to produce final EPC during sale or rental of the building (van Eck, 2016).
Poland	Information not found.
Portugal	Information not found.
Romania	Yes. Failure to produce EPC during sale or rental constitutes a civil offence (Tenea et al., 2016.).
Slovakia	Yes. In case of not having an EPC when needed, building owners can be fined of 500 up to 3,000 EUR (arnea.sk, n.d.).
Slovenia	Yes. Display of EPC during sales or rentals is mandatory. Non-compliance can result in penalties (Zavrl et. al, 2018).
Spain	Yes.
Sweden	Yes.
UK	Yes. Building owners can be fined if they do not get an EPC when they need one (Gov.UK, n.d.).

Table 25: Sanctions for building owners failing to own or present an EPC

6.4 Presenting EPC to official building sales bodies (i.e. notaries, etc.) as an obligatory/mandatory measure

Another way to improve compliance with the requirement to own an EPC when selling a property is to make it obligatory/mandatory to present the EPC to official building sales bodies (i.e. notaries, etc.) when selling buildings or parts thereof, as practiced in Greece, Hungary (inclusion in sales contract), and Sweden, as well as a number of other EU member states (see figure below).

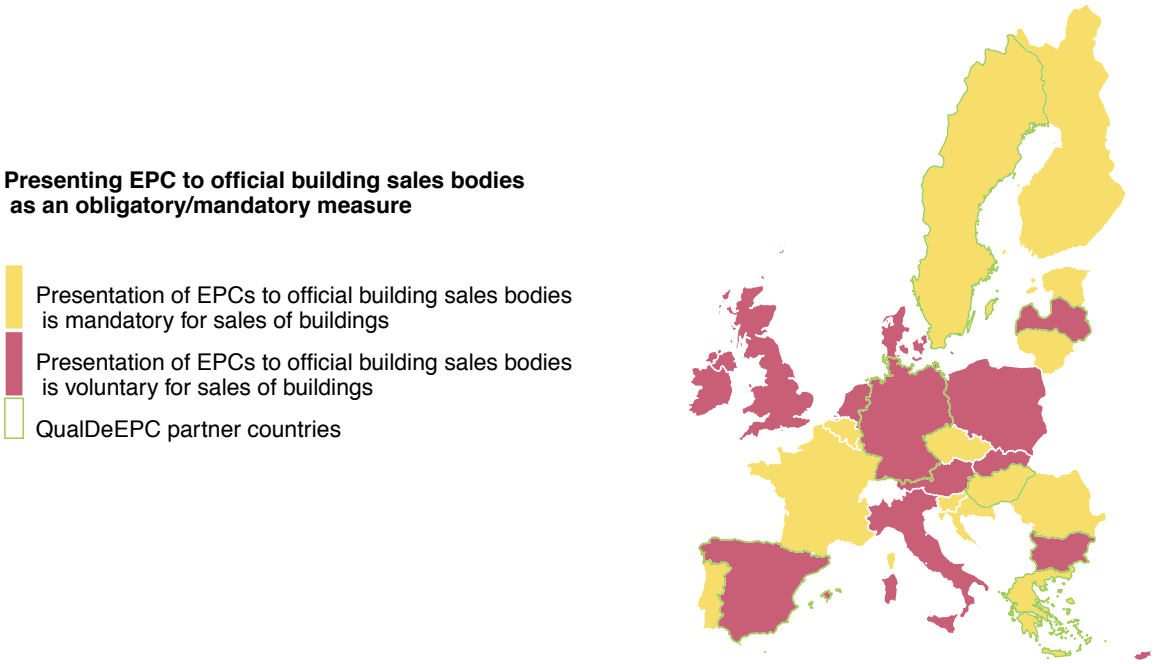

Figure 18: Presenting EPC to official building sales bodies as an obligatory/mandatory measure

	Presentation of EPCs to official building sales bodies, such as notaries, is mandatory for sales of buildings
Austria	No.
Belgium	Yes. The notary has to report the absence of an EPC to the Flemish Energy Agency (De Meulenaer, 2016).
Bulgaria	Information not found
Croatia	Yes. At least for new buildings: An investor of a new building has to provide a building energy certificate before performing the technical inspection and attach it to the application for issuance of a use permit (Croatia Real Estate Agency, n.d.).
Cyprus	No.
Czech Republic	Yes. Before commencing new construction or major renovation, the builder should submit an EPC to the State Energy Inspectorate for assessment on whether the energy performance obligation is fulfilled (Svoboda, 2016).
Denmark	No.
Estonia	Yes. The EPC is necessary for the erection of a building and transfer of ownership or entry into a financial lease agreement in respect of the building (Riigi Teataja, 2012).
Finland	Yes. EPCs are necessary for all new buildings, along with the building permit application. For existing buildings, an EPC is needed when the building (or a part of a building, e.g., an apartment) is sold or rented (Haakana et. al, 2016).
France	Yes. The technical diagnosis file (e.g. including EPC) must be attached to all promises to sell and all sales of residential properties (Notaries de France, 2020).
Germany	No.
Greece	Yes.
Hungary	Yes.
Ireland	No.
Italy	Information not found.
Latvia	No.
Lithuania	Yes. For new buildings, an EPC is necessary for the completion of construction procedures, which means a building can be registered as completed and in use. The same is applicable for buildings after major renovations. In the case of buying, selling or renting an existing building, EPCs are checked by a notary during the signing of real estate contracts (Encius, Baranauskas, 2016).
Luxembourg	Yes. An EPC is required to get a building permit (Le Gouvernement du Grand-Duché de Luxembourg, 2017).
Malta	Yes. A copy of the design rating EPC shall also be attached to the promise of sale/deed (Energy Performance of

	Presentation of EPCs to official building sales bodies, such as notaries, is mandatory for sales of buildings
	Buildings Regulations, 2018).
Netherlands	Information not found.
Poland	No. During sales or rentals the owner should hand over the EPC to the buyer or tenant. If this is not done, the buyer may request the EPC at the expense of the owner. The owner and the buyer are informed about their rights by a notary while signing the notary deed (Bekierskie et. al, 2016).
Portugal	Yes. An EPC is required (Fragoso and Baptista, 2016).
Romania	Yes. Starting as a voluntary system in 2001, presenting EPCs during sale and rental of buildings became mandatory with the EPBD transposition in 2005 (iBroad, 2017).
Slovakia	Information not found.
Slovenia	Yes. For new buildings an EPC is part of the documentation of completed construction works. When renting or selling a building, the EPC has to be displayed before the contract is concluded (Zarvl et. al, 2016).
Spain	No.
Sweden	Yes.
UK	No.

Table 26: Presenting EPC to official building sales bodies as an obligatory/mandatory measure

6.5 Advertising guidelines for presenting EPCs in real-estate ads during sale and rental

In most EU Member States it is mandatory to display the energy class of the EPC in selling or renting advertisements (see next chapter) but the compliance varies. A potential way to improve compliace is to make it easier for sellers or landlords of buildings is to provide them with concrete guidelines for the use and presentation of EPCs and the legally required data in advertisements of sales/rentals or buildings/dwellings. In some countries, such guidelines issued by energy agencies/public authorities are already available. For example in Ireland, a detailed guideline plus the respective energy class artwork files are available for download and use (SEAI 2013). In France, examples of adverts are available, at least, the energy class label should be presented (Ministère de la Transition écologique et solidaire, 2018).

Among QualDeEPC partner countries, it appears that advertising guidelines for presenting EPCs in real-estate ads during sale or rental are still unavailable.

6.6 Controlling and enforcing the mandatory use of EPCs in real estate advertisements

The requirement to present the EPC or at least the EPC rating and key values in real estate advertisements is given in most EU Member States. However, the level of compliance with this requirement is varying, and data available to us are inconclusive on how many countries are actively controlling and enforcing this legal requirement. This is also the case for the QualDeEPC partner countries. We therefore abstain from presenting a graphical presentation or a table on the results for all EU member states and the UK. Some countries, for which available information suggests that they have concrete control or enforcement responsibilities in place, are included in the table below.

	Legal requirement to present EPC, or at least the EPC rating and key values in advertisements is controlled and enforced
Croatia	Yes. Supervision is under the competence of the Ministry of Economy, Market Inspectorate. This obligation is commonly followed and no fines have been issued so far (Skoro, 2016).
Cyprus	Yes. Non-compliance has led to penalties in 22 cases. This has led to a higher rate of EPC display in advertisements (Hadjinicolaou, 2016).
Estonia	Yes. The Estonian Technical Surveillance Authority is in charge of checking the use of EPCs in case of selling or renting property (Kuusk and Tali, 2014).
Slovakia	Yes. The Slovak Trade Inspection is in charge of control checks (Sternova et. al, 2016).

Table 1: Controlling and enforcing the mandatory use of EPCs in real estate advertisements

6.7 Public database of EPCs

Most EU Member States have implemented databases of all issued EPCs. The general public can access many of them, but sometimes the access is limited for special groups like energy advisors etc. The ways to access databases are also different across the countries. Sometimes inserting the street plus housing number is sufficient (like in the UK), sometimes the EPC number has to be inserted (like in Ireland). Furthermore, the amount of data accessible from a public database is different. In some of the countries a full EPC along with the recommendations can be accessed, while in the others, the publically available information is limited to key values, such as EPC rating class, energy consumption and the full EPC is only available for the building owner (like in the Netherlands). In Germany a database of EPCs do not exist.

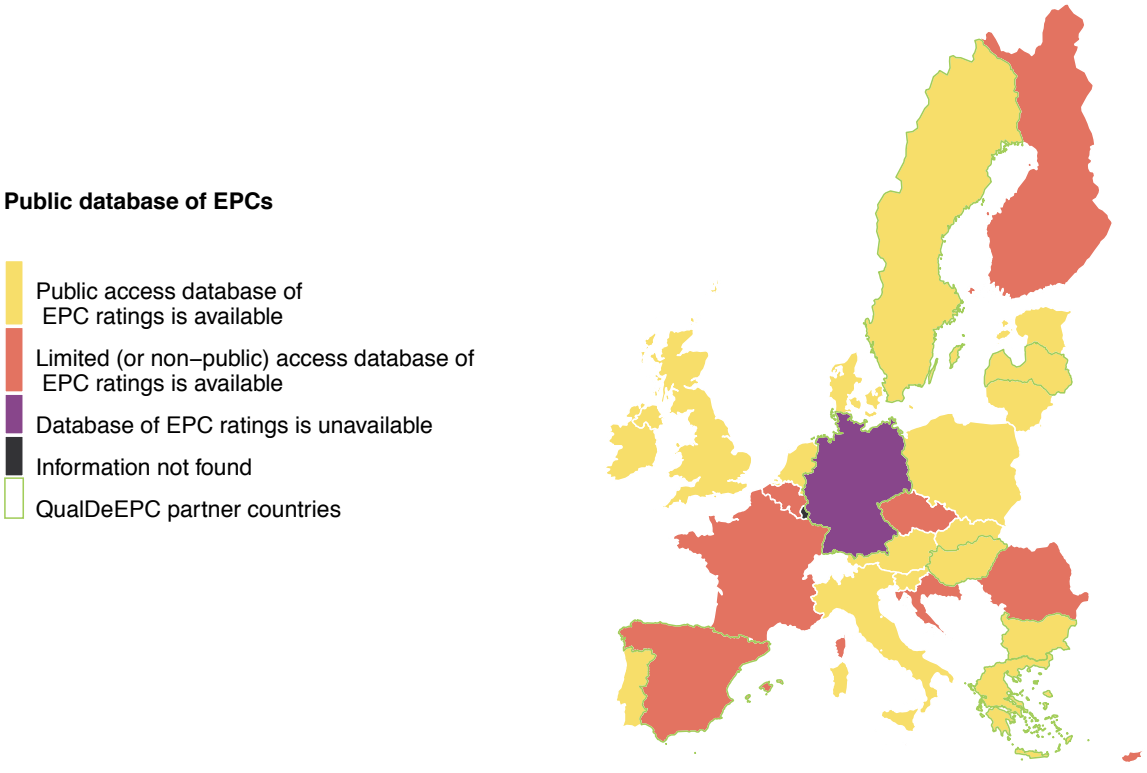

Figure 19: Public database of EPCs

	Public database (protecting privacy) of EPC ratings is available
Austria	Yes. EPCs are centrally stored in regional energy certificate databases (e.g.: ZEUS, Energy pass centre Vorarlberg, WUKSEA). The aim of the central storage of the energy certificates is to represent the building stock as realistically as possible (Austrian Energy Agency, n.d.).
Belgium	No. A database exists in the property of the Flemish Energy Agency. Access is limited and only qualified experts can view only their own files/EPCs. This is due to privacy issues (Altmann-Mavaddat et. al, 2015).
Bulgaria	Yes.
Croatia	No. However, Currently, Croatia is running a test phase for implementing an electronic database for the EPCs (Skoro, 2016). However, this does not seem to be publically accessible (EC, n.d.).
Cyprus	No. The access to the database is restricted to energy inspectors under personal data protection law (Mudgal et. al, 2013).
Czech Republic	No. A central register exists; however, no public access is available (EC, n.d.).
Denmark	Yes. All EPCs are registered in a central database that is publicly available on the website http://sparenergi.dk.
Estonia	Yes. (Arcipowska et. Al, 2014).
Finland	No. A database exists, but it is not accessible by the public (EC, n.d.).
France	No. However, the database has limited access. Professionals (in charge of the certifications, accredited auditors as well as public organization) have a privileged access to this database. For the general public, it allows either to search for a specific DPE using a reference number or to obtain statistics on EPCs per type of building, construction year or type of heaters (Geissler et. al, 2016).
Germany	No. No central database exists.
Greece	Yes.
Hungary	Yes.
Ireland	Yes. The National BER Register exists. However, one has to insert the BER/DEC number of the MPRN (Meter Point Reference Number) (SEAI, n.d.).
Italy	Yes. Probably still not available in all regions/autonomous provinces. The region of Lombardy publishes all its EPC data in a spread sheet that is openly available online (Constanzo et. al, 2016).
Latvia	Yes.
Lithuania	Yes. A public EPC register exists at spsc.lt.
Luxembourg	The third National Energy Efficiency Action Plan announced the build up of a national database (Le Gouvernement du Grand-Duché de Luxembourg, Ministère de l'Économie, 2014)
Malta	No. The Buildings Regulation Office maintains EPC registry. One can check the validity of the EPC by entering the EPC number (Energy Performance of Buildings Regulations, 2018).
Netherlands	Yes. The letters of energy labels for buildings are registered on www.ep-online.nl and are retrievable per address on that site. The energy labels themselves, including the underlying information to those label letters and the recommendations of energy-saving measures, in principle, are only available to building owners (van Eck et. al., 2016.
Poland	Yes. A database of the publicly available central register shows, on the basis of issued EPCs in Poland, information about these buildings (among other things, the parameters of the energy performance, the share of RES, the value of CO2 emissions (Bekierski et. al, 2016).
Portugal	Yes. The database is accessible at https://www.sce.pt/pesquisa-certificados/
Romania	No. A central register exists; however, no public access is available (EC, n.d.).
Slovakia	Yes. Slovakia established a national database in 2010, which is becoming more and more functional with open content (Davis et. al, 2018).
Slovenia	Yes. Following information is publically available: Serial number of EPC, building cadastre identification code, address of the building, cadastral municipality and parcel number, name of EPC assessor, date of issuance (Official Gazette, 2014).
Spain	No.
Sweden	Yes.
UK	Yes.

Table 27: Public database of EPCs

6.8 Linking EPC database to other buildings- or energy-related databases

Linking EPC database to other buildings- or energy-related databases, e.g. on green certificates. Such linking helps in planning informed polices and design novel financial schemes for deep renovation.

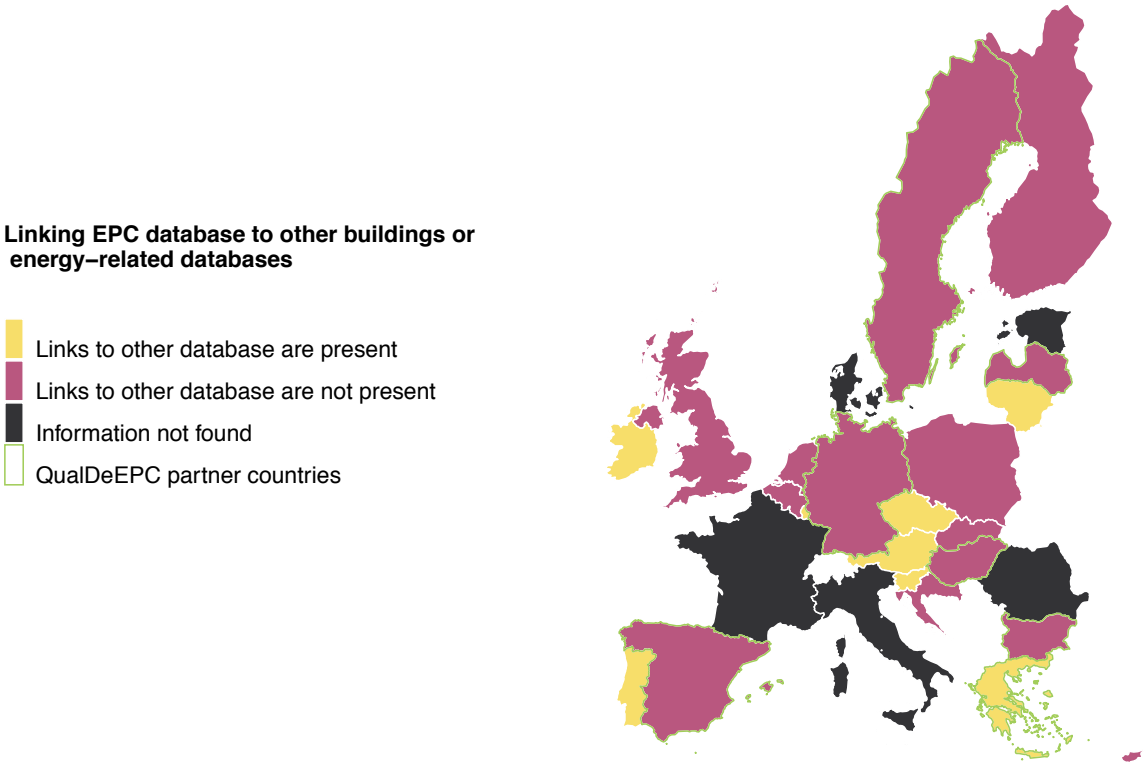

Figure 20: Linking EPC database to other buildings- or energy-related databases

	Links to other database are present
Austria	Yes. There is a another building standard, the "Klimaaktiv standard". It is quite ambitious and already meets those requirements today that will be relevant in 2020 and beyond. The basis is the EPC, but requirements for the Klimaaktiv standard go beyond (klimaaktiv, 2018).
Belgium	Information not found.
Bulgaria	Information not found.
Croatia	Information not found.
Cyprus	Information not found.
Czech Republic	Yes. The Central Register of Administrative Buildings keeps records of 5,000 buildings that are properties of the state (Svoboda, 2016).
Denmark	Information not found.
Estonia	Information not found.
Finland	No.
France	Information not found.
Germany	No.
Greece	Yes.
Hungary	No.
Ireland	Yes. The data can be used in combination with other data sources including census (Altmann-Mavaddat, 2015). The information available in the database is being used also for strategic energy planning (https://renewables.maps.arcgis.com/home/index.html).
Italy	Information not found.
Latvia	No.

	Links to other database are present
Lithuania	Yes. Since July 2014, all data are also transferred to the Real Property Register and Cadastre of Lithuania (Encius, Baranauskas, 2016).
Luxembourg	Yes. "LENOZ" is a voluntary sustainability assessment of residential buildings adapted to Luxembourg conditions. The abbreviation "LENOZ" stands for "Lëtzebuerger Nohaltegkeets certification" (Le Gouvernement du Grand-Duché de Luxembourg, 2017).
Malta	Information not found.
Netherlands	No.
Poland	No.
Portugal	Yes. EPC database is connected to other databases to better operate funding schemes (Fragoso and Baptista, 2016).
Romania	Information not found.
Slovakia	No.
Slovenia	Yes. The EPC register should be connected with cadastre database as well with spatial online portal, enabling wider data accessibility and transparency (Geissler et. al, 2016).
Spain	No.
Sweden	No.
UK	No.

Table 28: Linking EPC database to other buildings- or energy-related databases

7 HOW ARE EPCS IN EU MEMBER STATES EMBEDDED IN WIDER POLICIES AND PUBLIC ACTIVITIES TO STIMULATE DEEP RENOVATION?

Improving the usefulness, use, and impact of EPCs for stimulating deep energy efficiency renovation is a focus of the QualDeEPC project. Therefore, we analysed a number of options for this purpose.

7.1 Linking EPCs and renovation recommendations to detailed energy audits

EPCs could become the first step towards a detailed energy audit, or they could even be based on such an audit. The next figure and table shows the overview about whether EPC assessments / calculations and the recommendation are based on a detailed energy audit, as is already the case e.g. in Latvia and Bulgaria. A problem can be the ownership of the EPC data model. For example, when the EPC issuer is not the energy consultant, the building data must be recaptured. That would take time and would cause further costs for the building owner. Additionally, the results are only conditionally comparable, since different boundary conditions underlie. In the same direction go arguments by several other stakeholders. In many countries it is a general view among EPC assessors that an EPC belongs to the building, regardless of its owner and of its owner's behaviour and use of the building. An audit also mirrors the habits of the owner/user and this should only be taken as the basis of the recommendations for improving the building's performance with some care and abstraction from the users' habits.

There are only few EU member states, for example, Croatia that require a detailed energy audit as the basis for an EPC, also, QualDeEPC partner countries Bulgaria and Latvia are among them.

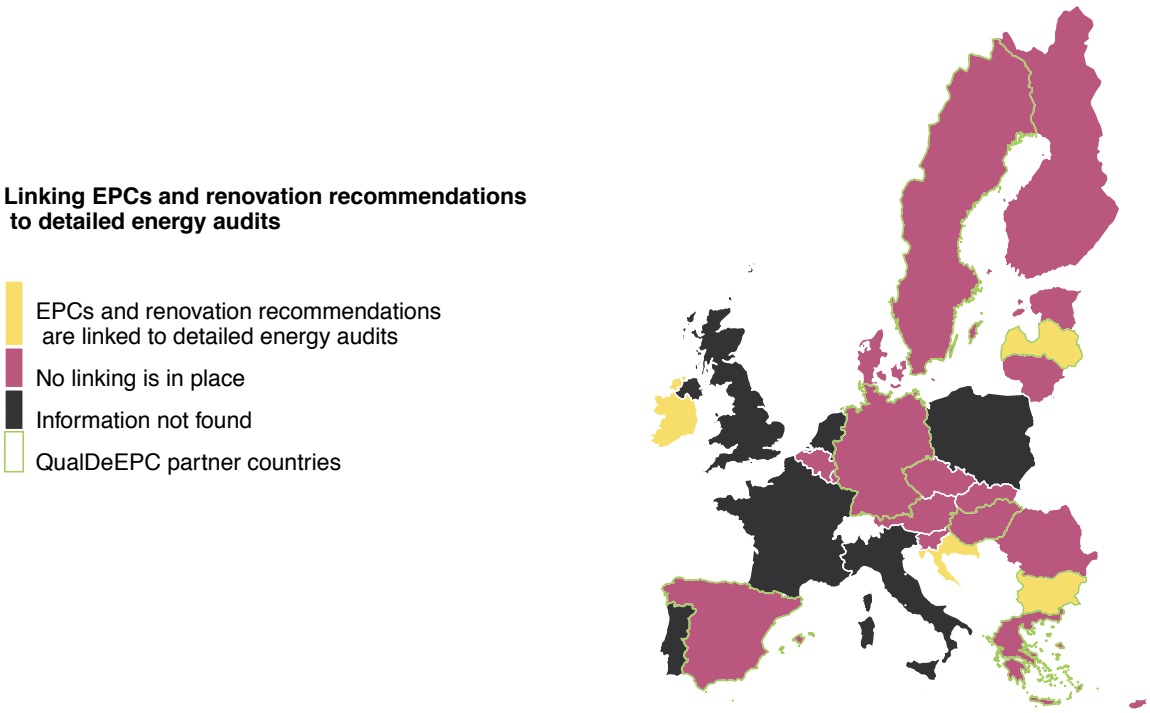

Figure 21: Linking EPCs and renovation recommendation to detailed energy audits

	Linking EPCs and renovation recommendation to detailed energy audits
Austria	No.
Belgium	No. (in general) The EPC is based on technical building issues only (CertiBru, 2020).
Bulgaria	Yes.
Croatia	Yes. Energy audit is a pre-condition for producing EPCs (Marđetko-Škoro, 2014).
Cyprus	No EPCs are only based on technical building performance.
Czech Republic	No.
Denmark	No.
Estonia	No. EPCs and energy audits for buildings are different measures (Eesti Energia, n.d.).
Finland	No. EPCs are only based on technical building performance. The only target of comparison is the building itself, not its current occupants (Motiva, 2018).
France	For example, in 2016 the DPE (EPC) replaced a mandatory energy audit for collective residential buildings with less than 50 units (Switzerland Global Enterprise, n.d.). An EPC based on measured energy consumption is mandatory for older buildings and flats with collective heating systems.
Germany	No. If the EPC issuer is not the energy consultant, the building data must be recaptured (takes time and causes new costs for the building owner) The results are conditionally comparable, since different boundary conditions underlie.
Greece	No.
Hungary	No. In Hungary it is a general view among assessors that an EPC belongs to the building, regardless of its owner, and of its owner's behaviour/use of the building. An audit mirrors the habits of the owner, but it should not be the basis of the recommendations for improving the building's performance.
Ireland	Yes. The BER is quite detailed. It includes on-site inspection, and individual energy and water use into the calculation. The recommendations are quite detailed (SEAI, n.d.).
Italy	Information not found
Latvia	Yes.
Lithuania	No.
Luxembourg	No.
Malta	Information not found.
Netherlands	Information not found.
Poland	Information not found.
Portugal	Information not found.
Romania	No. The information provided in the EPC is sufficient to conduct an evaluation of the energy performance of the certified building. However, the detailed technical information is often incomplete or incorrect (iBroad, 2017).
Slovakia	No. EPCs can be issued via an online form. An energy audit is an extensive evaluation (e.g. arnea.sk, n.d.).
Slovenia	No. An EPC is not an Energy audit. To obtain overall evaluation of the energy performance of the buildings a more extensive evaluation should be performed (energy audit is one of the most useful forms) (Geissler et. al, 2016).
Spain	No.
Sweden	No.
UK	Information not found.

Table 29: Linking EPCs and renovation recommendation to detailed energy audits

7.2 Monitoring implementation of renovation recommendations given in the EPCs

A monitoring of the implementation of recommended actions for energy efficiency renovations given in the EPCs can be easy, if EPCs are linked with financial incentive/financing schemes, as in QualDeEPC partner countries Bulgaria, Greece, and Hungary. However, such linkages (see 7.3) are not often available. As a result, also a monitoring of the implementation of recommendations is rarely given. In most countries an implementation of the recommendations is voluntary and is not monitored. Although not a way of monitoring implementation of renovation recommendations, in Cyprus, EPCs of public buildings, the recommendations accompanying them, and energy audits, where applicable, were the basis for evaluating 120,000 m^2 of public buildings that was planned to be renovated for the period 2014 – 2020.

7.3 Linking EPCs to financial incentive schemes

In some countries, EPCs are directly linked to financial incentive schemes. This includes a mandatory issuance of asset rating EPCs before and after renovation. Countries in which such schemes are available are e.g. Bulgaria, Greece, Hungary and Latvia.

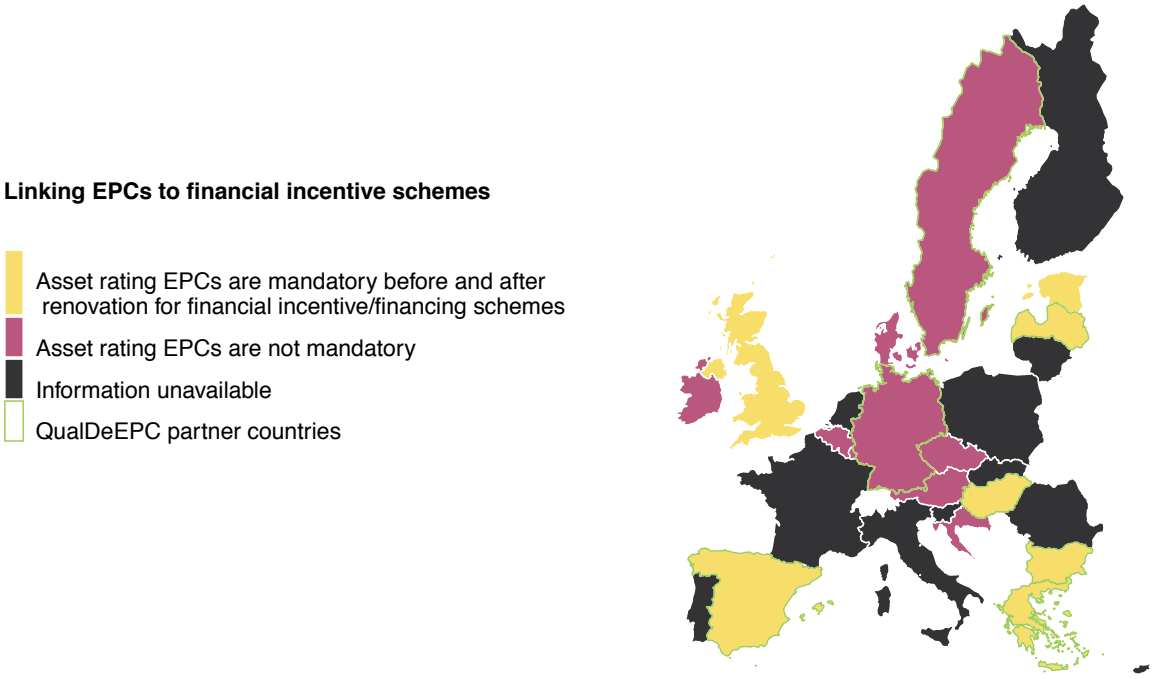

Figure 22: Linking EPCs to financial incentive schemes

	Asset rating EPCs are mandatory before and after renovation for financial incentive/financing schemes
Austria	No. For some funding schemes like "Sanierungscheck für Private 2019" the EPC has to be provided before, but not after renovation (Kommunal Kredit Public Consulting, 2019).
Belgium	No.
Bulgaria	Yes.
Croatia	No.
Cyprus	Yes. A "Scheme for Promoting Saving and Upgrading of Households" is available. One type of investment is targeting the achievement of at least B class of energy efficiency in the EPC. Unclear, if asset rating of EPC before and after is mandatory (Republic of Cyprus, n.d.).
Czech Republic	No.
Denmark	No. Subsidy programmes for renovation are available, however, not linked to EPCs.
Estonia	Yes. A grant scheme, managed by Fund KredEx, started in 2015 to renovate existing apartment buildings, and is strongly linked to the EPC system. For example, a 15% grant can be applied when EPC Class E (minor renovation) will be achieved after the completion of renovation works (Kuusk and Tali, 2014).
Finland	Information not found.
France	Information not found.
Germany	No. There are different boundary conditions for funding programs and EnEV calculations.
Greece	Yes.
Hungary	Yes.
Ireland	No.
Italy	Information not found.
Latvia	Yes.
Lithuania	Information not found.

	Asset rating EPCs are mandatory before and after renovation for financial incentive/financing schemes
Luxembourg	No.
Malta	Information not found.
Netherlands	Information not found.
Poland	Information not found.
Portugal	Information not found.
Romania	Information not found.
Slovakia	Information not found.
Slovenia	Information not found.
Spain	Yes.
Sweden	No.
UK	Yes For receiving grants from the Energy Saving Trust, e.g. in Scotland, the measure has to be recommended in an EPC. After the work has been done, an updated EPC is needed for receiving the grant (Energy Saving Trust, n.d.).

Table 30: Linking EPCs to financial incentive schemes

7.4 Creating Deep Renovation Network Platforms

A promising step towards deep renovation are Deep Renovation Network Platforms. Such platforms provide one-stop-shops for deep renovation linked to EPCs, including administrative, energy advice, financial and supply-side information to building owners, with active marketing of deep renovation and EPC, and coordinating supply-side actors and supporting their marketing, training and quality. Such one-stop-shops for deep renovation linked to EPCs may be available on national, regional or local level. In many countries one-stop-shops for building renovation exist, however, only some of them target “deep renovation”. In addition, the intensity of the service offered may vary a lot, from online platforms offering the above information in an integrated way, through local offices and staff for the information and coordination activities, to one-stop-shops even coordinating concrete renovation works for the clients.

The following graph and figure relate to either the latter service intensity (Denmark, France) or to a comprehensive information platform at national level (Ireland, UK).

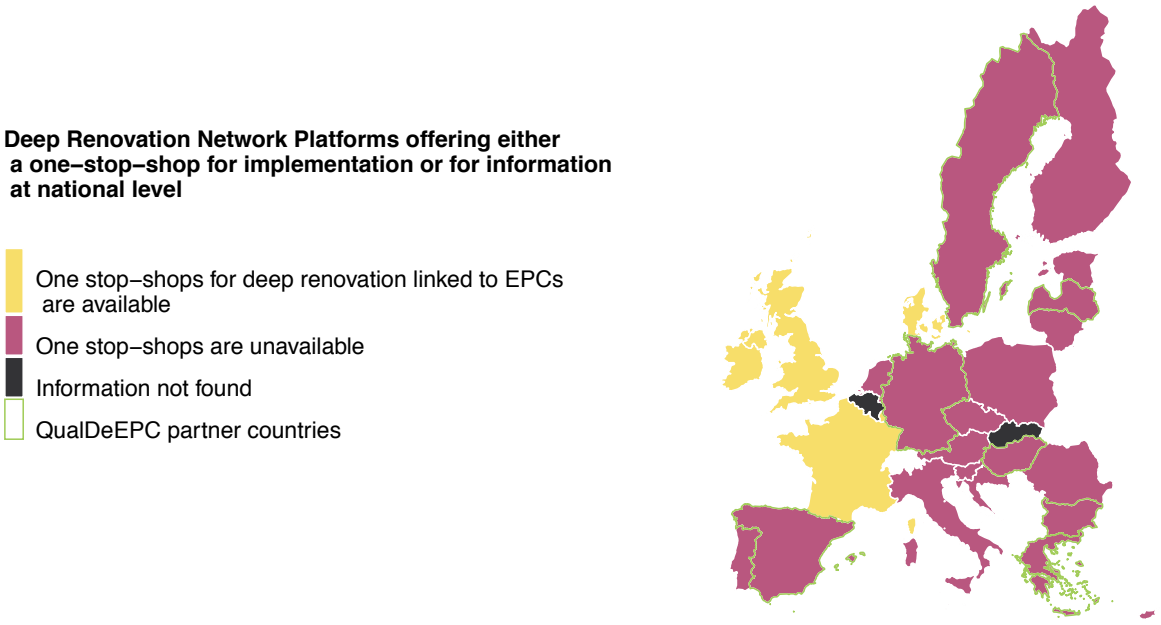

Figure 23: Deep Renovation Network Platforms offering either a one-stop-shop for implementation or for information at national level

	One stop-shops for deep renovation linked to EPCs are available
Austria	No.
Belgium	Deep renovation programs exist: BEreel, Renovatiepact: However, linkages to EPC are unclear, the programs go much further.
Bulgaria	No.
Croatia	No.
Cyprus	No.
Czech Republic	No.
Denmark	Yes. BetterHome is an industry-driven one-stop-shop model, which has proven successful in boosting demand for holistic energy renovations in Denmark, since the model was launched in 2014 (BetterHome, n.d.).
Estonia	No.
Finland	No.
France	Yes. There are some regional one-stop-shops. For example Ile-de-France Energies: A one-stop-shop in the region Ile de France. The main aim is to accompany condominiums and social housing organizations in various phases of ambitious energy renovation projects and providing them with organizational, technical, legal and financial engineering services (JRC, 2017; Ile-de-France Energies, n.d.).
Germany	No. at national level. However, there are a number of local information and coordination offices for information, advice, and coaching on deep renovation
Greece	No.
Hungary	No.
Ireland	Yes. The SEAI (Sustainable Energy Authority of Ireland) Homepage includes the EPC database, includes detailed information on how to get an EPC, building renovation, databases, links to installers etc, and also for grants (www.seai.ie).
Italy	No.
Latvia	No.
Lithuania	No.
Luxembourg	Yes. myenergy (www.myenergy.lu) is the national structure for promoting the national energy transition. The Homepage includes information for all stakeholders, provides a list of EPC assessors, shows how to get funding.
Malta	No.

	One stop-shops for deep renovation linked to EPCs are available
Netherlands	No.
Poland	No.
Portugal	No.
Romania	No.
Slovakia	Information not found.
Slovenia	No.
Spain	No.
Sweden	No.
UK	Yes. Services of the Energy Saving Trust include the Home Energy Check and the Home Energy Check Scotland. They include lots of detailed information, tools and calculators, financial support, lists of registered hand-crafts, database of energy efficient products (www.energysavingtrust.org.uk).

Table 31: Deep Renovation Network Platforms offering either a one-stop-shop for implementation or for information at national level

8 CONCLUSIONS

This report from the QualDeEPC project has examined the degree, to which EU member states and the UK may have already implemented a large number of potential improvement options for energy performance certification schemes, the use of EPCs in building markets, and for advancing deep renovation. The results show, once more, the high diversity in EPC schemes across the EU (cf. several publications of the Concerted Action on the EPBD and Arcipowska et al. 2014). They also provide useful information in at least two directions: 1) which improvement options are not yet implemented at all or in sufficient quality in most QualDeEPC partner countries as well as other EU member states, and could therefore be interesting candidates for the further work of the QualDeEPC project in development, testing, discussion, and possibly implementation of elements for enhanced and converging EPC schemes (to be analyzed in Tasks 2.3 and 2.4 of the project at first hand); and 2) which countries, within or beyond the QualDeEPC project, offer good practice examples for the implementation of these options that could serve to guide the development and implementation in other countries (Task 2.2 of the project).

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