



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

QualDeEPC H2020 project

AUTHORS: Sriraj Gokarakonda, Maike Venjakob, Dr. Stefan Thomas (Wuppertal Institut)

Co-authors: Daniela Kostova (EAP)

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Accelerating Deep Energy Renovation”

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CRES: Centre for renewable energy sources and saving

DENA: Deutsche Energie-Agentur GmbH (dena)

EAP: Energy agency of Plovdiv Association

EKODOMA

ENERGIACLUB: Energiaklub Szakpolitikai Intezet Modszertani Kozpont Egyesulet

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

FEDARENE: Federation europeenne des agences et des regions pour l'energie et l'environnement

ESCAN: Escan SL

CIT ENERGY MANAGEMENT AB



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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.

Against this background, the 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.

The first part of the QualDeEPC project (work package 2) aims to identify the priorities for elements of EPC schemes that show a need to be improved, and for which the project will investigate further and propose how the elements can be improved. The first step in identifying these priorities is taking stock of the existing EPC schemes. Based on the input from all national consortium partners and other sources, 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 analysis was based on a list of almost 50 potential options for enhancing the existing EPC schemes.

The aim of this deliverable is to present this stock-taking by a detailed analysis on which of the potential enhanced EPC elements are 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 at 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 presentation on the elements implemented as well as a cross-country comparison matrix (see Annex I) 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.



TABLE OF CONTENTS

1	INTRODUCTION	11
2	Overview of partner countries' EPC situation	13
2.1	Bulgaria	13
2.1.1	How are EPCs implemented in your country/region (also as a part of national policies and regulations)?	13
2.1.2	What are possible purposes for issuing EPCs?	14
2.1.3	Who is allowed to issue EPCs?	14
2.1.4	For whom are EPCs relevant and interesting?	15
2.1.5	Who are the key market actors?	15
2.1.6	What are the key success factors?	15
2.1.7	What are key barriers?	15
2.2	Germany	16
2.2.1	How are EPCs implemented in your country/region (also as a part of national policies and regulations)?	16
2.2.2	What are possible purposes for issuing EPCs?	16
2.2.3	Who is allowed to issue EPCs?	17
2.2.4	For whom are EPCs relevant and interesting?	17
2.2.5	Who are the key market actors?	17
2.2.6	What are the key success factors?	17
2.2.7	What are key barriers?	17
2.3	Greece	17
2.3.1	How are EPCs implemented in your country/region (also as a part of national policies and regulations)?	17
2.3.2	What are possible purposes for issuing EPCs?	18
2.3.3	Who is allowed to issue EPCs?	18
2.3.4	For whom are EPCs relevant and interesting?	18
2.3.5	Who are the key market actors?	18
2.3.6	What are the key success factors?	19
2.3.7	What are key barriers?	19
2.4	Hungary	19
2.4.1	How are EPCs implemented in your country/region (also as a part of national policies and regulations)?	19
2.5	Latvia	20
2.5.1	How are EPCs implemented in your country/region (also as a part of national policies and regulations)?	20
2.6	Spain	20
2.6.1	How are EPCs implemented in your country/region (also as a part of national policies and regulations)?	20
2.6.2	What are possible purposes for issuing EPCs?	23
2.6.3	Who is allowed to issue EPCs?	24
2.6.4	For whom are the certificates relevant?	24
2.6.5	Who are the market players?	24
2.6.6	What are the key success factors?	25
2.6.7	What are key barriers?	25



2.7	Sweden	26
2.7.1	How are EPCs implemented in your country/region (also as a part of national policies and regulations)?.....	26
2.7.2	What are possible purposes for issuing EPCs?	26
2.7.3	Who is allowed to issue EPCs?.....	27
2.7.4	For whom are EPCs relevant and interesting?	27
2.7.5	Who are the key market actors?	27
2.7.6	What are the key success factors?	27
2.7.7	What are key barriers?	27
3	Assessment and certification of EPCs in EU member states	28
3.1	Official or certified private EPC Software to ensure quality and comparability of assessments 28	
3.2	EPC Software: default values or validity ranges for input parameters	32
3.3	Online tool for comparing EPC recommendations to deep energy renovation recommendations	36
3.4	On-site inspection during EPC assessment.....	40
3.5	High user-friendliness of the EPC	42
3.6	Improving the renovation recommendations	47
3.7	Compliance between EPC rating and operational rating	53
3.8	EPC scheme for new buildings compatible with NZEB requirements	53
3.9	Treatment of innovative technologies in EPC assessment calculations.....	55
3.10	Cost of EPCs.....	56
3.11	Updating of EPCs when legislation and regulations for EPC scheme changes	57
3.12	EPC calculation procedure in adherence with new CEN OAS standard	57
4	Requirements for qualified experts in Eu member states	58
4.1	Registry of EPC assessors.....	58
4.2	Requirements for regular mandatory EPC assessor training on assessment and recommendations as a precondition for certification and registry	60
4.3	Eligibility requirements (pre-qualifications) for EPC assessor certification	63
4.4	Renewal of EPC assessor certification through an examination	66
4.5	Regular events and workshops on innovative solutions for deep renovation	68
5	Independent control systems for EPCs in EU member states	69
5.1	Using common quality criteria for independent control.....	69
5.2	Achieving sufficient sample size for independent quality control	71
5.3	Quality control of both EPCs and assessors.....	73
5.4	Performing automatic validity/quality check of EPC assessments.....	75
5.5	Achieving C or C* level control of EPC assessments for the sample according to EPBD.....	77
5.6	Availability of a central database for reporting errors or faulty procedures from EPC assessments for analysis and learning	80
5.7	Sanctions and penalisation for EPC assessors	80
5.8	Channelling monetary gains from sanctions for enhancing EPC schemes	83
6	Use of EPCs and their data in EU member states, including in wider buildings-related databases.....	84
6.1	Public opinion about EPCs	84

6.2	Mandatory use of EPC during sale and rental of buildings	85
6.3	Sanctions and penalisation for building owners failing to own or present an EPC.....	85
6.4	Presenting EPC to official building sales bodies or permit authorities as an obligatory/mandatory measure	87
6.5	Advertising guidelines for presenting EPCs in real-estate ads during sale and rental	89
6.6	Controlling and enforcing the mandatory use of EPCs in real estate advertisements.....	89
6.7	Public database of EPCs.....	90
6.8	Linking EPC database to other buildings- or energy-related databases.....	92
7	How are EPCs in EU member states embedded in wider policies and public activities to stimulate deep renovation?.....	95
7.1	Linking EPCs and renovation recommendations to detailed energy audits.....	95
7.2	Monitoring implementation of renovation recommendations given in the EPCs	97
7.3	Linking EPCs to financial incentive schemes.....	97
7.4	Creating Deep Renovation Network Platforms	99
8	CONCLUSIONS	101
9	REFERENCES	102
10	Annex I.....	117



INDEX OF FIGURES

Figure 1: Sample EPC in Germany	16
Figure 2: Sample EPC in Spain	20
Figure 3: Availability of official or certified EPC software to ensure quality and comparability of assessments	29
Figure 4: EPC software: default values or validity ranges for input parameters	33
Figure 5: Availability of online tool for comparing EPC recommendations to deep energy renovation recommendations	37
Figure 6: On-site inspection during EPC assessment	40
Figure 7: High user-friendliness of the EPC	44
Figure 8: Improving the renovation recommendations towards deep renovation	48
Figure 9: Compatibility of EPCs with NZEB requirements	54
Figure 10: Registry of EPC assessors	58
Figure 11: Requirements for regular mandatory EPC assessor training on assessment and recommendations for certification and registry	61
Figure 12: Eligibility requirements for EPC assessor certification	64
Figure 13: Renewal of EPC assessor certification through an examination	66
Figure 14: Quality control of both EPCs and assessors	73
Figure 15: Performing automatic validity/quality check of EPC assessments	76
Figure 16: Achieving C or C* level control of EPC assessments for the sample according to EPBD	78
Figure 17: Sanctions and penalisation for EPC assessors in case of poor assessments or recommendations	81
Figure 18: Sanctions for building owners failing to own or present an EPC	86
Figure 19: Presenting EPC to official building sales bodies as an obligatory/mandatory measure	88
Figure 20: Public database of EPCs	91
Figure 21: Linking EPC database to other buildings- or energy-related databases	93
Figure 22: Linking EPCs and renovation recommendation to detailed energy audits	96
Figure 23: Linking EPCs to financial incentive schemes	98
Figure 24: Deep Renovation Network Platforms offering either a one-stop-shop for implementation or for information at national level	99
Figure 25: Current status of assessment and certification of EPCs in EU member states	118
Figure 26: Current status of requirements for qualified experts and independent control systems for EPCs in EU member states	119
Figure 27: Current status of assessment and certification of EPCs in EU member states	120



INDEX OF TABLES

Table 1: Document Factsheet	2
Table 2: Document Status	2
Table 3: Document History.....	2
Table 4: European Directives and their transposition in Spain.....	22
Table 5: EPC software in Spain	23
Table 6: EPC quality control statistics in Spain.....	23
Table 7: Minimum qualifications for EPC Assessors in Spain.....	24
Table 8: Availability of official or certified EPC software to ensure quality and comparability of assessments	32
Table 9: EPC software: default values or validity ranges for input parameters.....	36
Table 10: Availability of online tool for comparing EPC recommendations to deep energy renovation recommendations	39
Table 11: On-site inspection during EPC assessment	42
Table 12: High user-friendliness of the EPC	46
Table 13: Improving the renovation recommendations towards deep renovation	53
Table 14: Compatibility of EPCs with NZEB requirements	55
Table 15: Treatment of innovative technologies in EPC assessment calculations.....	56
Table 16: Registry of EPC assessors.....	60
Table 17: Requirements for regular mandatory EPC assessor training on assessment and recommendations for certification and registry.....	63
Table 18: Eligibility requirements for EPC assessor certification	66
Table 19: Renewal of EPC assessor certification through an examination	68
Table 20: Using common quality criteria for independent control	71
Table 21: Sufficient sample size for verification and quality control.....	72
Table 22: Quality control of both EPCs and assessors	75
Table 23: Performing automatic validity/quality check of EPC assessments.....	77
Table 24: Achieving C or C* level control of EPC assessments for the sample according to EPBD	80
Table 25: Sanctions and penalisation for EPC assessors in case of poor assessments or recommendations	83
Table 26: Public opinion about EPCs.....	85
Table 27: Sanctions for building owners failing to own or present an EPC	87
Table 28: Presenting EPC to official building sales bodies as an obligatory/mandatory measure	89
Table 29: Controlling and enforcing the mandatory use of EPCs in real estate advertisements	90
Table 30: Public database of EPCs.....	92
Table 31: Linking EPC database to other buildings- or energy-related databases.....	94
Table 32: Linking EPCs and renovation recommendation to detailed energy audits	97
Table 33: Linking EPCs to financial incentive schemes	99
Table 34: Deep Renovation Network Platforms offering either a one-stop-shop for implementation or for information at national level.....	100



1 INTRODUCTION

Considering that 40% of the European Union's energy consumption can be traced back to its buildings, it is essential to improve energy efficiency in buildings to achieve the EU's overall 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.

Against this background, the 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 QualDeEPC 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.

To ensure homogenous data retrieval, a specialized questionnaire was developed to assess the local situation in the participating countries. 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 the elements have already been implemented in a number of EU member states but not in all of them. Therefore, 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.

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. 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. We are grateful to a number of partners from the Horizon2020 funded project Xtendo, who commented on the first analysis for their country. In some countries, such as Italy and Belgium, regional variations may be present in some elements of the EPC scheme. In such cases, this has been mentioned where appropriate, and for the sake of brevity, if an EPC element is present in at least one region, then it has been assumed that it's available in that country.



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 extent 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 EPC 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.
- Section 9 lists the references used in the study.
- Section 10 contains an annex showing the cross country comparison matrix of current status of different elements of EPC implementation in various member states.



2 OVERVIEW OF PARTNER COUNTRIES' EPC SITUATION

It is useful to gain an overview of the current situation in each partner country, for which QualDeEPC will develop enhancement proposals for their EPC schemes. Each country partners received a questionnaire containing 7 questions that are useful for analysing the current situation of EPC implementation, based on which improvement options will be developed for enhancing EPCs and processes and use. 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 subsections presents the information received from the country partners.

2.1 Bulgaria

2.1.1 *How are EPCs implemented in your country/region (also as a part of national policies and regulations)?*

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?*

All public services buildings in use with a total floor area of over 250 square metres shall be subject to a mandatory audit and certification with the exception of:

1. Places of worship of the legally registered religious denominations in Bulgaria;
2. Temporary buildings with a planned time of use not exceeding two years;
3. Non-residential buildings of low energy consumptions used for agricultural activities;
4. Manufacturing buildings and parts of buildings with a productive assigned use;
5. Residential buildings which are used as such for either less than four months of the year or, alternatively, for a limited annual time of use and with an expected energy consumption of less than 25 per cent of what would be the result of all-year use;
6. Stand-alone buildings with a total floor area of less than 50 square metres

Pending the issuing of an energy efficiency certificate of a building in use, the energy performance shall be certified by an energy performance certificate of a new building.

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 are performed by persons, registered under Article 44 (1) of the Energy Efficiency Act, and meet the following requirements:

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:



- 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;
- 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;
- 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.

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?*

- Obligated by the Energy Efficiency Act
- Building owners
- Investors

2.1.5 *Who are the key market actors?*

- Energy auditors
- Energy consultants
- Consultant for applying for funding schemes
- Investors
- Building owners
- Local authorities

2.1.6 *What are the key success factors?*

- Well structured and comprehensive regulatory framework and procedure for implementation of EPC at national level – transparent procedure and detailed requirements for
- Existing and official list of registered energy auditors
- Existing and comprehensive methods for calculation of energy performances
- Existing approved software based on the national Methodology for calculation of the energy performance of buildings
- National Program for Energy Renovation supports issuing of energy certificates of multifamily residential buildings

2.1.7 *What are key barriers?*

- Low level of awareness among building owners regarding EPC procedures
- 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



- Trainings for energy auditors are not conducted frequently, resulting in poor quality of EPC
- Lack of ambitious recommendations for deep renovation (only basic measures are recommended in residential buildings for reaching energy class C)

2.2 Germany

2.2.1 How are EPCs implemented in your country/region (also as a part of national policies and regulations)?

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, e.g. 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: Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR)]



ENERGIEAUSWEIS für Wohngebäude
gemäß den §§ 16 ff. Energieeinsparverordnung (EnEV) vom¹⁾ 18.11.2013

Gültig bis: 23.06.2024 Registriernummer²⁾: 123456789

Gebäude

Gebäudetyp	Mehrfamilienhaus
Adresse	Musterstr. 123, 10115 Musterstadt
Gebäudeteil	Vorderhaus
Baujahr Gebäude ³⁾	1927
Baujahr Wärmeerzeuger ³⁾	1982
Anzahl Wohnungen	9
Gebäudefußfläche (A _G)	548 m ² <input type="checkbox"/> nach § 19 EnEV aus der Wohnfläche ermittelt
Wesentliche Energieträger für Heizung und Warmwasser ⁴⁾	Erdgas H
Erneuerbare Energien	Art: keine Verwendung: keine
Art der Lüftung / Kühlung	<input type="checkbox"/> Fensterlüftung <input type="checkbox"/> Lüftungsanlage mit Wärmerückgewinnung <input type="checkbox"/> Anlage zur Kühlung <input type="checkbox"/> Schachtlüftung <input type="checkbox"/> Lüftungsanlage ohne Wärmerückgewinnung
Anlass der Ausstellung des Energieausweises	<input type="checkbox"/> Neubau <input type="checkbox"/> Modernisierung (Änderung / Erweiterung) <input type="checkbox"/> Vermietung / Verkauf

Hinweise zu den Angaben über die energetische Qualität des Gebäudes

Die energetische Qualität eines Gebäudes kann durch die Berechnung des Energiebedarfs unter Annahme von standardisierten Randbedingungen oder durch die Auswertung des Energieverbrauchs ermittelt werden. Als Bezugsgröße dient die energetische Gebäudefußfläche nach der EnEV, die sich in der Regel von den allgemeinen Wohnflächenangaben unterscheidet. Die angegebenen Vergleichswerte sollen überschlägig Vergleichswerte ermöglichen (Erfolgsangaben – siehe Seite 9). In den Energieausweisen sind die Modernisierungsmaßnahmen (Seite 6).

Der Energieausweis wurde auf der Grundlage von Berechnungen des Energiebedarfs erstellt (Energiebedarfsausweis). Die Ergebnisse sind auf Seite 2 dargestellt. Zusätzliche Informationen zum Verbrauch sind freiwillig.

Der Energieausweis wurde auf der Grundlage von Auswertungen des Energieverbrauchs erstellt (Energieverbrauchsausweis). Die Ergebnisse sind auf Seite 3 dargestellt.

Datenerhebung Bedarf / Verbrauch durch: Eigentümer Aussteller

Dem Energieausweis sind zusätzliche Informationen zur energetischen Qualität beigefügt (freiwillige Angabe).

Hinweise zur Verwendung des Energieausweises

Der Energieausweis dient lediglich der Information. Die Angaben im Energieausweis beziehen sich auf das gesamte Wohngebäude oder den oben bezeichneten Gebäudeteil. Der Energieausweis ist lediglich dafür gedacht, einen überschlägigen Vergleich von Gebäuden zu ermöglichen.

Aussteller:
Paul Mustermann
Musterstraße 45
12345 Musterstadt

24.06.2014
Datum

P. Mustermann
Unterschrift des Ausstellers

¹⁾ Datum der angeordneten EnEV, gegebenenfalls angewandter Änderungsverordnung zur EnEV. ²⁾ Bei nicht rechtzeitiger Zahlung der Registriernummer § 11 Absatz 4 Satz 4 und § 10 Absatz 1 Satz 1 der Energieeinsparverordnung (EnEV) ist die Registrierung nicht wirksam. ³⁾ Bei nicht rechtzeitiger Zahlung der Registriernummer § 11 Absatz 4 Satz 4 und § 10 Absatz 1 Satz 1 der Energieeinsparverordnung (EnEV) ist die Registrierung nicht wirksam. ⁴⁾ Bei nicht rechtzeitiger Zahlung der Registriernummer § 11 Absatz 4 Satz 4 und § 10 Absatz 1 Satz 1 der Energieeinsparverordnung (EnEV) ist die Registrierung nicht wirksam.

Figure 1: Sample EPC in Germany

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
- In case of 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
- Real estate finance institutions

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 etc.)

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 implemented in your country/region (also as a part of national policies and regulations)?

- The EPBD was transposed to the national legislative framework with the Law 3661 of 2008, updated in 2013 (Law 4122) in harmonization with the EPBD recast.
- EPCS are issued in Greece since 2011, when full implementation of the EPBD started
- All EPCs are produced automatically (and stored) on a web-based platform (www.buildingcert.gr).



- On-site visit of the auditor, for purposes of EPC issuance, is mandatory.
- The building data collected on-site are used for the calculation of the building energy performance, with the use of national software. The calculation of the energy performance and
- production of the certificate is performed automatically on the 'buildingcert' platform, after uploading the building data and calculations (xml file) by the registered auditor, having access to the platform.
- Energy performance on EPCs is calculated with the use of official national software integrated in the platform and also available to the auditors. The auditors can also use commercial software tools, after validation and approval of compliance and compatibility by the Ministry of Environment & Energy.
- 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.

2.3.2 What are possible purposes for issuing EPCs?

EPC issuance is required for:

- New buildings, after completion of construction
- Existing buildings, in cases of deep renovation
- Real estate transactions (sale or rental)
- Public buildings over 250m²
- Applying for funding in national incentive programmes providing funding for renovation

2.3.3 Who is allowed to issue EPCs?

Qualified energy auditors, registered in the national database of energy auditors, issue EPCs. Qualifications of auditors are defined by law; they need to be licensed engineers, Members of the Hellenic Technical Chamber or graduate engineers of technological institutes. They are classified in 3 categories, depending on their qualifications and proven experience in energy audits.

- Energy experts classified in cat. A have the right to conduct energy audits in (only) residential buildings up to 250 m² and heating or cooling systems up to 50 kW
- Energy experts classified in cat. B have the right to conduct energy audits, in buildings of a total surface area of 250-1,000 m², and in Heating or AC systems of total power of 50-400 kW. Energy experts of cat. A can upgrade their category to cat. B and be registered in category B, if records of at least 30 energy audits of class A are provided.
- Energy experts classified in category C have the right to conduct energy audits in all buildings, independently of size. Energy experts of cat. B can upgrade their category to cat. C and be registered in category C, if records of at least 10 energy audits of class B are provided.

2.3.4 For whom are EPCs relevant and interesting?

- Building owners
- Building users
- Public authorities, responsible for energy and climate
- Energy auditors
- Engineers, Building designers
- Contractors
- Investors, Financial institutions

2.3.5 Who are the key market actors?

- Energy auditors / Energy consultants
- Policy makers
- The Ministry responsible for the implementation of the relative building energy regulations



- Building owners (public and private)

- Building contractors
- Building managers

2.3.6 *What are the key success factors?*

- Quality control of EPCs and energy auditors
- Competences of energy auditors / Regular training
- EPC databases allowing for implementation monitoring and identification of gaps
- Friendliness of EPC
- Usefulness of EPCs recommendations in deep renovations
- National programmes providing incentives (financial / fiscal) for building renovation

2.3.7 *What are key barriers?*

- Low level of awareness and interest of building owners in EPC information
- Low level of credibility and acceptance of EPC as an efficient tool for building renovation
- Low fees of energy audits resulting in low quality of EPC
- Lack of regular promotional-awareness activities on EPCs and deep building renovation
- Lack of monitoring of compliance with the existing legislation on EPCs in real estate advertisement – no sanctions foreseen
- Limited funding boosting deep renovation of the building stock

2.4 Hungary

2.4.1 *How are EPCs implemented in your country/region (also as a part of national policies and regulations)?*

- 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 certification. Further regular trainings are available, but not compulsory, it is not a condition to remain an assessor



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 (Royal Decree 235/2013 approving the basic procedure for the certification of the energy efficiency of buildings, 2013). 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 CO₂ 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 reference 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 CO₂ 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 >250m² 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. Defines 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 4: 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 (Ministry for Ecological Transition and Demographic Challenge, n.d.). 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 CO₂ 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 CO₂ 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)
	Existing buildings	Households Households and tertiary sector	CERMA CE3

Table 5: EPC software in Spain

Currently, these programmes 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 is also specific inspection mechanism that reaches 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 6: 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
- With sale or renting of the building, or part of the building with a floor surface larger than 50 m²
- Also for public buildings: Building or part of the building with a floor area larger than 250 m² that is often visited by the public



It should be an information tool on the energy consumption and CO₂ emissions of the building, in addition this shows it in 4 uses (heating, cooling, Domestic Hot Water 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 CO₂ 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. In Spain EPC assessors does not require the mandatory certification 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 (BPIE, 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 certification
Public availability of lists	Lists of certifiers provided by region

Table 7: 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 with a floor surface larger than 50 m²
- People who are going to buy a flat with a floor surface larger than 50 m²
- 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 (DECREE 25/2019, of February 26, certification of the energy efficiency of buildings in the Autonomous Community of the Basque Country, its control and registration procedure., 2019).
- 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 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 CO₂ 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 2.6.3).
- 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 implemented in your country/region (also as a part of national policies and regulations)?

- The implementation of EPCs in Sweden is regulated by: A law decided by the Swedish Riksdag: Lag (2006:985) om energideklaration för byggnader, ändrad t.o.m. SFS 2018:314.
- Regulations decided by the government: SFS nr: 2006:1592. Förordning (2006:1592) om energideklaration för byggnader, ändrad t.o.m. SFS 2016:178.
- Detailed regulations decided by the National Board of Housing, Building and Planning: BED 10. Boverkets föreskrifter och allmänna råd (BFS 2007:4) om energideklaration för byggnader BED. Ändrad t.o.m. BFS 2018:11.
- Regulations for definition of the energy performance: BBR 28. Boverkets byggregler (BFS 2011:6) – föreskrifter och allmänna råd - Boverkets byggregler BBR 9:2. Ändrad t.o.m. BFS 2019:2
- Regulations for normalisation to of the energy performance to a standard year and standard users: 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.
- Regulations for certification of energy experts: 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 square meters that are 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:

- New buildings prior to sale or latest within two years after commissioning
- Existing buildings (or part of building) prior to sale

Some buildings are exempt from the EPC obligation, e.g. buildings with industrial operations, military buildings, weekend cottages, temporary buildings and buildings with a floor area smaller than 50 m². It is compulsory to base the EPCs on measured energy performance, if such values are available. That means that nearly all EPCs for existing buildings are based on measured values. For new buildings, according to the building regulations, requirements of energy performance are based on measured values for a full year. Validation must be done within 24 months after the building has been commissioned. If the building is not sold within this time the EPC is based on these measurements. For new buildings that are sold before measurements could be performed the EPC is based on calculated values. 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. Therefore, the energy certificate also includes information about radon content, if it has been measured for the building, and if ventilation control is approved, if the building is subject to mandatory ventilation control.

2.7.3 *Who is allowed to issue EPCs?*

Only certified energy experts are allowed to issue EPCs. Today, two certification bodies in Sweden are accredited for certification of energy experts (EPC experts). SWEDAC, Sweden's national accreditation body, in turn accredits the certification bodies for Accreditation and Conformity Assessment. 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 normal for simple buildings and one qualified for complex buildings.

2.7.4 *For whom are EPCs relevant and interesting?*

- Building owners
- Potential buyers of a building
- Tenants
- 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 of 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 different EPC assessors carry out assessment 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. Such comparability can be ensured by using, a single mandatory, or at least an official (not mandatory) software, or by establishing a certification mechanism when multiple private vendors provide software solutions for EPC assessment and recommendations. 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 more comprehensive software for the energy audit. The following figure shows the status of availability of EPC software in various member states. In all member states, either official or private EPC software are available.

In few countries, such as Luxembourg, Greece and Slovakia, the EPC procedure is organized online and controlled by 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 electronic national EPC database, or produce output in formats such as xml, which are then used by the database to produce a valid EPC.

Most member states have an official certification mechanism for private software, 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, Hungary, Latvia and Sweden uses uncertified private EPC software, while the rest of the countries have either official software or a certification mechanism for private software.



Availability of official or certified private EPC Software to ensure quality and comparability of assessments

- Single, mandatory or official software
- Software provided by private vendors
- Both official and private software
- ^{*} Certification of private software
- QualDeEPC partner countries



Figure 3: 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 validated private software are available (Austrian Energy Agency, n.d.-b). 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. Same version of an official software is used 3 Regions (Wallonia, Brussels-Capital, Flanders) of Belgium (Wallonie energie SPW, n.d.-a).	No. Only official software is used for EPC purposes.	No. See columns 1 and 2
Bulgaria	Yes. Official software is available.	No. Private software are not available.	No. See columns 1 and 2
Croatia	Yes. The national calculation tool has been developed and is in a test phase (Škoro, 2018).	No. Private software do not appear to be available.	No. See columns 1 and 2
Cyprus	Yes. 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.).	Yes. Private software approved by the Energy Service are available, for example, Eco-Engine (MODECSOFT Ltd, 2020). Energy Service examines the compatibility of software with the calculation methodology and provides its approval for issuing EPCs, upon justified request (Energy Service, 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
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, 2014).	Yes. Private software is available for EPC purposes (Arcipowska et al., 2014).	No. There appears to be no validation mechanism (Arcipowska et al., 2014).
Denmark	No. Official software is not available (Brand et al., 2019).	Yes. Private software approved by the Danish Energy Agency are available (Brand et al., 2019).	Yes. See column 2.
Estonia	No. Official software is not available (Kurnitski, 2019).	Yes. Commercial software for calculating the building energy performance and issuing EPCs are available. For example, IDA Indoor Climate and Energy (IDA ICE) (EQUA Simulation AB, n.d.). 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 (Minimum requirements for energy performance, 2012).	
Finland	Yes. Calculation methodology and spread sheet based tools are available for the calculation of Energy Efficiency Reference number (E-number); based on which EPC class is determined (Motiva Oy, n.d.-b).	Yes. For example, one such tool is made available by the insulation industry for the calculation of E-number (Eristeteollisuus, n.d.).	Information not found.
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 (Ministère de la Transition écologique et solidaire, n.d.).	Yes. Commercial software are available. Commercial software have to be validated as per any one of the three prescribed calculation methodologies. Official algorithms have been developed for incorporation into private software (Ministère de la Transition écologique et solidaire, n.d.).	
Germany	No.	Yes.	Yes.
Greece	Yes. National (official) software developed by the Hellenic Technical Chamber is available at low cost.	Yes. Private software tools developed by the market can also be used. Private software tools are validated and approved by the Ministry of Environment & Energy. They need to be compatible with the national official software integrated in the national EPC web-platform.	
Hungary	No. Official software is not available.	Yes. It is not necessary to use the certified software, and most assessors use one of the available private tools.	No. There is 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.-i).	Yes. Private software are available, for example, IES-VE (Integrated Environmental Solutions Limited, 2019). Private NEAP software packages must have the approval of SEAI and can be classified as Dynamic Simulation Modelling (DSM) or Interface for SBEMie (SEAI, n.d.-e).	
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 (CTI, n.d.-b). The Italian Thermotechnical Committee carries out validation of commercial software tools (CTI, n.d.-a).	
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 is unavailable.
Lithuania	Yes. Official software is available (Arcipowska et al., 2014).	No. Private software appear to be unavailable.(Arcipowska et al., 2014).	No. See columns 1 and 2



	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
Luxembourg	Yes. National software exists and is included in the national EPC database (Reding et al., 2018).	No. Private software appear to be unavailable.	No. See column 1 and 2.
Malta	Yes. Official software, EPRDM Software, is available (BRO, 2020).	No. Private software appear to be unavailable (Arcipowska et al., 2014).	No. See columns 1 and 2
Netherlands	Yes. For existing buildings, 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 (Government of the Netherlands, n.d.-b).	Yes. For new buildings, a different measure of energy efficiency is required, called Energy Performance Coefficient (EPC). Software from private vendors are available. The Building Decree designates NEN 7120 as a method for determining the energy performance coefficient (EPC). A program called EPCheck is available to validate the commercial software programs and calculations done by assessors. However it is unclear whether a certification mechanism for validated software is available (Arcipowska et al., 2014; Government of the Netherlands, n.d.-a).	
Poland	No. There appears to be no official software (Arcipowska et al., 2014).	Yes. Several private software are available, for example, the Audytor OZC, the ArcADia Thermo and the BuildDesk Energy Certificate (BPIE & KAPE, 2017; Graitec, Arcipowska et al., 2014). 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. Private software are available and certification mechanism exists (Arcipowska et al., 2014).	
Romania	No. Official software is not available (BPIE et al., 2017).	Yes. Several private software for applicable to all building types, are available. E.g., AllEnergy, Certificat-energetic.com, Doset-PEC, ALLPLAN, Matrix Energy and TermoExpert (BPIE et al., 2017). However, certification mechanism is available only for the software for issuing EPCs in collective apartments.	
Slovakia	Yes. For individual apartments, the entire EPC procedure is organized online and is controlled by the backend software (Sternova & Magyar, 2018).	Yes. Private software are available (Arcipowska et al., 2014).	No. There appears to be no certification mechanism (Arcipowska et al., 2014).
Slovenia	No. There appears to be no official software (Arcipowska et al., 2014).	Yes. Private 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 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. Certification mechanism is in place.	
Sweden	No. Because the Swedish EPC is based on metered values when such values exist, there are no mandatory software for calculation of energy performance. For assessment of new buildings that are sold prior to measurements calculated values are needed. Any dynamic calculation tool can be used since the authorities protect competitiveness between commercial software.	Yes, there are private software for energy performance simulations and calculations of reduction in energy consumption by adopting various measures. Some of them directly have html-codes for reporting to the EPD register.	No. There is no certification mechanism.



	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
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, 2020).	Yes. For new and existing dwellings, Standard Assessment Procedure software (SAP) and Reduced data SAP software approved by BRE is used for calculating Building Energy Performance and generating EPCs (BRE, n.d.-a). For non-residential buildings National Calculation Methodology allows the calculation to be carried out by approved simulation software, besides SBEM (GOV.UK, n.d.-a).	

Table 8: 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 different EPC assessors carry out assessment 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.

In most countries, default values are often available:

- In the regulations or legislation governing the building energy performance calculation methods for the purposes of EPCs
- As a part of the reference standards or guidelines as mentioned in the relevant regulation or standards
- As default values in EPC calculation software

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 ways to determine the input values. In Austria, an online public database called *baubook* is available 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.

In few countries, alternative calculation methodologies are also allowed, such as choosing between multiple prescribed methodologies for calculation or following un-prescribed methodology upon providing justification. However, such measures should only be available for use in rare circumstances, such as when calculation methodologies are not prescribed for innovative building technologies.

The following figure shows the status of availability of input data for EPC software in different member states.



EPC Software: default values or validity ranges for input parameters

- Practical default values for input data are available
- Validity ranges for input data are available
- Both practical default values and validity ranges for input data are available
- Information not found
- Alternative calculation methods for determining input values, other than the default values, are available
- QualDeEPC partner countries



Figure 4: 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 (Sutter & Geissler, 2016).	Yes. Complex and dynamic calculations can be performed to calculate the input values in place of the available default values (Sutter & Geissler, 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).
Bulgaria	Yes. Default data for the different climate zones are integrated in the EPC software.	No.	No.



	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
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)" is 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, 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, 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 (Department of Building Services, CTU, n.d.).	No. It does not appear to be 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 a website dedicated for HB2019 (Danish Energy Agency, n.d.-a).	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.-a).	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, 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, 2019).
Finland	Yes. Default values for existing buildings are available (Motiva Oy, n.d.-b).	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., 2014).	No. It does not appear to be the case.	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	Yes, default values are available as a part of the reference building standards. EPC calculation software also provides default values for climatic data of the various climate zones in Greece	Yes. Validity ranges for input data are available in the Technical Guides developed by the Hellenic Technical Chamber and approved by Ministerial Decision.	No.



	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.	No.
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, 2019a, 2019b).	No. When input data from primary sources is unavailable, default values should be used (SEAI, 2019a, 2019b).	Information not found.
Italy	Yes. Default values for input parameters are available under Annexes of the national standards UNI/TS 11300 2014 (parts 1 to 4) - energy performance calculation methodologies and other relevant standards on calculations for artificial lighting etc (Moneta et al., 2015).	Information not found.	Information not found.
Latvia	Yes. In the beginning of March 2020 national annexes to around 40 different ISO standards about building energy efficiency were published. In these national annexes default values for input data also are described.	No. Validity ranges for input data are unavailable.	No. Such a provision is unavailable.
Lithuania	Yes. Technical Regulation STR 2.01.09:2012 "Energy Performance of Buildings; Certification of Energy Performance", adopted on 21 August 2012 by Order No. D-1-674 of the Minister of Environment defines the calculation procedure and provides default input values (Energy performance of buildings. Energy Performance Certification, 2005; Moneta et al., 2015).	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. The current regulation (regulation of the minister of infrastructure and development of 27 February 2015 on the methodology for determining the energy performance of a building or part of a building, and energy performance certificates) gives a procedure of determining input data for energy efficiency indicators - first the manufacturer data should be used, if not present the data from regular inspection should be used, if not present the default data can be used. In term of distribution and storage efficiency of the systems (heating, cooling, d.h.w.) two approaches are given - first based on size of the installation and heat losses ration, and second with the use of default values.	No. It does not appear to be the case.	Yes. See column 1.
Portugal	Information not found.	Information not found.	Information not found.



	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
Romania	Yes. Calculation methodology and default values are available in the regulation MC 001-2006 (Petran et al., 2017).	Information not found.	Information not found.
Slovakia	Yes. Calculation for EPC are carried out in accordance with CEN standards fully integrated into the Slovak technical standards system (STN), and amended by the respective national annexes. Default input values are available for various fields, such as climate, thermal transmittance values (Sternova et al., 2015).	Information not found.	Information not found.
Slovenia	Yes. Default values are available (Regulations on the methodology for producing and issuing energy performance certificates for buildings, 2014).	Information not found.	Yes For non-residential buildings also a metered EPC is possible (Regulations on the methodology for producing and issuing energy performance certificates for buildings, 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 data connected to user behaviour are available, for different types of buildings (domestic, office, educational), to calculate energy performance of new buildings before they are built. These values are also used to adjust the measured energy performance of existing buildings to normal use of a building. The EPCs are based on measured energy use adjusted to normal use and a normal year.	Yes. There is no official data but different guides are available.	Yes. There is no official data but different guides are available.
UK	Yes. Calculation methodology and default values for various input data are available in SAP, RdSAP and NCM (BRE, n.d.-b, 2020).	No. It does not appear to be the case.	No. Such a provision appears to be unavailable.

Table 9: EPC software: default values or validity ranges for input parameters

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

Online tools, such as those that allow building owners to compare the energy consumption data (and the renovation recommendations) as per the EPC with market average/typical buildings and those that provide 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, such tools also act as a decision support mechanism for building owners to focus on specific measures while choosing between different deep energy efficiency renovation recommendations.

In several member states, an online decision support tool/mechanism for building owners to focus on specific measures while choosing between different 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 RentalCal has devel-



oped 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.

Online tools for comparison of energy consumption as per EPC with market average/typical buildings are available in few countries, such as France, Ireland and Italy. This is enabled in the EPC itself in few other countries, such as Belgium and Sweden.

Among QualDeEPC project partner countries, an online tool/decision support mechanism on energy efficient renovations for residential buildings is available in Germany, Greece and Sweden. In Sweden and Latvia, an online tool is available that compares energy consumption as per EPC with market average/typical buildings.

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

-  Online tool/decision support mechanism on energy efficient renovations
-  No such tool available
-  Information not found
-  Online tool that compares energy consumption as per EPC with market average/typical buildings
-  QualDeEPC partner countries

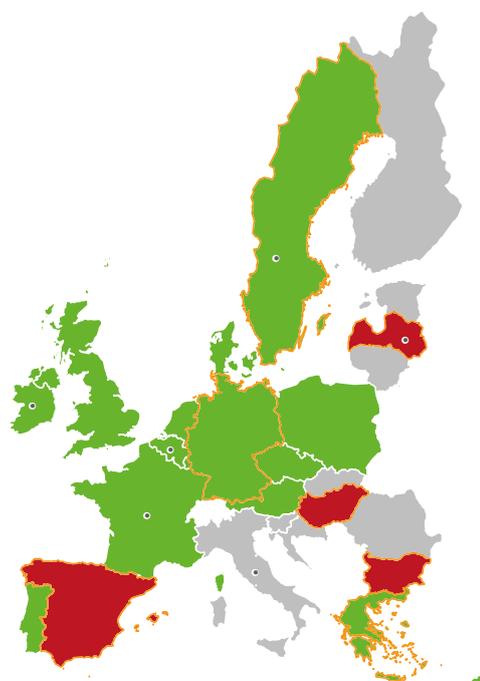


Figure 5: Availability of online tool for comparing EPC recommendations to deep energy renovation recommendations

The following table shows in brief the status of availability of online tools in various member states.



	Online tool/decision support mechanism for building owners to focus on specific measures while choosing between different energy renovation recommendations is available	Online tool that compares energy consumption as per EPC with market average/typical buildings is available
Austria	Yes. A suite of online decision support tools for building owners to choose the profitability of various energy efficiency measures is available (Austrian Energy Agency, n.d.-a).	Information not found. EPC only carries reference values as per of minimum energy performance requirements (Energie Tirol, n.d.).
Belgium	Yes. EPC tool itself includes this feature.	Yes. EPC tool itself includes this feature.
Bulgaria	No. Online tool is unavailable.	No. Online tool is unavailable.
Croatia	Information not found.	Information not found.
Cyprus	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 (Cyprus Energy Agency, n.d.).	Information not found.
Czech Republic	Yes. Czech Republic is a partner in the RentalCal project and has dedicated national pages on the rental market and a translated RentalCal tool in Czech (RentalCal, n.d.-a).	Information not found.
Denmark	Yes. Energy efficient building solutions, their tentative costs and along with the details of vendors and hand workers is available on SparEnergi.dk. IT tools for cost-benefit analysis of energy efficient renovations is available from National Building Research Institute (Statens Byggeforskningsinstitut, n.d.). Denmark is a partner in the RentalCal project and has dedicated national pages on the rental market and a translated RentalCal tool in Danish (RentalCal, n.d.-c).	No. However, one can compare EPCs of different buildings on a publicly accessible database of EPCs (Danish Energy Agency, n.d.-b).
Estonia	Information not found.	Information not found.
Finland	Information not found.	Information not found.
France	Yes. France is a partner in the RentalCal project and has dedicated national pages on the rental market and a translated RentalCal tool in French (RentalCal, n.d.-d).	Yes. This feature is available on the public EPC database (ADEME, n.d.).
Germany	Yes. A tool from the Ministry for Economic Affairs and Energy is available (BMWi, 2015). Germany is also a partner in the RentalCal project and has dedicated national pages on the rental market and and a translated RentalCal tool in German (RentalCal, n.d.-b).	No. Online tool is unavailable.
Greece	Yes. An online decision support tool -EnergyHUB for ALL- was developed in the frame of the Request2Action project and is still in operation. The tool is integrated in an One-stop-shop for building renovation platform (CRES, 2017).	No. Online tool is unavailable.
Hungary	No. Online tool is unavailable.	No. Online tool is unavailable.
Ireland	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 spread sheets (SEAI, n.d.-j).	Yes. National BER Research tool provides for searching dwelling based on their BER (EPC) rating, location, area, and 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.-g).
Italy	Information not found.	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 (Dipartimento Unità Per L'efficienza



	Online tool/decision support mechanism for building owners to focus on specific measures while choosing between different energy renovation recommendations is available	Online tool that compares energy consumption as per EPC with market average/typical buildings is available
		Energetica, 2020).
Latvia	No. Online tool is unavailable.	Yes. However, it is not actually a tool but each year for 3 types of buildings (apartment buildings, office buildings, educational buildings) the value of space heating consumption is given (this value then goes into EPC)
Lithuania	Information not found.	Information not found.
Luxembourg	Yes. An online tool, called Energy Pass Simulator by my-energy 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.).	Information not found.
Malta	Information not found.	Information not found.
Netherlands	Yes. An online tool that provides recommendations for energy efficient improvements for dwellings as well as cost benefit analysis is available. (Milieu Centraal, n.d.-b) Netherlands is a partner in the RentalCal project and has dedicated national pages on the rental market and a translated RentalCal tool in Dutch (RentalCal, n.d.-e).	Information not found.
Poland	Yes. Poland is a partner in the RentalCal project and has dedicated national pages on the rental market and a translated RentalCal tool in Polish (RentalCal, n.d.-f).	Information not found.
Portugal	Yes. An online tool is available as a part of one-stop-shop (Casa Eficiente 2020, 2020).	Information not found.
Romania	Information not found.	Information not found.
Slovakia	Information not found.	Information not found.
Slovenia	Information not found.	Information not found.
Spain	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. Spain is a regional partner for the programme RentalCall.	No. Online tool is unavailable.
Sweden	Yes. There are commercial programs for sale that are adapted to Swedish EPC, although there is no official tool.	Yes. Within the EPC two reference values are given besides the building's actual energy performance. One that gives the energy performance for similar buildings and ones that gives the requirement for new construction within the same building category.
UK	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.-d, n.d.-b). UK is a partner in the RentalCal project and has dedicated national pages on the rental market and a translated RentalCal tool in English (RentalCal, n.d.-g).	Information not found

Table 10: 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. The following figure shows the status of requirements for on-site inspection during in different member states. 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 of the law.

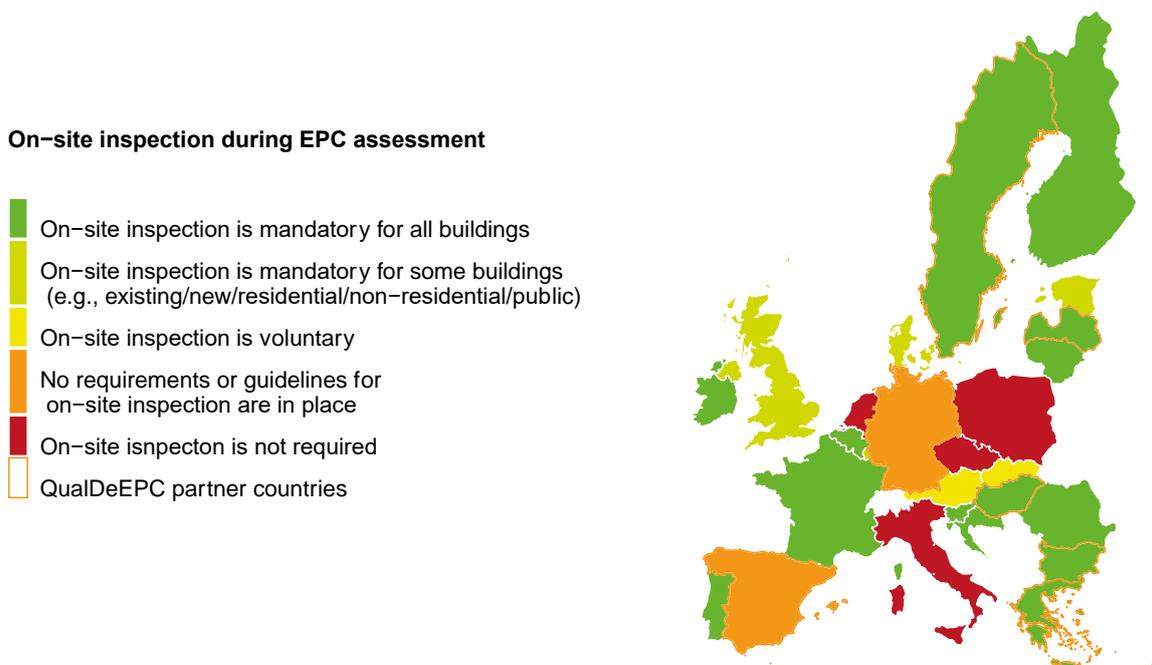


Figure 6: On-site inspection during EPC assessment

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.-b).
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, under the EE Act and related ordinance E-ПД-04-1 for EPC implementation	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. See column 2.	Yes. It appears that on-site inspections are required only for existing buildings (Dracou, 2016).	No. See column 2
Czech Republic	No. On-site inspection is not required (Arcipowska et al., 2014).	No. See column 1	No. See column 1
Denmark	No. See column 2.	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 2.
Estonia	No. See column 2.	Yes. On-site inspections are required only in exceptional circumstances (Arcipowska et al., 2014).	No. See column 1 and 2.
Finland	Yes. On-site inspection is mandatory for all buildings (Decree of the Ministry of the Environment on the energy certificate for the building, 2017).	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	Yes. On-site inspection is mandatory as per law.	No. See column 1.	No. See column 1.
Ireland	Yes. On-site inspection is required for all buildings. The BER Assessor is required to visit premises being assessed (SEAI, 2019a, 2019b).	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.



	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
Lithuania	Yes. On-site inspection is required for all buildings (Arcipowska et al., 2014).	No. See column 1.	No. See column 1.
Luxembourg	No. See column 2.	Yes. On-site inspection is mandatory for existing buildings (Guichet.lu, n.d.).	No. See column 2.
Malta	Yes. On-site inspection 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 inspection is required for all buildings (Arcipowska et al., 2014).	No. See column 1.	No. See column 1.
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. (SSE, 2020)).	No. See column 1.	Yes. An on-site inspection is possible, but more expensive (e.g. (SSE, 2020)).
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 (Regulations on the methodology for producing and issuing energy performance certificates for buildings, 2014).	No. See column 1.	No. See column 1.
Spain	No. Currently, 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. See column 2.	Yes, On-site visit is mandatory for existing buildings, but not for new buildings (Department for Communities and Local Government, 2017).	No. See column 2.

Table 11: 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 is essential, such as presentation of energy consumption and rating, and recommendations for renovation, potential energy (and cost) savings and other benefits. The following figure shows the status of these aspects of user-friendliness of the EPC in different member states. It would be optimal if 'high user-friendliness were 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; 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.

Recommendations are usually based on their potential of technical and economic feasibility for implementation in compliance with the EPBD and are presented in EPCs of all member states. 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 the assessors are also free to suggest other recommendations, based on justification. In some EPCs recommendations are classified, bundled and presented 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 Greece, 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).



High user-friendliness of the EPC

- EPC rating and recommendations as well as potential energy (and cost) savings and benefits are presented
- EPC rating and recommendations are presented
- QualDeEPC partner countries



Figure 7: 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. Recommendations for renovation are presented in the Annex.	Yes.	No. Potential energy and cost savings and benefits are not presented (OIB, 2015).
Belgium	Yes. EPC rating is presented in classes.	Yes. However, presentation of recommendations might vary regionally (environnement.brussels, n.d.; Flemish Energy Agency, n.d.-b; Wallonie energie SPW, n.d.-b).	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.	Yes. EPC rating and recommendations as well as potential energy (and cost) savings and benefits are presented
Croatia	Yes. EPC rating is presented in classes.	Yes. A list of cost-effective recommendations are presented	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.	Yes. See column 3.	Yes. Recommendations report is presented along with EPC, which consists of information on recommendations and payback periods (Xichilos & Hadjinicolaou, 2011).
Czech Republic	Yes. EPC rating is presented in classes.	Yes. Recommendations for improvement are presented.	No. Potential energy and cost savings and benefits are not presented (Šance pro budovy, 2018).
Denmark	Yes. EPC rating is presented in classes	Yes.	Yes. Recommendations as well as potential tonnes of CO2 emission and cost savings and benefits are presented. In addition, a list of energy savings that are estimated to be profit-



	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
			able to implement in short-term and long-term are presented (Danish Energy Agency, 2016).
Estonia	Yes. EPC rating is presented in classes.	Yes. A list of energy saving measures for existing buildings, which are technically and economically reasonable, is presented.	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.	Yes.	Yes. Recommendations as well as potential energy savings are presented (Motiva Oy, n.d.-d).
France	Yes. EPC rating is presented in classes (Ministère de la Transition écologique et solidaire, n.d.).	Yes.	Yes. Recommendations as well as potential investment, savings, payback period and tax credits are presented (Roger et al., 2014).
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.	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.	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-comprehensible 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, n.d.-a).	Yes.	Yes. An advisory report is accompanied to the BER certificate, identifying potential improvements that could lead 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, 2017b).
Italy	Yes. EPC rating is presented in classes. Classes (Ministry of Economic Development, n.d.).	Yes.	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.	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.	Yes. Recommendations for improvement are provided.	No. Potential energy (and cost) savings and benefits are not presented (Encius & Baranauskas, 2018).
Luxembourg	Yes. EPC rating is presented in classes.	Yes.	Yes. A list of measures for improvement as well as their potential energy and cost savings and



	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
			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).	Yes. EPC rating and recommendations for renovation are presented.	No. Potential energy (and cost) savings and benefits are not presented (Building Regulation Office, 2020b).
Netherlands	Yes. EPC rating is presented in classes.	Yes. The energy label contains tips on making dwellings more energy efficient.	No. Potential energy (and cost) savings and benefits are not presented (EnergieDeskundig.nl, 2019).
Poland	Yes. Linear continuous scale ranging from 0 to 500 (the lower the number, the more energy efficient).	Yes. Recommendations for cost-effective and feasible technical improvement are presented.	No. Potential energy (and cost) savings and benefits are not presented (Regulation of the Minister of Infrastructure and Development of 27 February 2015 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.	Yes.	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.	Yes. Recommendations are provided.	No. Information on potential energy and cost savings is not often provided (BPIE et al., 2017).
Slovakia	Yes. EPC rating is presented in classes.	Yes. Recommendations are presented	No. Potential energy (and cost) savings and benefits are not presented (energeticky-certifikat.sk, n.d.).
Slovenia	Yes. Both classes and sliding scale for new buildings and only sliding scale for existing buildings.	Yes. A list of recommendations is provided. Recommendations should be state of the art and technically feasible. Recommendations target the building shell, energy efficiency, use of renewable energy and organizational measures.	No. Potential energy savings and benefits are not presented (Regulations on the methodology for producing and issuing energy performance certificates for buildings, 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 from A-G.	Yes. The EPC assessor should give recommendations for renovation measures that are cost-effective. Recommendations are presented in three main categories; BAC systems, building services and building envelope. There are several subdivisions.	Yes. Recommendations and indicative potential of energy (and cost) savings should be reported if they are cost-effective. This means that recommendations may differ dependent on available input data for investment costs.
UK	Yes. EPC rating is presented in classes.	Yes.	Yes. Recommendations for renovation as well as potential energy and cost savings and benefits are presented (Energy Saving Trust, n.d.-a).

Table 12: 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.

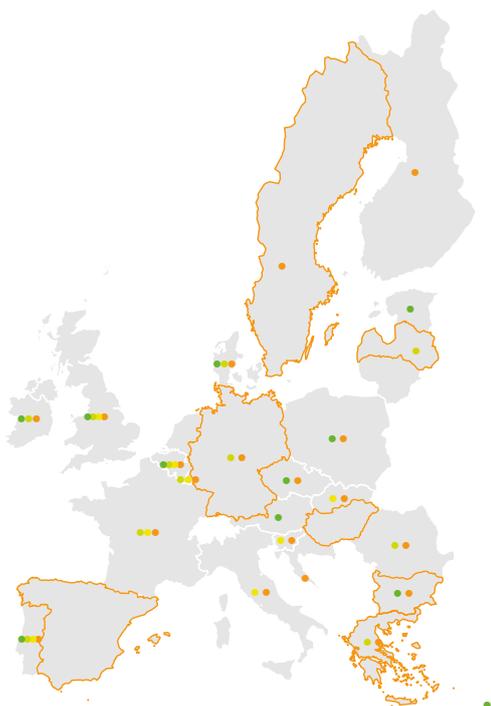
Among QualDeEPC project partner countries, Hungary, and Spain do not have any of the features that improve the renovation recommendations towards deep renovation. In Sweden, cost-effective recommendations should be presented in the first few pages of EPC. In Germany, recommendations are presented in the first few pages of EPC (not necessarily the front page). 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.



Improving the renovation recommendations towards deep renovation

- Assessment software tools include high quality and high energy efficiency options for renovation recommendations
- 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
- Recommendations on EPCs include links for further information and financial support
- 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)

QualDeEPC partner countries



Absence of labels in QualDeEPC partner countries indicate that they are unavailable. In other countries, it indicates that they are unavailable or information not found; check the corresponding table.

Figure 8: 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.	No. Recommendations are not presented in the Annex.	No. Such recommendations are not provided in the guidelines and may be absent from the EPC (OIB, 2015).
Belgium	Yes. Recommendations are presented in a way to improve the energy class of the building. Information and benefits for further pursuing a detailed energy audit and acting on the recommendations are presented, for example, EPCs from Flemish region (Flemish Energy Agency).	Yes. Recommendations are presented in various categories, such as building envelope, heating and hot water installations, ventilation system and renewables, for example, EPCs from Flemish region (Flemish Energy Agency, n.d.-b).	Yes. Recommendations are provided in 2nd and 3rd pages of the EPC report (environnement.brussels, n.d.; Flemish Energy Agency, n.d.-b; Wallonie energie SPW, n.d.-b).	Yes. Links to further information and financial information are provided (Wallonie energie SPW, n.d.-b).



	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
	Agency, n.d.-b).			
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.	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.	Yes. EPC software presents some recommendations, and the assessor can choose from this list and/or can create their own set of recommendations.	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 (Xichilos & Hadjinicolaou, 2011).
Czech Republic	Only a summary of the improvements is provided on the first pages of EPC.	Recommendations are presented in various categories, such as building envelope, heating and hot water installations, ventilation system.	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, 2018).	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 energy renovation of buildings (Thomsen et al., 2015).	Yes. Private software appear to include high quality and high energy efficiency options for renovation recommendations.	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 (Danish Energy Agency, 2016).	Information not found.
Estonia	Information not found.	Yes. Recommendations are usually provided by the EPC issuer from the list provided in the elec-	No. It does not appear to be the case.	No. It does not appear to be the case.



	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
		tronic 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).		
Finland	Information not found	No. Assessment software appears to be used only to calculate building energy performance and the corresponding EPC class. The assessor provides the recommendation based on the on-site visit.	Yes. Summary of recommendations is provided on the second page and details are provided few pages later.	No. Links to financial support are not mandatorily provided (Motiva Oy, n.d.-d).
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.	Yes. Recommendations are summarized on page 4 of EPC.	Yes. Links for further information and financial support are provided (Roger et al., 2014, 2015).
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. Renovation recommendations are provided along with energy savings, payback periods and potential upgrade of the energy class.	No. Assessment tools do not include options for renovation.	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 improvement scenario.	No. Links for further information and financial support are not provided.
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 recommenda-	Yes. SBEMie software generates a detailed advisory report listing	Yes. Although the detailed advisory report is technically an Annex, as the EPC is only	No. Links to financial information 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
	tions (SEAI, n.d.-c).	potential renovation recommendations for cost effective improvement to the energy performance of the building.	one page, this is the next piece of information that is available as a part of the EPC (Commercial Energy Ratings, 2017; SEAI, 2017b).	
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.	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 (Ministry of Economic Development, n.d.).
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. EPC assessor provides the renovation recommendations based on the site visit (Reding & Flies, 2014).	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.	Yes. Links are provided below the recommendations measures (guychet.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.).	No. See column 1.	No. See column 1.	No. See column 1.
Poland	No. Cost-effective and feasible recommendations are provided, without further information for making informed choice on renovation recommendations.	Yes. The assessment software allows including high quality and high energy efficiency options. However, the choice of final recommendations depends on the auditor.	Yes. Recommendations are provided in the third page of the EPC report.	No. No links are provided (Regulation of the Minister of Infrastructure and Development of 27 February 2015 on the methodology for determining the energy performance of a building or part of a building, and energy performance certificates, n.d.).



	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
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 (Fragoso & Baptista, 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.	Information not found	Yes. Recommendations are presented on the first page itself. Links to financial incentives are presented beside the recommendations (energeticky-certifikat.sk, n.d.).	
Slovenia	No. Only generic recommendations are provided.	No. See column 1.	Yes. Recommendations are provided on page 3 of the EPC report. 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 (Regulations on the methodology for producing and issuing energy performance certificates for buildings, 2014).	
Spain	No.	No.	No. The EPC assessor may write or not the recommendations and these are included in another file.	No.
Sweden	No. However, cost-effective renovation measures should be given.	No.	Yes. Cost-effective renovation measures are given in the first few pages.	No.
UK	Yes. Renovation recommendations and the associated information are presented in a way to become first step towards individual deep renovation passports.	Yes. As per requirements in SAP (BRE, 2020).	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	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



	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
			page 3.	savings per year, rating after implementing the recommendation (Energy Saving Trust, n.d.-a).

Table 13: 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, if the building is sold prior to that measured values are available, the EPC can 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 or even before, 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. Approximately 11 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, Greece, Hungary, Latvia, Spain and Sweden are compatible with NZEB requirements.



EPC for new buildings compatible with NZEB requirements

- EPC scheme for new buildings is compatible with (national) NZEB requirements
- Not compatible
- Information not found
- QualDeEPC partner countries



Figure 9: 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., 2018). 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. There is National Plan for NZEB that set requirements for new public and private buildings. The Ordinance for Energy Efficiency in buildings still required Energy Class B for new buildings and Energy Class C for existing buildings.
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., 2015).
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 labelled A2020 (Danish Energy Agency, 2016; Thomsen et al., 2018).
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.



EPC scheme for new buildings is compatible with (national) NZEB requirements	
France	No. NZEB is not displayed on the EPC.
Germany	Information not found.
Greece	Yes. EPC scheme for new buildings is compatible with NZEB requirements (Ministerial Decree of December 2018 – Approval of the National Plan for increasing the number of nearly zero-energy buildings). For new buildings, the energy rating corresponding to NZEB on the EPC label is A (For existing buildings the EPC rating is B+)
Hungary	Yes.
Ireland	Yes. NZEB compatible buildings will have a BER rating of A2 compared with a current rating for new builds of A3 (Government of Ireland, 2019).
Italy	Yes. EPC clearly indicates whether NZEB standard has been attained (Ministry of Economic Development, n.d.).
Latvia	Yes. In EPC legislation NZEB is defined as a building having A class energy consumption for space heating. Also, ventilation with heat recuperation has to be used. Building is classified as a NZEB if there is at least a part of renewable energy used for building energy needs. In EPC there is a check mark if a building qualifies as a NZEB. Since 2019 new buildings owned and controlled by the state and occupied by the state have to be NZEB. Other new buildings have to reach NZEB requirements if they are built starting from 2021.
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.-c). 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.-a).
Poland	No. Although, NZEB requirements are in place and are obligatory from 1st January 2021 for all non-public buildings (Bekierski et al., 2018).
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	No. NZEB is not displayed on the EPC. However, New public buildings must fulfil NZEB requirements from 1 January 2019 (Sternova & Magyar, 2018).
Slovenia	No. NZEB is not displayed on the EPC (Šijanec & Potočar, 2015).
Spain	Yes. 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.
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 14: 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 (Flemish Energy Agency, n.d.-b).
Bulgaria	The national methodology for calculating energy consumption indicators and the energy performance of buildings was developed on the basis of BDS EN ISO 13790 and the best European practices in the field of determining the annual energy consumption for heating, ventilation, cooling and hot water.
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, 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 15: 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. . There are two types of EPCs in Germany. The market regulates the price for issuing depending on the size and the effort for data acquisition of the building, there are also regional differences. A serious issued consumption-based EPC costs at least 50 Euros. For a small single-family house, the price for a demanded-based EPC is at least 300 Euros. For large and complex non-residential buildings, the prices are several thousand Euros for demanded-based EPC. 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). Typical prices in Sweden are 250 – 500 Euro for one-family houses and for non-residential buildings 1000 Euro or more are common.

In most countries, the market regulates the costs for EPCs. 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. In Poland, there were meetings in 2018 with the department responsible for EPC system in Poland where the postulate of including new EN ISO standards has been raised.



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 have an official registry of EPC assessors. Few countries, such as 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. Association of EPC assessor etc. also maintain unofficial/commercial registries.

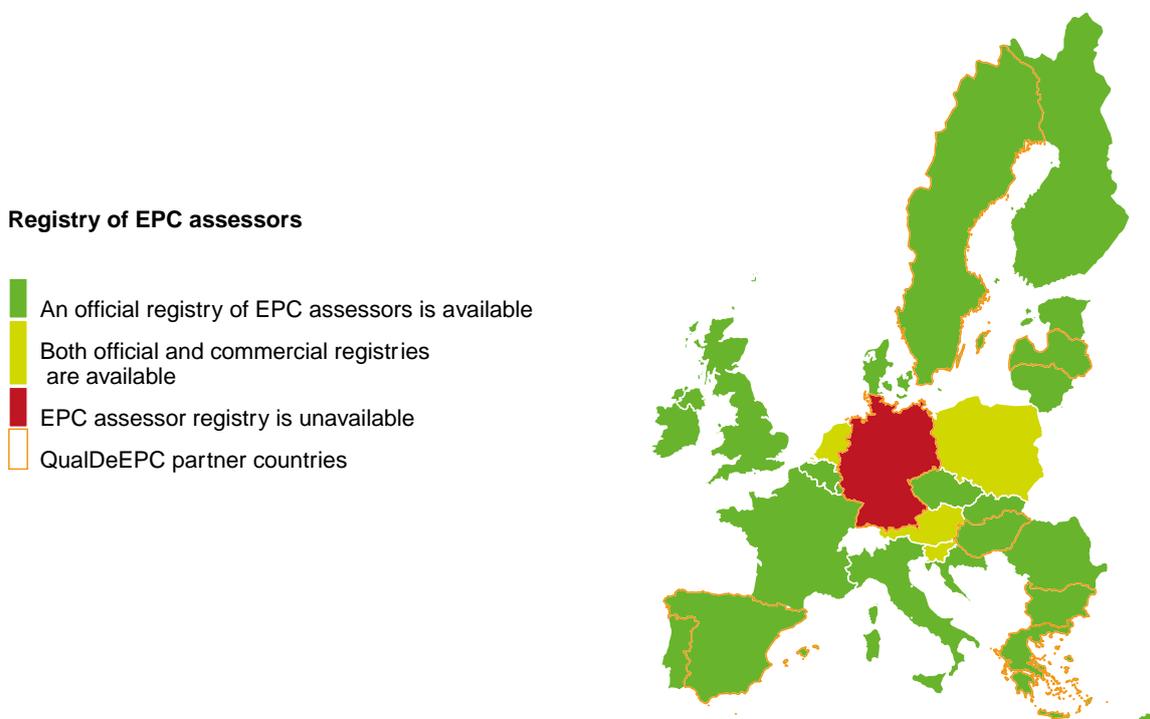


Figure 10: Registry of EPC assessors



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. For example, (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, regionally (Flemish Energy Agency, n.d.-e).	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, Republic of Croatia, 2020).	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 (Energistyrelsen, n.d.).	No. Unavailable.
Estonia	Yes. An official registry of EPC assessors is available (Ministry of Economic Affairs and Communications, n.d.-b).	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 (SEAI, n.d.-h).	No. Unavailable.
Italy	Yes. An official registry of EPC assessors is available (Moneta et al., 2015).	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, 2020a).	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, 2020a).	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.-a, n.d.-b).	Yes. An un-official registry of EPC assessors for residential units is also available, which is maintained by 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.).	Yes. The Association of Energy Auditors has a registry of recommended auditors (Association of Energy Auditors & Association of Energy Auditors Themelsle, n.d.).
Portugal	Yes. ADENE maintains a central register of all EPC assessors (ADENE, n.d.-e).	No. Unavailable.
Romania	Ministry of Regional Development and Public Administration maintains a	Information unavailable.



	An official registry of EPC assessors is available	An unofficial and/or commercial registry of EPC assessors is available
	registry of energy auditors on its website (Ministry of Public Works, Development and Administration, 2018).	
Slovakia	Yes. An official register of EPC assessors is available from the Slovak Chamber of Civil Engineers (Slovak Chamber of Civil Engineers, 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.energetskaizkaznica.si provides a search for independent EPC assessors (energetskaizkaznica, n.d.).
Spain	Yes. There is an official registry in some Regions.	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 publicly available (Ministry of Housing, Communities and Local Government, n.d.).	No. Unavailable.

Table 16: Registry of EPC assessors

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

Undergo mandatory training on EPC assessment and providing recommendations for being certified as an EPC assessor and included in the registry enables EPC assessors 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 most often candidates should pass an examination for certification.

The duration and contents of the course varies in various member states. In some countries, the qualifications of the candidates and their professional experience determine the amount of required training, 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 (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 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 and registration as an EPC assessor for the first time. In Sweden, it is mandatory to pass an examination before being certified, which means that nearly all assessors are doing training provided by academia or commercial education bodies before obtaining certification as an EPC assessor for the first time.



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

- Mandatory training on assessment and recommendations is required for obtaining certification and registration as EPC assessor for the first time and maintaining certification after validity period of certification
- Mandatory training on assessment and recommendations is required for obtaining certification and registration as EPC assessor for the first time
- Periodic training is mandatory for maintaining certification and registration as EPC assessor after validity period of certification
- Mandatory training on assessment and recommendations is not required for obtaining certification and registration as EPC assessor for the first time and maintaining certification after validity period of certification
- QualDeEPC partner countries



Figure 11: 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 eligible to issue EPCs. Mandatory training is not required (Government of Austria, 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 (Flemish Energy Agency, n.d.-c).	Yes. Continuing to receive annual training has been mandatory since 2017 in order to retain recognition as type A energy expert (Flemish Energy Agency, n.d.-d).
Bulgaria	Yes. An initial and mandatory training on assessment and recommendations is required for certification.	No. Not required.
Croatia	Yes. Mandatory training in specific modules is required.	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, n.d.).	No. See Column 1.
Czech Republic	No. Mandatory training is not required. Taking an examination is compulsory.	Yes. Continuing professional education is required (Energy Management Act, 2001).



	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
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.	Yes. Qualified energy consultants must attend mandatory courses and meetings in accordance with the Danish Energy Agency's decision (Order on energy labeling of buildings, n.d.).
Estonia	Yes. The Open University, of Tallinn University of Technology, provides mandatory training and the examination is conducted by the Estonian Association of HVAC Engineers (Ministry of Economic Affairs and Communications, n.d.-a).	Yes. Mandatory amount of academic points has to be collected during a period of time (five years).
Finland	No. It appears that mandatory training is not required, however, Finnish Association of HVAC Engineers provides training for taking the mandatory examination for qualifying as an EPC assessor.	No. However, as initial certification is valid for 7 years, periodic training is one of the options for continuing as EPC assessor after the completion initial 7 years (Motiva Oy, n.d.-a)..
France	No. Taking an examination is mandatory, but not training.	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 (Decree of December 13, 2011 amending the decree of October 16, 2006 as amended defining the criteria for certification of the skills of natural persons carrying out the energy performance diagnosis and the criteria for accreditation of 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 centres 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 certification.	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.	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.-b).
Italy	Yes. Regional and autonomous provinces have their own approach towards mandatory training, but usually mandated especially for people with relevant professional qualifications.	No. Not necessary (Moneta et al., 2015).
Latvia	Yes. It is mandatory to work under (train) for 2 years under the guidance of a certified EPC assessor to be able to take the exam for becoming an energy auditor.	No. Periodic training is not required.
Lithuania	Yes. Undertaking training course organized by designated organizations and passing a qualifying examination is mandatory (SPSC, 2020a).	Yes. EPC assessor must undertake an additional 20 hours of training and pass an examination every 5 years (Meškauskienė et al., 2015).
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 Economic Affairs to issue EPCs after	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
	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).	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.-a, n.d.-b).	No. See column 1.
Poland	No. There is no need to complete a mandatory course and pass an examination, according to the Act on Energy Performance of Buildings.	No. See column 1.
Portugal	Yes. EPC assessors should undertake mandatory training courses. Besides mandatory courses, there are also complementary training courses.	No. Periodic verification is not mandatory (ADENE, n.d.-a).
Romania	Yes. An initial mandatory training in short-term courses of 80 hours, or master classes in 1 to 2-year programmes on energy efficiency, or the energy performance of buildings and an examination are required.	Yes. EPC certification is awarded for a period of 5 years, which may be extended upon evidence of continuous training (Tenea et al., 2015).
Slovakia	No. Training is only optional. Additionally, an examination at a test committee has to be done. (Sternova et al., 2015).	No. See column 1.
Slovenia	Yes. A one-week training with a written and oral exam is needed for certification (Šijanec & Potočar, 2015).	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. It is, however, mandatory to pass an examination before being certified, which means that nearly all assessors are doing training provided by academia or commercial education bodies before doing the examination. Furthermore, a 2-year technical degree from university and 5 years of practical experience within the building sector thereof 2 years should be within the energy use and indoor climate are required.	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 17: 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

For providing effective recommendations for deep renovation qualified EPC experts should have relevant educational background or professional qualification. 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 countries, higher education in technical disciplines, such as engineering, architecture or sciences are required, along with professional experience. However, it is also possible to take part in supplementary training programmes (see section 4.2) when the candidates do not have sufficient credentials 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, only Spain does not have any eligibility requirements for EPC assessor certification.

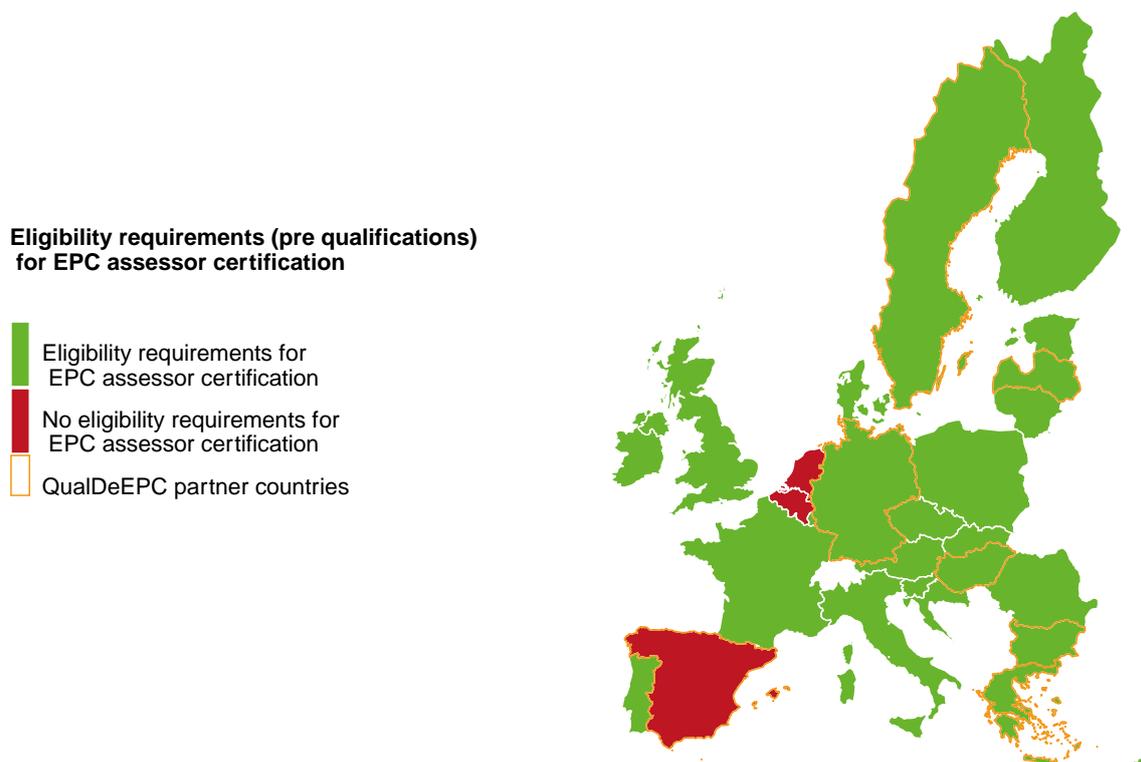


Figure 12: Eligibility requirements for EPC assessor certification

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 eligible to issue EPCs. (Government of Austria, 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 (Flemish Energy Agency, n.d.-c).
Bulgaria	Yes. According to the EE Act, the energy auditors should have: a secondary technical education, higher education or an advanced degree in the field of higher education "Technical Sciences", completed or recognized in the Republic of Bulgaria, or a secondary technical education, higher education or an advanced degree in equivalent higher education in another member state the European Union, or in another country party to the Agreement on the European Economic Area, or the Swiss Confederation; have acquired an internship in the specialty after completion of education - not less than 6 years for persons with secondary technical education, not less than three years for persons with a bachelor's degree and not less than two years for those with a master's degree and a scientific degree.
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



Eligibility requirements for EPC assessor certification	
	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, 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 labeling of buildings, n.d.).
Estonia	Yes. Mandatory EPC assessor training is offered for professionals with a University degree in technology (Tallin University of Technology, n.d.).
Finland	Yes. Technical qualification or equivalent professional experience that is required for performing building performance calculations and issuing EPCs is required (Act on Building Energy Certification, 2013).
France	Yes. Post-secondary diploma in the field of building technology or equivalent professional experience (Decree of December 13, 2011 amending the decree of October 16, 2006 as amended defining the criteria for certification of the skills of natural persons carrying out the energy performance diagnosis and the criteria for accreditation of 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.
Greece	Yes. University degree in engineering or architecture is required or diploma of engineering of technological institutes. Assessors are classified in different categories, depending on their qualifications and proven experience in energy audits.
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.-b).
Italy	Yes. Professional education and registration in the fields, such as engineering and architecture are required (Moneta et al., 2015).
Latvia	Yes. First or second level higher professional or academic education in the relevant education program that provides knowledge in the following subjects - thermal engineering of building envelopes, building engineering systems (heating, cooling, ventilation, air conditioning, water supply, lighting), building climatology and indoor climate evaluation and calculation methods are required.
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., 2015).
Luxembourg	Yes. At least 3 years university education in architecture or engineering, or equivalent field is required (Reding & Flies, 2014).
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).
Netherlands	No. Only mandatory certification of BRL 9500-01,-02,-03,-04,-06 are required for residential and non-residential buildings (RVO, n.d.-a, n.d.-b)..
Poland	Yes. According to the Act on Energy Performance of Buildings, only a qualified expert may issue an EPC. A person who is qualified expert has completed: higher studies completed by obtaining the title of professional engineer, architect engineer, landscape architect engineer, fire engineer, master architect engineer, master engineer landscape architect, master fire engineer or master engineer; or higher studies other than those mentioned above and postgraduate studies, the program of which takes into account issues related to the energy performance of buildings, performing energy audits of buildings, energy-saving construction and renewable energy sources; or has building qualifications.
Portugal	Yes. Professionals from the fields of architecture or engineering, with specific qualifications and minimum experience of 5 years are required (ADENE, n.d.-b, n.d.-c).
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., 2015).
Slovakia	Yes. It is necessary to have a professional competence regarding energy consumption in buildings (Implementing Act no. 555/2005 Coll. on the energy performance of buildings and on amendments to certain acts, as amended, 2012).



Eligibility requirements for EPC assessor certification	
Slovenia	Yes. For certification 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 (Šijanec & Potočar, 2015).
Spain	No.
Sweden	Yes. Detailed knowledge requirements are listed in regulation CEX. Also needed: relevant technical education (2 years at university within energy use in buildings, building services or building physics) and documented experience of practical work (at least 5 years within the building sector, of which 2 years should be related to energy use 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 (GOV.UK, n.d.-c, n.d.-b).

Table 18: Eligibility requirements for EPC assessor certification

4.4 Renewal of EPC assessor certification through an examination

In some member states, EPC assessors should undergo a periodic verification, by means of an examination, for being certified 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 in most countries only continuing education and further training is required as a means for being certified and registered, few countries also require an examination.

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

Renewal of EPC assessor certification through an examination

-  Periodic verification, by means of an examination is mandatory
-  Periodic verification, by means of an examination is not required
-  Information not found
-  QualDeEPC partner countries



Figure 13: Renewal of EPC assessor certification through an examination

The following table briefly explains the requirements for renewal of EPC assessor certification through an examination in various member states.

	Periodic verification by means of an examination is mandatory
Austria	No. Professionals from the listed sectors, such as builder, electrical engineering, civil engineering, and architecture are eligible to issue EPCs. Separate verification is not required (Government of Austria, n.d.).
Belgium	No. Type A experts should take part compulsory annual training for stipulated number of hours and context to retain certification (Flemish Energy Agency, n.d.-c).
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 Construction and Physical Planning, 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., 2015).
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.
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, 2013).
France	Yes. The certificate is renewed upon satisfactory clearance of a documentary exam and a practical exam (Decree of December 13, 2011 amending the decree of October 16, 2006 as amended defining the criteria for certification of the skills of natural persons carrying out the energy performance diagnosis and the criteria for accreditation of 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	No. EPC assessors are certified only once.
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., 2015).
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 (van Eck, 2015)
Poland	No. There appears to be no such requirements (Kasperkiewicz et al., 2015).
Portugal	No. There appears to be no such requirements (Fragoso & Mateus, 2015).
Romania	No. There appears to be no such requirements (Tenea et al., 2015).
Slovakia	No. There appears to be no such requirements (Sternova et al., 2015).
Slovenia	No. The license for EPC assessors is valid for unlimited time (Decree on the promulgation of the Energy Act (EC-1), 2017).
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



	Periodic verification by means of an examination is mandatory
	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	No. There are no such requirements (GOV.UK, n.d.-c, n.d.-b).

Table 19: Renewal of EPC assessor certification through an examination

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. In Poland, since 2000 the Association of Energy Auditors organize the conference "Forum Termomodernizacja" where various topics related with energy efficiency, renovation, technologies are presented (Association of Energy Auditors, n.d.). 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. 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 regular program 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).

Among QualDeEPC partner countries, opportunities for such renovation workshops are available only in Latvia.



5 INDEPENDENT CONTROL SYSTEMS FOR EPCS IN EU MEMBER STATES

Article 18 of the EPBD requires member states to install independent control systems for energy performance certificates to monitor their quality and compliance with legal requirements. As per Annex II of the EPBD, “the competent authorities or bodies to which the competent authorities have delegated the responsibility for implementing the independent control system shall make a random selection of all the energy performance certificates issued annually and subject them to verification. The sample shall be of a sufficient size to ensure statistically significant compliance results. The verification shall be based on the options indicated below or on equivalent measures:

- a | Validity check of the input data of the building used to issue the energy performance certificate and the results stated in the certificate;
- b | Check of the input data and verification of the results of the energy performance certificate, including the recommendations made;
- c | Full check of the input data of the building used to issue the energy performance certificate, full verification of the results stated in the certificate, including the recommendations made, and on-site visit of the building, if possible, to check correspondence between specifications given in the energy performance certificate and the building certified.”

However, the sample size of EPCs for control, the level and content of the input data appears to differ between member states. This section analyses different aspects of independent control in various member states.

5.1 Using common quality criteria for independent control

Independent control of the quality of EPCs and EPC assessors is based on quality criteria. The convergence of these criteria between EU MS enhances quality of EPCs across member states. Most member states have established a nodal authority with well-defined responsibilities for quality control of EPCs. The independent control authorities are often the Ministries concerned with EPCs, technical inspectorates, and energy agencies and in a few cases, accredited third parties.

When the EPC register/software consists of automatic validation of the input data, input parameters of almost all EPCs are screened for quality check. In the absence of automatic validation, desk check of input parameters is conducted. While most countries check input data of building parameters and EPC assessor credentials, the level and content vary among various member states. The following table includes information on the nodal authority and quality control procedure in various member states.

	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	The National EPC Body – Sustainable Energy Development Agency is the responsible authority for quality assurance of EPCs. The quality control includes conducting a verification of compliance with the regulatory requirements (completeness of documents, form and model) of the submitted documentation from the energy efficiency audit and building certification; sending notification letters to correct identified deficiencies;



	Using common quality criteria for independent control
	performing input control for the accuracy of the data and the results of documentation from energy efficiency audits of industrial systems and energy efficiency audits and certification of buildings; sending notification letters in case of identification of gaps in the received documentation for the elimination of the gaps and correction of the data.
Croatia	The Minister of Construction and Physical Planning is the responsible authority for quality assurance of EPCs. 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 (Škoro, 2018).
Cyprus	The Ministry of Energy, Commerce and Industry is the responsible authority for quality assurance on EPCs. Approximately ten specific input parameters are checked; among U-values, efficiencies of heating and cooling systems, and window size are specifically checked (Hadjinicolaou, 2016).
Czech Republic	The State Energy Inspectorate is the responsible authority for quality assurance of EPCs. Verification includes whether the EPCs were processed objectively, truthfully and completely, as per the requirements of the Energy Management Act (Svoboda, 2016).
Denmark	The Danish Energy Agency is the implementing authority on quality assurance for EPCs (Thomsen et al., 2015).
Estonia	The Estonian Technical Regulatory Authority is the responsible authority for quality assurance on EPCs. Checks include the procedural formalities, such as use of correct forms, input data etc. For new buildings, the fulfilment of minimum energy performance requirements are checked through the EPC before the permit is issued (Kuusk et al., 2016).
Finland	The Housing Finance and Development Center is the responsible authority for quality assurance on EPCs. A number of energy certificates issued each year are audited, with a focus on the correctness of the certificate's source data, energy quantities, and recommendations for savings (Act on Building Energy Certification, 2013).
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., 2015).
Germany	The Deutsches Institut für Bautechnik (DIBt) carries out random electronic 1st level controls. 2nd and 3rd level (more detailed) controls are under the sovereignty of the Federal States. These probably have different quality criteria.
Greece	Automatic validity check is performed for all EPCs uploaded on the web platform and operated by CRES, On-desk checks of data entry are also performed for a randomly selected sample, by the competent Ministry's assigned staff. Checks on-site are performed by the Ministry's assigned staff whenever required (e.g. depending on the results of on-desk checks or in case of complaints). On-desk checks of all EPCs issued for the purposes of national subsidy programmes are performed.
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/DEC assessors and BER/DEC assessments via audits. Checks include comprehensive input data, such as building drawings and documentation, data from site visit and survey forms, and output data, such as provisional and final BER/DECs and advisory report (renovation recommendations). Furthermore, the audit process is tailored to minimize (common) errors in future by providing a systematic and direct feedback to BER/DEC assessors (SEAI, 2016).
Italy	The responsibility for quality assurance of the EPCs lies with the regions. The national legislation requires 2% of all EPCs to be annually checked starting from best class EPC. Checks are as per EPBD option c), point 1 of Annex II "full verification of the results stated in the certificate, including the recommendations made, and on-site visit of the building (Costanzo et al., 2018).
Latvia	There is a provision for independent control.
Lithuania	All EPCs in the database are checked automatically and the outliers are selected for desk audit, primarily for incorrect and/or incomplete data, software version, certificate validation and the completion of any additional training needed by qualified experts. A detailed audit is also performed following client complaints (Encius & Baranauskas, 2018).
Luxembourg	An annual series of controls of issued EPCs is carried out by the Ministry of the Economy organises to verify their compliance with the legal requirements. The first level consists in an automatic plausibility check of the calculated values by the EPC software, and the second level includes deeper analysis of the EPC containing non plausible elements (Reding et al., 2015).
Malta	The Malta Competition and Consumer Affairs Authority (MCCAA) is the responsible authority for quality assurance on EPCs. The verification system devised by the BRO and MCCAA consists of a number of checks on a statistically significant sample of certificates including the input data, results, an recommendations (Degiorgio



Using common quality criteria for independent control	
	& Barbara, 2018).
Netherlands	Since January 2015, the Dutch Environment and Transport Inspectorate (IL&T) is responsible for the quality assurance of EPCs. For the purpose of quality assurance, the IL&T has access to the RVO database that comprises the updated entries, evidence and expert assessments. In addition, the RVO also checks whether energy assessors comply with the procedural requirements, such as pricing policy and indemnity (van Eck, 2015).
Poland	An independent body exists 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., 2018).
Portugal	There are three steps of checking: automatic input validation, simple quality checks, and detailed quality checks. Quality check includes a full data review of calculations and a building audit to check the compliance with the requirements and methodologies, based on supporting documentation prepared and used by the expert (e.g., projects, drawings, reports, photos, etc.) and identification of eventual differences and mistakes that occurred and possibly a site visit (Fragoso & Mateus, 2015).
Romania	The State Construction Inspectorate is responsible for the quality assurance of EPCs. Checks include energy auditor certification requirements (specific higher education, area of expertise), signatures and stamps on the EPCs and energy audit reports for building, if required; the completeness and accuracy of information presented in the EPCs and energy audit reports. (Tenea et al., 2015).
Slovakia	Since 2014, the State Energy Inspection, as part of the Slovak Trade Inspection, is responsible for the quality assurance of EPCs (Sternova et al., 2015).
Slovenia	The Ministry of Infrastructure is the responsible authority for quality assurance of EPCs. Checks include the validity of the input data, results and recommendations (Šijanec & Potočar, 2015).
Spain	The quality control is managed by Regional Governments. Two steps of control: automatic input validation and quality checks.
Sweden	Boverket, the National Board of Housing, Building and Planning, makes yearly check of 1% of EPCs. Furthermore, individuals can give complaints to Boverket or to the certification bodies.
UK	Scheme Operating Requirements (SORs), which ensures a common set of minimum quality standards for all accreditation schemes, cover the quality assurance for EPCs. This includes several procedural aspects pertaining to the assessors, such as their status of certification, qualification, indemnity etc. as well as checks specific to EPC assessment and renovation recommendations. In addition, the Government also carries out quality assurance audits (Delorme & Cousens, 2015).

Table 20: Using common quality criteria for independent control

5.2 Achieving sufficient sample size for independent quality control

Achieving a sufficient sample number of buildings and their EPCs and their assessors for performing verification and quality control of EPCs is required as per Annex II of the EPBD (also cf. DG Energy guidance on sample sizes). However, the sample size significantly varies between various member states and also between regions in a country. The following table briefly shows the information on how the quality control is implemented in EU member states.

Sufficient sample size for verification and quality control	
Austria	In 2013, 11,039 EPCs were checked (Altmann-Mavaddat et al., 2018).
Belgium	In Brussels Capital Region 156 EPCs were checked in 2013, 236 in 2014 (Govaert et al., 2016). In the Walloon Region about 50% of EPCs have been selected by the web application for control in 2014 (Fourez et al., 2015).
Bulgaria	The Control and Monitoring Department of SEDA publishes yearly reports of the control activities. According to the published reports for 2018 it is performed check of 65% (or 1061 documents) of the received energy audits. 11 visits to control at place for implementation of the energy recommendations have been performed.
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 (Škoro, 2018).
Cyprus	In the period 2010 to 2013, 10% of EPCs have been checked by desk audit, 21% of EPCs by on-site check (Hadjinicolaou, 2015).

	Sufficient sample size for verification and quality control
Czech Republic	In 2016, the State Energy Inspectorate controlled 20% of energy specialists. These controls covered 1,305 EPCs to verify whether they were processed objectively, truthfully and completely, as per requirements of the Energy Management Act (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 (Thomsen et al., 2015).
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., 2015).
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., 2015).
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.
Greece	On EPC registration platform, all EPCs are checked automatically. In addition, law requires on-desk check of a randomly selected sample of 5%. All EPCs issued for obtaining renovation grants or finance are checked too. Up to the end of 2018, approx. a 2.5% of all EPCs issued has been further checked on-desk or on-site.
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 et al., 2018).
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. Actual assessment of EPCs has started in Latvia from end of 2019.
Lithuania	All EPCs are automatically checked by software. About 0.5% of all issued EPCs are controlled via a detailed audit (Meškauskienė et al., 2015).
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 & Barbara, 2018).
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., 2018).
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 (Tenea et al., 2018).
Slovakia	In 2013, 103 EPCs (0.035%) have been checked (Sternova et al., 2015).
Slovenia	A statistically significant proportion of annual issued EPCs, set on 31 March each year, will be checked (Decree on the promulgation of the Energy Act (EC-1), 2017).
Spain	The situation is that 100% of EPCs are automatic controlled, thanks to computer mechanism. Additionally, a document control is carried out on nearly 50% of the EPCs, the number of document control was 1.392.880 in 2017. Also, specific inspection that reach 0.5% of EPCs and a deep inspection with visit to the building with 0.05 of the EPCs in 2017. The verification of competent technicians as of 2017 covered 27029 assessors.
Sweden	Boverket, the National Board of Housing, Building and Planning, makes yearly check of 1% of EPCs.
UK	Regarding public buildings in England, the random size should be at least 2% (Delorme & Cousens, 2016).

Table 21: Sufficient sample size for verification and quality control



5.3 Quality control of both EPCs and assessors

In most countries control is based on the sample of EPCs, i.e., statistically significant percentage of EPCs is verified. However, few countries such as France and Czech Republic, control is based on EPC assessors, i.e., statistically significant percentage of EPC assessors/all EPC assessors are verified, periodically. Either way, practically, in the majority of the member states, both EPCs and assessors are controlled (see figure below). Quality checks on EPCs include accuracy of the input data and results, calculation methodology used. Quality checks on assessors include their certification, history of errors, and quality of recommendations. However, the basis of quality checks might vary across member states.

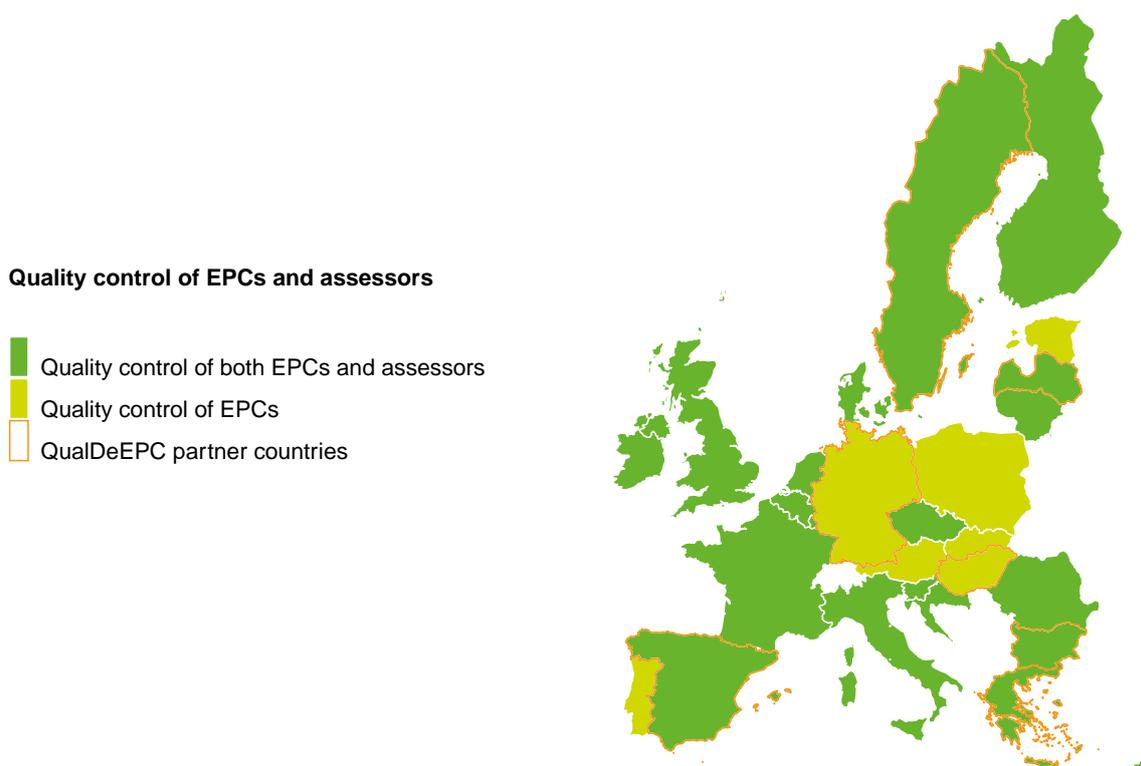


Figure 14: Quality control of both EPCs and assessors

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 randomly checks the correctness of EPCs.	Yes. Flanders: The Energy Agency randomly checks the qualifications and services provided by EPC assessors (Flemish Energy Agency, n.d.-a).
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	Yes. Assessors are obligated to rectify the mistakes found in EPCs during quality



	Quality control of EPCs	Quality control of assessors
	of the input data, the accuracy of the EPC and the calculated and proposed measures to improve the energy performance of the building (Škoro, 2018).	check. If a number of EPCs from a particular assessor are found to be incorrect, their certification may be revoked (Mardetko-Škoro, 2015).
Cyprus	Yes. Desk audit from the data retrieved from the EPC database and on-site visits are performed.	Yes. EPC assessors are audited at their premises (Hadjinicolaou, 2015).
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 (Thomsen et al., 2015).	Yes. Certified companies incur staged sanctions (three levels) from notification for rectification of errors, warning, and suspension of certification depending on the nature and frequency of errors (Thomsen et al., 2015).
Estonia	Yes. In 2013 0.6% of EPCs have been quality checked (Arcipowska et al., 2014).	No.
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.	Yes. Criminal liability provisions shall apply to a certifying staff member in the performance of his or her duties (Act on Building Energy Certification, 2013).
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., 2015).
Germany	Yes. The inspection body has to randomly check EPCs.	No.
Greece	Yes. On-desk control of the data retrieved from the EPC database and on-site visits are performed	Yes. Penalties for assessors are also set and vary depending on the type of mistakes or negligence
Hungary	Yes.	No.
Ireland	Yes. Quality control of EPC assessments is carried out.	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.	Yes. The tolerance of errors and penalty depends on the type and repetition rate (Costanzo et al., 2018).
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.	Yes. Possible sanctions include warning, suspension and cancellation of the certification (Meškauskienė et al., 2015)..
Luxembourg	Yes. The Ministry of Economy controls EPCs in order to verify their compliance with legal regulations.	Yes. Penalties in the form of a time-limited suspension can be imposed (Reding et al., 2018).
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 & Barbara, 2018).	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.	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



	Quality control of EPCs	Quality control of assessors
		issued by qualified assessors (van Eck, 2015).
Poland	Yes. An independent control system of EPCs took place between 2013 and 2014.	No. The number of licensed persons issuing EPCs is too high for a quality control process (BPIE & KAPE, 2017).
Portugal	Yes. Short or detailed assessments of EPCs can take place (Fragoso & Baptista, 2018).	Information not found.
Romania	Yes. The ISC control mainly focuses on the validity of EPC assessor's 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	Yes. Since 2014, the State Energy Inspection, as part of the Slovak Trade Inspection, is responsible for the quality assurance of EPCs (Sternova et al., 2015).	Information not found.
Slovenia	Yes. A 2-level approach of EPC quality control is given (Šijanec & Potočar, 2015).	Yes. The quality control of EPCs also includes an "expert supervision".
Spain	Yes. All the EPCs are controlled and generate automatic notices about the EPCs that do not correspond with reasonable average parameters.	Yes. The quality control of assessors as of 2017 covered the verification of 27,029 technicians.
Sweden	Yes.	Yes.
UK	Yes. The certification schemes are responsible for monitoring 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 Development, 2017).	Yes. See column 1.

Table 22: 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/registry 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 (see figure below). The contents of the automatic check include input data of building parameters, results of energy consumption, energy class, EPC assessor credentials, and renovation recommendations. Furthermore, the level of check also varies, for example, input data of building parameters include building typology, area, thermal transmittance properties, system efficiencies; and EPC assessor credential check might include registration number, qualifications, and indemnity. However, the level and content of checks varies in different member states.



Performing automatic validity/quality check of EPC assessments during assessment and/or during upload to EPC database

- Automatic validity/quality check of EPC assessments is implemented
- Automatic validity/quality check of EPC assessments is not implemented
- Information not found
- QualDeEPC partner countries



Figure 15: 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., 2015).
Bulgaria	Yes. It is already partially implemented in Bulgaria, but can be improved, for example, through additional database functionality.
Croatia	No.
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, 2015).
Czech Republic	Information not found.
Denmark	Yes. The EPC database has an automatic data validation (Brand et al., 2019).
Estonia	Yes. An automatic validation of the data (only format of upload is checked) 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., 2015).
France	Information not found.
Germany	Yes.
Greece	Yes. Automatic validity check of EPCs data is performed on the national EPC registry platform.
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).



	Automatic validity/quality check during assessment and/or during upload to EPC database for all EPCs is available
Latvia	Yes. When registering EPC in a database only basic math is checked (it is checked if numbers that should make a certain sum do actually make this sum and other similar mathematical checking).
Lithuania	Yes. An automatic quality check in the EPC database is implemented (Meškauskienė et al., 2015).
Luxembourg	Yes. The EPC database as well as the national software currently checks the plausibility of the EPC automatically (Reding et al., 2015).
Malta	Information not found.
Netherlands	No (Arcipowska et al., 2014).
Poland	Yes. There is an automatic check of input data in the registry when EPC is issued in the case of missing data. However, there is no automatic check of correctness of data on EPC. Proposals to improve the central register of EPCs are currently being prepared. Following their introduction, it will be possible to check the correctness of EPCs more quickly and easily.
Portugal	Yes. The software automatically checks the input data (Fragoso & Baptista, 2018).
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 (Šijanec & Potočar, 2015).
Spain	Yes. An automatic quality check in the EPC registry is implemented after the EPC. Regional variations may exist.
Sweden	Yes. EPC registry performs automatic check.
UK	Information not found.

Table 23: 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 Annex II. The majority of the member states have 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.



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

- Both C and C* level control are achieved
- C level control is achieved
- None of both is achieved
- Information not found
- QualDeEPC partner countries



C including full check of input data, calculation results, and recommendations; C with additional check through on-site visit if C level has shown major deviations*

Figure 16: 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 as per Annex II of EPBD(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.	Yes. Site visits are also performed as a part of quality check (De Meulenaer & Triest, 2018).	Yes
Bulgaria	Yes. All three options mentioned in Directive 2010/31 are applied in Bulgaria.	Yes. See column 1.	Yes. See column 1.
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, 2015).	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, 2015).	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 (Thomsen et al., 2015).	Yes. The technical revision includes a re-certification of the EPC and can also include a second on-site visit.	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 of Finland checks the sample EPCs regarding the input data, the accuracy of calculations and the appropriateness of recommendations (Haakana et al., 2015).	Information not found.	Information not 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	Yes. See column 1.	Yes. See column 1.



	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
	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., 2015).		
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 (Deutsche Bundesregierung, 2014).	Yes. See column 1.	Yes. See column 1.
Greece	Yes. There are 3 levels of control. 1 st validity check of EPC input data performed on the EPC platform. 2 nd level of control is performed on-desk for random sample. 3 rd level if control is performed on-site, depending on results of the on-desk control.	Yes. See column 1.	Yes. See column 1.
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, 2018).	Yes. Quality control audit process could also take place on the building site (SEAI, 2018).	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.	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., 2018).	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., 2015).	No.	No.
Malta	Yes. Schedule II (Regulation 32) of the Energy Performance of Buildings Regulations, 2012 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, 2016).	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 & Baptista, 2018).	Yes. See column 1.	Yes. See column 1.
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 check by the EPC registry. A Second level control includes a check of the EPC issued (Šijanec & Potočar, 2015).	No.	No.
Spain	Yes. However, level control is varied in different Regions	Yes. See column 1.	Yes. See column 1.
Sweden	Yes, First level control is an automatic validity check by the EPC registry. The National Board of Housing, Building and Planning, also makes yearly check of 1% of EPCs. The check	Yes. See column 1.	Yes. See column 1.



	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
	may be full check of input data, calculations results and recommendations as well as on-site visit. Additional sample checks may also be done if there have been specific complains about incorrect certificates.		
UK	Information not found.	Information not found.	Information not found.

Table 24: 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 Portugal, and to some extent in Denmark and Ireland.

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). In Denmark, although it is unclear whether it is a central database or not, there is a seven-step plan in implementation that entails shortening the time from error to learning increase the overall quality of the EPC (Thomsen et al., 2018). In Ireland, care is taken that issues or errors identified during the audit process are not repeated in the future by communicating the feedback directly with the concerned BER/DEC assessor and to other BER/DEC assessors as appropriate through relevant communication channels (SEAI, 2016).

In Greece, one of the QualDeEPC partner countries, such a process of identification of errors or faulty procedures is performed on the platform and automatic warning or written notification is sent to the assessor, the common mistakes / errors are not yet aggregated to be used in statistics or in future training. However, the issue is under consideration.

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 for producing poor quality assessments or recommendations once or repeatedly: stage 1) obligation to produce correct EPC pro bono (and controlling that it happens), stage 2) fines, and stage 3) withdrawal of certification. 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.



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

- Differentiated and staged sanctions
- Differentiated and staged sanctions, and a distinction between fraud and negligence is made
- QualDeEPC partner countries



Figure 17: 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 Österreich (WKO), 2019).	Information not found.
Belgium	Yes. Flanders: Sanctions can reach from re-issuance of the EPC to penalties from 250 to 5,000 EUR (Flemish Energy Agency, n.d.-a).	Yes. See column 1.
Bulgaria	Yes. The sanctions are defined in EE Act.	Yes. EPC assessors are provided an opportunity to correct errors in the EPCs.
Croatia	Yes. If several invalid EPCs have been issued, EPC assessor can be sanctioned with a fine or loss of certification (Marđetko-Škoro, 2015).	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.	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, 2015).
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 resort, the EPC assessor can lose his license.	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 resort, the EPC assessor can lose his license (Brand

	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
		et al., 2019).
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 (Act on Building Energy Certification, 2013).	Information not found.
France	Yes. Penalties up to loss of certification are in place (Decree of December 13, 2011 amending the decree of October 16, 2006 as amended defining the criteria for certification of the skills of natural persons carrying out the energy performance diagnosis and the criteria for accreditation of 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. Administrative and monetary sanctions are imposed to assessors for faulty procedures and errors. A 1 st warning is sent if repeated faults are identified. Temporary license suspension (1-3 years) or permanent is foreseen, depending on the gravity / impact of mistakes. Monetary fines ranging from 500 to 20,000€ are also foreseen and depend on gravity / impact of mistakes or fraud.	Yes. See column 1.
Hungary	Yes. Penalties up to withdrawal of certification are in place.	No.
Ireland	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. Penalties include suspension or termination from registration. (SEAI, 2016).	Yes. See column 1.
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., 2018).	Yes. See column 1.
Latvia	Yes. A penalty point system is implemented (Regulation No.531 Regulations Regarding Assessment of the Competence of Independent Experts and Monitoring of Professional Activity Thereof in the Field of Energy Performance of Buildings). With 10 penalty points, the EPC assessor certificate is withdrawn.	Yes. 5 points can be given only if deliberate violations of the laws and regulations in the field of the assessment of energy performance of buildings are made. In other cases maximum of 3 points can be given for errors in EPCs.
Lithuania	Yes. Penalties up to loss of certification are in place.	No. Does not appear to be the case (Meškauskienė et al., 2015).
Luxembourg	Yes. Penalties in the form of a time-limited suspension can be imposed (Reding et al., 2018).	Information not found.
Malta	Yes. EPC assessors are obligated to rectify incorrect EPCs in stipulated time, pending which their certification 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, 2015).	Yes.
Poland	Yes. Expulsion/disqualification is the only from sanction available, except for minor errors.	Yes. There are no penalties for minor errors (Kasperkiewicz et al., 2015)
Portugal	Yes. Penalties are in place, up to the (limited) suspension of the EPC assessor from the national list (Approves the access and exercise requirements of the expert activity qualified for energy certification and installation and maintenance technician for buildings and systems, conforming it with the discipline of Law No. 9/2009, of 4 March, which transposed Directive No. 2005/36 / EC, of the European Parliament and of the Council, of 7 September 2005, on the recognition of professional qualifications., 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	Information not found.



	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
	be imposed (Tenea et al., 2018).	
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 a new one in the register (Šijanec & Potočar, 2015).	No.
Spain	Yes. Initially warnings are issued if EPC data is found to be incorrect. Usually the mistakes are corrected, and the EPC is registered again.	Yes. See column 1.
Sweden	Yes. If the EPC assessor fails in its independence or has issued incorrect declarations, it may be notified to the certification body which may withdraw the certification. The Swedish National Board of Housing, Building and Planning can also withdraw certifications.	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 Development, 2017).	Information not found.

Table 25: 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 where a EU member state 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 by means of assessment and certification, qualification of EPC assessors, and independent control systems, this chapter analyses potential improvements on how EPCs are used in the building markets. 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).
Bulgaria	Statistical information not found. QualDeEPC country partner estimates that people are less aware about EPCs or often see them as a burden.
Cyprus	The general public in Cyprus is considered not to be well aware about the EPC and its importance (Geissler et al., 2016).
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).
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 seems to have some understanding of the energy categories provided in the EPC etc. and the legal obligation 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 in stimulating energy efficiency renovation, due to limited number of recommendations 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 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.
Latvia	Statistical information not found. The QualDeEPC country partner estimates that many people do not care about EPCs or see them as a burden.
Poland	In order to increase the public perception, the graphic design of the EPC could be improved. Additionally, includ-

	Public opinion about EPCs
	ing recommendations into the EPC would be supportive (BPIE & KAPE, 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. EPC is not fully understood by general public and nobody explains the meaning.
Sweden	Statistical information not found. The QualDeEPC country partner draws the following conclusions: 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 26: 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 have to be presented to the buyer or tenant. However, the strict implementation of this requirement is different in various member states. 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 placing 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).

The sanctions for building owners for missing to obtain/present an EPC are often defined in the legislation governing EPCs, but the degree of control and implementation may vary between member



states. In most of the member states, there are sanction for building owners failing to own or present an EPC, when required/on demand.

Sanctions for building owners failing to own or present an EPC

- Sanctions for building owners missing to obtain/present an EPC
- No sanctions for building owners missing to obtain/present an EPC
- Information not found
- QualDeEPC partner countries



Figure 18: 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 (EVAG 2012, 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 (Flemish Energy Agency, n.d.-a).
Bulgaria	No. There is no control body; the notaries who profess the transactions can in practice monitor the activity.
Croatia	Yes. Penalties are laid for not providing the EPC at the time of sale, rent or lease (Mardetko-Škoro, 2015).
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 € (Xichilos & Hadjinicolaou, 2011).
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 30,700 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 (Thomsen et al., 2015).
Estonia	Yes. Penalties can be imposed (Kuusk et al., 2016).
Finland	Yes. The owner is liable in the case of non-compliance (Act on Building Energy Certification, 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 (Ministère de la Transition écologique et solidaire, n.d.).
Germany	Yes. The non-delivery of an EPC to the buyer or renter is an administrative offence (EnEV, 2014).
Greece	Yes. EPC is mandatory in rental/sale of buildings. Sanctions to owners are foreseen for non-compliance.
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 penalised with Class A fine (i.e. a fine not exceeding €5,000) or imprisonment for a term

	Sanctions for building owners missing to obtain / present an EPC are in place
	not exceeding 3 months or both (European Union (Energy Performance of Buildings) Regulations 2012, n.d.).
Italy	Yes. In case of not providing the EPC in sale or rent, a penalty between 300 and 18,000 EUR can be imposed (Costanzo et al., 2018).
Latvia	Yes. However, the control and monitoring are weak and the sanctions have never been applied.
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 provided with a provisional EPC. Building owners are required to produce final EPC during sale or rental of the building (van Eck, 2015).
Poland	No.
Romania	Yes. The investor/owner/manager is obliged, as appropriate, to make a copy of the EPC available to the prospective buyer or new tenant before concluding the sale or lease, without which, contracts of sale concluded are considered null and void and in non-compliance with the Civil Code (Tenea et al., 2015).
Slovakia	Yes. In case of not having an EPC when needed, building owners can be fined of 500 up to 3,000 EUR (ARNEA, n.d.).
Slovenia	Yes. Display of EPC during sales or rentals is mandatory. Non-compliance can result in penalties of up to 300 € (Šijanec & Potočar, 2015).
Spain	Yes. Display the energy class of the EPC during sales or rental is mandatory. In the household sales contract, an EPC should be attached; in the renting contract the label should be attached. The person who sells is the responsible to get the EPC and the notary will include EPC in the contract. Non-compliance building owners can be fined with penalties of 601 up to 1,000 €. Penalties for falsifying information between 1,001 and 6,000 €.
Sweden	Yes.
UK	Yes. Building owners can be fined if they do not get an EPC when it is required (Gov.uk, n.d.).

Table 27: Sanctions for building owners failing to own or present an EPC

6.4 Presenting EPC to official building sales bodies or permit authorities 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, such as notaries when selling buildings or parts thereof, as practiced in Greece, Hungary and Sweden, as well as a number of other EU member states (see figure below) and while applying for building permit during new construction.



Presenting EPC to official building sales bodies or permit authorities as an obligatory or mandatory measure

- Presentation of EPCs is mandatory for sales/permit of buildings
- Presentation of EPCs is voluntary for sales/permit of buildings
- QualDeEPC partner countries



Figure 19: 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 & Triest, 2018).
Bulgaria	The notaries who profess the transactions can in practice monitor the activity. Upon the sale of a new building as a whole, the seller shall provide to the purchaser the certificate. The owners of stand-alone units in a building shall have the right to receive a copy of the original energy performance certificate
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, 2020).
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 et al., 2015).
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. It shall be annexed to the application for written approval that is submitted to the local authority (Building Act, 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., 2015).
France	Yes. The technical diagnosis file (e.g. including EPC) must be attached to all promises to sell and all sales of residential properties (Notaires de France, 2020).
Germany	No.
Greece	Yes. EPC needs to be provided to notaries during the transaction process and the EPC registration number is included in the legal documents. It is also mandatory to upload the EPC on the Tax Authority electronic platform; however, in this case there is a tolerance in submission time.
Hungary	Yes.
Ireland	No.
Italy	Information not found.
Latvia	No.



Presentation of EPCs to official building sales bodies, such as notaries, is mandatory for sales of buildings

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, a notary checks EPCs during the signing of real estate contracts (Encius & Baranauskas, 2018).
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 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. A notary informs the owner and buyer about their rights while signing the notary deed (Bekierski et al., 2018).
Portugal	Yes. Notaries are obliged to report whenever a transaction occurs without the existence of an EPC (Fragoso & Baptista, 2018).
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 (BPIE et al., 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 (Šijanec & Potočar, 2015).
Spain	No.
Sweden	Yes.
UK	No.

Table 28: 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 compliance 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	
Bulgaria	Where a new building for which a energy performance certificate has been issued or a stand-alone unit therein is announced for sale or rent, the parameter "specific annual expenditure of primary energy" in kWh/m ² , stated in the certificate, shall be noted in all announcements. Prior to the conclusion of a contract for sale or lease, the seller or the lessor respectively shall provide to the purchaser or lessee respectively the certificate in order for them to acquaint themselves with it.
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 (Škoro, 2018).
Cyprus	Yes. Non-compliance has led to penalties in 22 cases. This has led to a higher rate of EPC display in advertisements (Hadjinicolaou, 2015).
Estonia	Yes. The Estonian Technical Surveillance Authority is in charge of checking the use of EPCs in case of selling or renting property (Kuusk et al., 2016).
Slovakia	Yes. The Slovak Trade Inspection is in charge of control checks (Sternova et al., 2015).
Sweden	Yes. The National Board of Housing, Building and Planning gives the regulations for presenting the EPC and its result and is in charge for control checks.

Table 29: 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 publicly 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.



Public database of EPCs

- Public access database of EPC ratings is available
- Limited (or non-public) access database of EPC ratings is available
- Database of EPC ratings is unavailable
- Information not found
- QualDeEPC partner countries

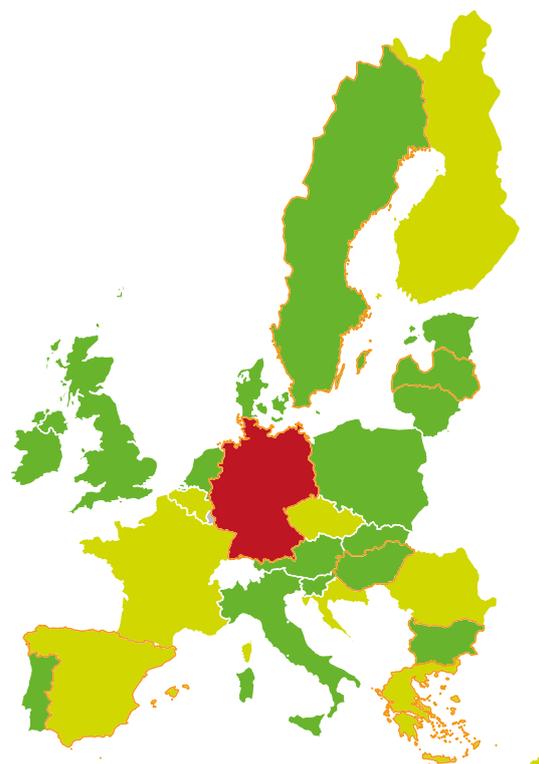


Figure 20: Public database of EPCs

	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.-b).
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. There is a National Energy Efficiency Information System For Certified Buildings
Croatia	No. However, Currently, Croatia is running a test phase for implementing an electronic database for the EPCs (Škoro, 2018).
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 (European Commission, n.d.).
Denmark	Yes. All EPCs are registered in a central database that is publicly available on the website (Danish Energy Agency, n.d.-b).
Estonia	Yes. (European Commission, n.d.).
Finland	No. A database exists, but it is not accessible by the public (European Commission, 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	No. The database is not publicly accessible. Access is limited to the Ministry and the operator of the platform (CRES). It is also accessible to the assessor/ issuer of the EPC as well as to the owner of the EPC, or any other physical person but only with the registration number and security number of the certificate and only for the information included in the 1 st page (Energy class, administrative data of the building). Aggregated / anonymised data can be requested by institutions for research and analysis purposes and are provided by the Ministry's assigned staff.
Hungary	Yes.



	Public database (protecting privacy) of EPC ratings is available
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.-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 (Costanzo et al., 2018).
Latvia	Yes.
Lithuania	Yes. A public EPC register is available complete with building address, energy class, energy consumption etc. (SPSC, 2020b)
Luxembourg	The third National Energy Efficiency Action Plan announced the build-up of a national database (Le Gouvernement du Grand-Duché de Luxembourg, 2017).
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 (Government of the Netherlands, n.d.-c; van Eck, 2015).
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., 2018; Ministry of Infrastructure and Construction, n.d.). However, this is only for buildings with floor area exceeding 250 m ² occupied by the judicial authorities, the prosecutor's office and public authorities that serve the public directly.
Portugal	Yes. A searchable public database exists (ADENE, n.d.-d).
Romania	No. A central register exists; however, no public access is available (European Commission, 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 publicly 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 (Rules on the methodology for the production and issuance of energy performance certificates for buildings, 2014).
Spain	No. The Regional Governments manage a registry of EPCs.
Sweden	Yes.
UK	Yes (European Commission, n.d.).

Table 30: 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 policies and design novel financial schemes for deep renovation. Such links are available only in few member states, where EPCs are mostly linked with building registries.



Linking EPC database to other buildings or energy-related databases

- Links to other database are present
- Links to other database are not present
- Information not found
- QualDeEPC partner countries

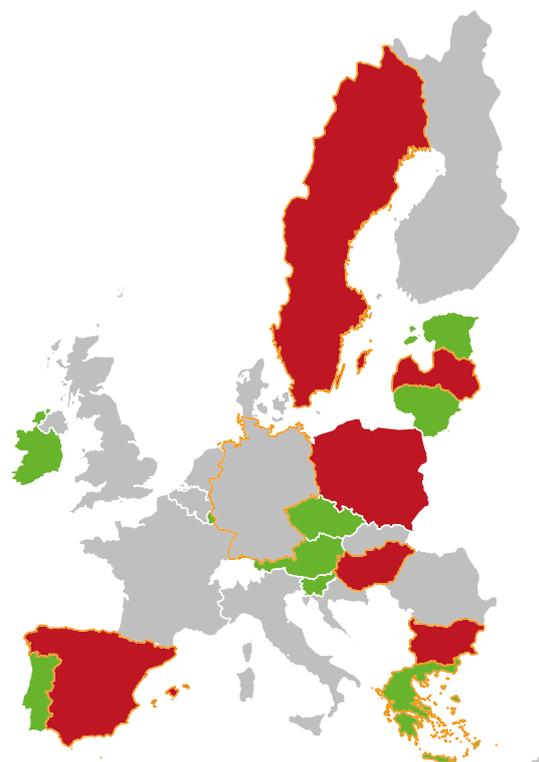


Figure 21: Linking EPC database to other buildings- or energy-related databases

	Links to other database are present
Austria	Yes. The building standard, the "Klimaaktiv standard", is quite ambitious and already meets NZEB requirements that will be relevant in 2020 and beyond. The basis is the EPC, but requirements for the Klimaaktiv standard go beyond (klimaaktiv, 2018).
Czech Republic	Yes. The Central Register of Administrative Buildings keeps records of 5,000 buildings that are properties of the state (Svoboda et al., 2015).
Estonia	Yes. EPC data is part of Building Registry (Kuusk & Tali, 2015).
Germany	No.
Greece	Yes. For the time being, the database is linked to the Tax Authority platform as well as to the platform of the national incentive programme 'Energy Efficiency at Household Buildings'.
Hungary	No.
Ireland	Yes. The data can be used in combination with other data sources including census (Altmann-Mavaddat et al., 2015). The information available in the database is being used also for strategic energy planning (SEAI, n.d.-f).
Italy	Information not found.
Latvia	No.
Lithuania	Yes. Since July 2014, all data are also transferred to the Real Property Register and Cadastre of Lithuania (Encius & Baranauskas, 2018).
Luxembourg	Yes. "LENOZ" is a voluntary sustainability assessment of residential buildings adapted to Luxembourg conditions. The abbreviation "LENOZ" stands for "Lëtzebuenger Nohaltegkeets certification" (Le Gouvernement du Grand-Duché de Luxembourg, 2017).
Poland	No.
Portugal	Yes. EPC database is connected to other databases to better operate funding schemes (Fragoso and Baptista, 2016). EPC database is also connected to other databases or sources of official or market information, such as Housing Energy Efficiency, Statistics institutes, Electricity utility, Building registry and notaries (Altmann-Mavaddat et al., 2015).
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.



	Links to other database are present
Sweden	No.

Table 31: 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 show 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. Additionally, the results are only conditionally comparable, as different boundary conditions may differ for EPC and audit. That consumes extra time and entails further costs for the building owner. In the same direction go arguments by several other stakeholders. In many countries it is a general view among EPC assessors that an EPC reflects the building's performance with regards to its thermal envelope and technical systems, regardless of its occupant behaviour and use of the building. As an audit also mirrors the habits of the occupants, recommendations should be based on building's performance with some care and abstraction from the occupant behaviour.

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.



Linking EPCs and renovation recommendations to detailed energy audits

- EPCs and renovation recommendations are linked to detailed energy audits
- No linking is in place
- Information not found
- QualDeEPC partner countries



Figure 22: 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. The Energy performance certificate is integral part of energy audit procedure.
Croatia	Yes. Energy audit is a pre-condition for producing EPCs as per Article 6 of the Ordinance on energy auditing of buildings and energy certification (Ordinance on energy auditing of buildings and energy certification, 2017).
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 Oy, n.d.-c).
France	Information not found.
Germany	No. If the EPC issuer is not the energy consultant, the building data must be recaptured (takes time and entails new costs for the building owner). The results are conditionally comparable since different boundary conditions underlie.
Greece	No. EPCs are based on technical building performance, calculated with the asset rating approach.
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. Especially for existing buildings, it includes on-site inspection, and individual energy and water use into the calculation. The recommendations are quite detailed (SEAI, 2019a, 2019b).
Italy	Information not found
Latvia	Yes. Usually EPC is viewed as an annex of energy audit (this has happened because mostly EPCs are issued only when building want to receive EU grant for building renovation and in this process a detailed energy audit of a building is needed).
Lithuania	No.
Luxembourg	No.
Poland	Yes. According to the new regulation the calculation of the energy audit can be done using EPC methodology.
Portugal	Information not found.



Linking EPCs and renovation recommendation to detailed energy audits	
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. (BPIE et al., 2017)
Slovakia	No. EPCs can be issued via an online form. An energy audit is an extensive evaluation e.g., (ARNEA, 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. The EPC is quite detailed. It includes on-site inspection, measured individual energy and water use and an assessment of indoor climate to determine the energy performance and suggest cost-effective renovation measures. However, a detailed energy audit may be needed in order to exactly design and calculate the profitability of the suggested measures and package the measures into a deep renovation plan.
UK	Information not found.

Table 32: Linking EPCs and renovation recommendation to detailed energy audits

7.2 Monitoring implementation of renovation recommendations given in the EPCs

Monitoring of the implementation of recommended actions for energy efficiency renovations given in the EPCs can be made easy if EPCs are linked with financial incentive/financing schemes, as in QualDeEPC partner countries Bulgaria, Greece, and Hungary. However, such linkages (see section 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 m² 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. Such linking and mandatory asset rating is available in few countries e.g. Bulgaria, Greece, Hungary and Latvia.



Linking EPCs to financial incentive schemes

- Asset rating EPCs are mandatory before and after renovation for financial incentive/financing schemes
- Asset rating EPCs are not mandatory
- Information unavailable
- QualDeEPC partner countries

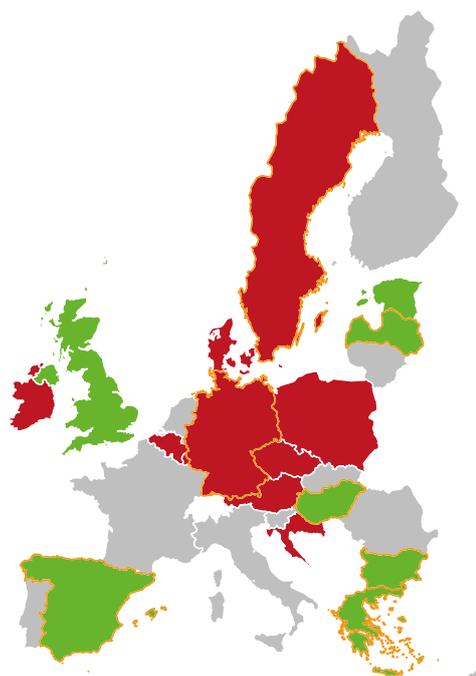


Figure 23: Linking EPCs to financial incentive schemes

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	As per a scheme for energy efficient upgrading of households' funds are provided based on the level of energy efficiency achieved, for example from at least class B of EPC to NZEB levels. However, the funds are linked to the investments made as per EPC recommendations and it is unclear whether an asset rating is required at all (Industry and Technology Service, Ministry of Energy, Trade and Industry, 2020).
Czech Republic	No.
Denmark	No. Subsidy programmes for renovation are available, however, not linked to EPCs.
Estonia	Yes. An Energy efficient upgrade of housing scheme 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 et al., 2016).
Germany	No. There are different boundary conditions for funding programs and EnEV calculations.
Greece	Yes. For the purposes of applying to the national incentive programme 'Energy Efficiency at Household buildings' an EPC needs to be issued before the implementation of the renovation measures as well as a second EPC needs to be issued and submitted after completion of renovation works.
Hungary	Yes.
Ireland	No.
Latvia	Yes. Usually, the length of mandatory monitoring period is 5 years.
Luxembourg	No.
Poland	No. Renovation of buildings with the use of the financial incentives requires an initial energy audit to propose measures and verify its economic feasibility. The EPCs do not have an impact on the renovation activities in Poland however the potential of using EPCs in financial support systems has been noticed (EPC instead of energy audit for single family houses).
Spain	Yes. For receiving grants PAREER includes a complementary financial support if the A or B class of the building is achieved.
Sweden	No. Not for the moment. Financing schemes are regularly changing but there have been some that links to the



Asset rating EPCs are mandatory before and after renovation for financial incentive/financing schemes

UK	<p>EPC.</p> <p>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.-c).</p>
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Table 33: Linking EPCs to financial incentive schemes

7.4 Creating Deep Renovation Network Platforms

A promising step towards deep renovation is 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).

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
-  One stop-shops are unavailable
-  Information not found
-  QualDeEPC partner countries

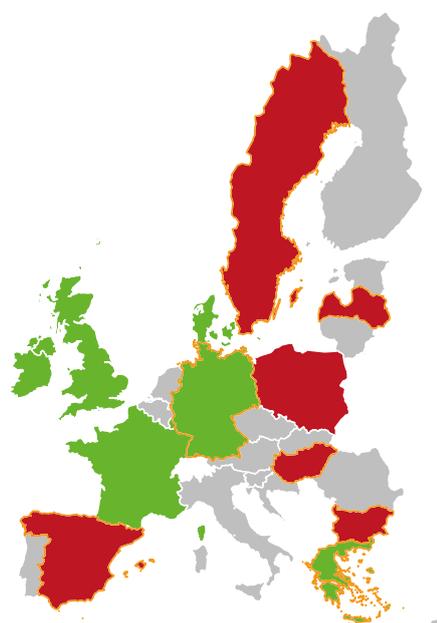


Figure 24: Deep Renovation Network Platforms offering either a one-stop-shop for implementation or for information at national level



Deep Renovation Network Platforms offering either a one-stop-shop for implementation or for information at national level	
Belgium	Deep renovation programs exist: BEreel, Renovatiepact: However, linkages to EPC are unclear, the programs go much further.
Bulgaria	No.
Denmark	Yes. Better Home 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 (Better Home, n.d.).
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 (Benigna Boza-Kiss, Paolo Bertoldi, 2018; île-de-France Energies, n.d.).
Germany	Yes. Not available at national level. However, there are a number of local information and coordination offices for information, advice, and coaching on deep renovation.
Greece	Yes. In the frame of the Request2Action project, CRES has developed a Hub that provides a wide range of information related to energy renovation solutions for buildings to building owners, trades people, investors, developers and policy makers.
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 (SEAI, 2017a).
Latvia	No.
Luxembourg	Yes. My energy 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 (myenergy, 2020).
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 handcrafts, database of energy efficient products (Energy Saving Trust, 2020).

Table 34: 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 analysed 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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10 ANNEX I

The current status of EPC processes and implementation across EU member states is summarized in five key sections, addressing the various potential EPC elements of an enhanced and converging EPC scheme, as shown below:

- Assessment and certification
- Requirements for qualified experts
- Independent control systems
- Use of EPC data, including in wider building-related databases
- How are EPCs embedded in wider policies and public activities to stimulate deep renovation?

The results of these five sections are summarized in the figures below.





Figure 26: Current status of requirements for qualified experts and independent control systems for EPCs in EU member states





Figure 27: Current status of assessment and certification of EPCs in EU member states

