Energy Performance of Buildings Directive (EPBD) Compliance Study

Specific Contract No. MOVE/ENER/SRD.1/2012-409-Lot3/ENER/C3/2014-542/S12.701648

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Acronyms

ADENE	Portuguese Energy Agency
BSC	Building Control Systems
CA EPBD	Concerted Action on the Energy Performance of Buildings Directive
CEBC	Consortium or European Building Control
COBRACE	Brussels Air, Climate and Energy Code
CPD	Continued professional development
DEA	Danish Energy Authority
DEC	Display energy certificate
DG ENER	European Commission's Directorate General for Energy
DIBt	German Institute for Building Technology
DIY	Do it yourself
EC	European Commission
EE	Energy experts (Belgium, Flanders)
EnEV	German Energy-Conservation Ordinance
EP	Energy performance
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificate
ESCO	Energy savings company
EU	European Union
EU-28	The 28 Member States of the European Union
FAQ	Frequently asked questions
ICS	Independent Control System
IEE	Intelligent Energy Europe
JESSICA	Joint European Support for Sustainable Investment in City Areas
kWh / TWh	Kilowatt-hour / Terawatt-hour
LED	Light emitting diode
m^2	Square meter
MEP	Minimum energy performance
MES	Missed energy savings
NEPI	Neural Energy Performance Index
NZEB	Nearly Zero Energy Building
OIB	Austrian Institute for Construction and Engineering
QA	Quality assurance
QE	Qualified expert
TSA	Estonian Technical Surveillance Authority
VEA	Flemish Energy Agency

Executive summary

ES1 Introduction

ES1.1 The scope and focus of the study

This study focused on analysing on-the-ground compliance with the current national regulatory frameworks across the EU-28 concerning the energy performance of buildings[1]. The scope of the study required a detailed analysis of these national frameworks and systems, put in place by Member States to help deliver and achieve compliance, specifically in relation to requirements of the Energy Performance of Buildings Directive (EPBD) concerning minimum energy performance (MEP) and energy performance certificates (EPCs). The study primarily focused on data pertaining to the year 2014. The study should therefore be considered as providing a 'snapshot' of compliance for 2014[2].

ES1.1.1 EPBD requirements within scope of this study

For the purposes of this study a reference number, from [A1] to [A3], was applied for each of the MEP requirements and also to each of the EPC requirements, from [B1] to [B6], set out in the Directive.

Application of EPC requirements for:
- new buildings [A1];
- existing buildings undergoing a major renovation [A2];
- retrofitted building elements [A3].

Application of EPC requirements:
- Production of EPCs for buildings or building units that are constructed, sold or rented out to a new tenant [B1];
- Production of EPCs for public buildings with a total useful floor area over 500m^2 (since 9 July 2015, 250m^2) that is occupied by a public authority and frequently visited by the public [B2];
- When a building or building unit is constructed, sold or rented out, the EPC is shown to the prospective new tenant or buyer [B3] and handed over to the buyer or new tenant [B4];
- Inclusion of EP indicator in advertising when a building is offered for sale or for rent [B5];
- Display of EPCs in large buildings frequently visited by the public [B6].

The aim of the study comprised two main elements. First, to attempt to measure **compliance at the national level** against this national legal basis, **seeking evidence of the application and enforcement of national legislation**; and second, to analyse the variability in compliance with national legislation across Member States, identifying, where possible, **reasons and factors driving different compliance rates, as well as good practices**.

The study did not seek to address the conformity of national laws with the European law, namely the EPBD. In other words, potential non-compliance of a specific country or region's national legislation with the EU Directive falls outside the scope of this study.

ES1.1.2 Understanding and interpreting the results of this study

For the benefit of readers unfamiliar with this subject, it is worth explaining briefly how 'compliance with national legislation' has been defined and assessed in this study. Where a specific country/region, for example, reported a 100% compliance rate with their national MEP requirements for existing buildings that undergo a major renovation, it would mean that it was **guaranteed that every single**

[1] The main consultation period for the study ended in September 2015.

[2] It is recognised that policy frameworks are continuously evolving in this area and in several countries the landscape changed during the timeframe of this study

refurbishment, which corresponded to the national definition for major renovation in this specific country/region, **was fully in line with the MEP requirements set by this country/region**.

The consequence of applying this strict interpretation was that 100% compliance is unlikely (except if all buildings are adequately controlled at appropriate points in time).

Furthermore, compliance can be affected in one of two ways:

- First, some refurbishments that corresponded to the national definition for major renovation may or may not have been identified as such and therefore compliance cannot be ascertained. In such cases, the compliance rate would be reported as “not applicable”.
- Second, some refurbishments identified as "major renovation" either did or did not fulfil national minimum standards. Additionally, if it happened that there was no national/regional legislation for major renovation, then, in practice, there was no compliance rate at all.

ES1.1.3 Definitions and interpretations

As part of the study’s approach to seeking explanations for the levels of compliance with the national legislation, it was necessary to drill down into the different systems and checking procedures which had been put in place in respective Member States. For the purposes of this study, a set of definitions were developed (and used consistently throughout the report) to describe the status of these systems. These definitions are set out in the **glossary** to this report.

For example, in the context of MEP requirements, the term “strength” is used to collectively describe an analysis of seven criteria which include the scope of the MEP requirements and the extent to which the enforcement and the financial and technical support systems are able to support compliance.

ES1.2 Study workflow

In order to overcome the difficulty in obtaining robust primary information on compliance with national legislation, a study approach was designed using multiple research pathways. These pathways included:

- collection of raw, reported information on levels of compliance from Member States;
- multi-criteria analysis of the "strength" of the various components in each country;
- adjusted MEP compliance rates based on “confidence” levels in country-specific monitoring and reporting methodologies.

In addition, four online questionnaires were used to gather the perspectives from secondary sources including national associations of tenants, building owners, and estate agents, as well as building control stakeholders. These secondary sources enabled gaps in the Member State responses to be filled, and in some cases, the triangulation of findings.

In addition, fieldwork data collection was undertaken in seven Member States. This field work did not set out to assess a statistically significant sample. In total 132 buildings were visited to gather insights into the current situation ‘on the ground’ regarding the requirement to display an EPC in large buildings frequently visited by the public. Interviews were also conducted with estate agents regarding the use of EPCs in the sales and letting transaction process.

ES2 Key findings

ES2.1 Key messages regarding compliance with minimum energy performance (MEP) requirements

ES2.1.1 Information capture and flow

There was a clear gradation in the ability of Member States to report compliance rates for the three main MEP requirements. Member States were more able to report rates for new buildings [A1] than they were for existing buildings [A2], and over three quarters of Member States were unable to report rates for retrofitted building elements [A3].

In general, information flows and data collection systems across Member States for MEP requirements were not fit for purpose and there were clear information deficiencies in many countries. These were not necessarily issues that had been acknowledged by the Member State, which may be satisfied working on the assumption that having the legislation in place automatically results in compliance. This problem greatly undermined the ability of many Member States to accurately and objectively report their levels of compliance with MEP requirements.

ES2.1.2 Reported and adjusted rates

A high proportion of Member States that were able to report MEP compliance rates for new buildings [A1] provided values at or around 100%, primarily based on an assumption that the compliance checking system was 100% effective.

Adjustments to reported MEP rates allowed for a more realistic picture of compliance to be established, based on a robust methodology that used information on key components of the compliance checking system to establish levels of confidence in the underpinning system. This procedure showed that, for those Member States reporting A1 rates, central case adjusted compliance rate mid-points ranged from 57% (Netherlands) to 97% (Lithuania)[3]. For most Member States, however, A1 rates remained well above 80%, even after adjustments.

For MEP requirements for major renovations [A2], Member States reported compliance rates that were generally slightly lower than those reported for new buildings. For seven Member States, rates of around 85% were reported, whilst other Member States reported lower rates of between 50% and 60%. Following triangulation of compliance data reported by secondary sources, the study team attributed a greater level of uncertainty to the A2 compliance rates for all Member States. Therefore, the adjusted A2 compliance rates ranged from 30% to 79%.

The MEP requirement with the lowest level of reported data points was for retrofitted building elements [A3]. After adjustment, the mid-point level of compliance ranged from 50% (Italy) to 93% (Belgium, Flanders).

ES2.1.3 Systems and support structures

Four core themes have been identified as potentially important factors in influencing levels of overall compliance: the mechanisms used for applying the MEP requirements; scope of MEP requirements; the penalty framework; and the support structures. Of these:

- the mechanisms for applying the MEP requirements (i.e. whether the MEP requirements are embedded within existing building control systems alongside issues such as health and safety, or whether they are implemented as stand-alone requirements) did not appear to directly and conclusively influence the rate of compliance;
- the scope of the requirements played an important role in framing overall compliance rates since all but one Member State had set requirements for new buildings and major renovations, while four had not yet established elemental requirements for non-major renovations;
- the imposition and enforcement of penalties appeared to significantly influence compliance rates and the study identified four prevailing typologies reflecting the way they have been applied in practice; and,
- levels of compliance with MEP requirements were more likely to be achieved where financial and technical support systems are in place. Such systems are particularly important in Member States where energy performance regulations have relatively recently been introduced and the industry and compliance bodies are still building capacity.

[3] A multi-criteria analysis of the monitoring, control and quality assurance systems in each Member State enabled a “confidence” score to be established which represented the confidence of the compliance rates reported. This was subsequently used to generate adjusted compliance rates which form the lower-bound to the compliance rate ranges.

Encouragingly, over 50% of Member State MEP regimes were classified as either high or very high "strength". Various good practices are also in evidence which can help to illustrate approaches to others. Examples include: the production of detailed practical technical guidance for the construction industry in the UK; providing clear signals to industry on future energy performance requirements in Denmark; and systems for ensuring skilled qualified experts in Belgium, Flanders.

Six scenarios have been developed by ICF to reflect the different configurations of monitoring, control and quality assurance components applied by Member States. These helped to explain some of the differences in reported levels of compliance with MEP requirements and can be used as a framework to help structure future knowledge sharing in this area.

ES2.2 Key messages regarding compliance with energy performance certificate (EPC) requirements

ES2.2.1 Reported rates

Production of EPCs [B1] - Compliance rates reported for sales [B1.ii] (which average 88%) were generally higher than those reported for rentals [B1.iii] (which average 73%). In addition, few Member State representatives (6) were able to report on EPC production compliance in the rental market [B1.iii]. This suggests that EPC production in the rental market is less well monitored and controlled than in the new construction [B1.i] and building sales sectors. The legal systems for checking compliance with the use and issue of EPCs in sales and new construction do not exist for a large proportion of tenancy agreements in most Member States.

Inclusion of EP / EPC indicator in advertisements in commercial media [B5] - only nine Member State representatives reported compliance rates although, taking into account other secondary stakeholder sources, data were available for 19 Member States. Compliance levels reported by Member States varied significantly, from 13% (Estonia) to 100% (Austria). Consistency amongst stakeholders from the same Member State was generally observed; responses from secondary stakeholders validated the values reported by the Member State representative in most cases. Belgium, Sweden and Portugal demonstrated most variance between stakeholders, suggesting that compliance practices varied across the country and in different markets (sales/rentals) and that further data collection is required.

Showing [B3] and handing over [B4] of a valid EPC to new tenants / buyers – although data from secondary sources was available for 20 Member States, very few Member States representatives reported compliance rates. A high range of reported compliance was observed, with under 10% (Poland) to over 80% for a group of around ten Member States. Those Member State representatives that did report compliance tended to report 100% compliance. In general, there was less agreement among different stakeholders from the same Member State than for other EPC requirements. Tenant associations in many Member States reported compliance rates of only around 30%. Typically these were significantly lower than the rates reported by other stakeholders.

Production [B2] and display [B6] of EPC in large buildings frequently visited by the public – only eight Member States were able to report compliance rates for requirement B6 and these ranged from 45% (Cyprus) up to 100% (Austria, Malta, Slovakia). Insights into compliance for this requirement were also gathered by the study team through fieldwork assessments in seven Member States. In total, across the seven Member States visited, around a quarter of buildings assessed had an EPC on display suggesting that compliance checking systems for this requirement were under development.

ES2.2.2 EPC regimes and influencing factors

The study identified the following four elements of the EPC regimes that appear to have influenced the compliance levels: the qualified experts' licence to operate; software and database systems in place; prevailing penalty frameworks; and the compliance checking system and characteristics of the independent control system (ICS).

A variety of requirements have been introduced by Member States to ensure an appropriate level of qualification of Qualified Experts (QEs) who produce and issue EPCs. These range from requiring

certain minimum qualifications, voluntary or mandatory training, exams and maintaining up-to-date knowledge through continued professional development (CPD) systems.

Software tools have also been developed in all Member States to support QEs in producing and issuing EPCs. In most countries, efforts to ensure a uniform and reliable interpretation and implementation of the calculation procedure is supported by a software accreditation process. However, such a system has not yet been implemented in around ten Member States, resulting in different software packages being available.

Finally, the introduction of an effective enforcement system is an essential part of the EPC quality assurance process. A penalty system is prescribed by national legislation in almost all countries. While most countries have imposed penalties in the form of warnings, fines and (temporary/permanent) suspension, five countries have not yet applied any enforcement actions at all, while in the Czech Republic, penalties have only recently started to be imposed.

ES2.2.3 Compliance checking systems

It was found that there were a myriad of compliance checking systems throughout Member States, covering different requirements and incorporating different selection methods for assessment (for example targeted vs. random selection).

For newly constructed and renovated buildings, it was found that, in half of the Member States, the EPC production process was linked to the controls in place to establish whether a building meets the minimum requirements for energy performance.

In most Member States the obligation to have an EPC produced when a building or building unit is sold or rented out to a new tenant had been introduced in the national legislation. However, only a fraction of Member States had established a robust control mechanism to ensure that EPCs were actually in place when buildings are sold or rented. In these countries, EPC production and validity was checked mainly by notaries during the sale transaction. Nevertheless, checks performed by notaries have proven to be strong control systems during sales transactions. For rentals, however, the transaction was reported to be often concluded informally, particularly in the residential sector, and so bypassing official controls. As such, the notary approach was less effective for the rental sector where systems for checking on compliance with the use and issue of EPCs were less well developed.

Information availability was significantly lower with regards to compliance with the requirement to share / present EPCs during the sale and rental marketing process. This may indicate that in most countries, the compliance checking system failed to monitor and enforce requirements on real estate actors (agencies, owners and other stakeholders) or that there was simply no mechanism in place to collect compliance information.

Member States had followed different approaches to the application of the display EPC requirements. For those that closely followed the text of the Directive, checking compliance was proving very challenging in terms of determining which buildings should fall under the requirement. A simplified interpretation in some Member States has allowed an approach to be taken that facilitates easy compliance checking, for example in Ireland and Greece.

ES2.2.4 Independent control systems

The research revealed that independent control systems have been implemented in the majority of Member States. In 12 countries these controls involved all types of control options (i.e. those control system options specified in Annex II of the EPBD which focused on assessing input data, recommendations and on-site visits). In nine others only the first two options (A and B)[4] were applied.

[4] As per Annex II of the EPBD, option (A) describes a validity check of the input data of the building used to issue the energy performance certificate and the results stated in the certificate; while option (B) describes a check of the input data and verification of the results of the energy performance certificate, including the

recommendations made;

No responses to requests for information on the independent control systems were received from five Member States.

ES2.3 Estimates of missed energy savings

The study has used the findings of research and consultations with Member States regarding levels of compliance with national legislation to generate **estimates of the missed energy savings** associated with any non-compliance that was identified.

The missed energy savings relate to non-compliance with the three MEP requirements; for new buildings, existing buildings undergoing major renovation, and for retrofitted building elements. The estimate does not encompass any missed energy savings that may occur as a result of non-compliance with any of the EPC requirements covered by this study. Similarly, it does not assess any missed energy savings stemming from national transposition measures that result in incomplete or a not fully conformant transposition of the legal requirements in the EPBD as these were not covered by this study.

The basis for the missed energy savings calculations was an analysis of five building types, covering residential and non-residential buildings, in seven Member States. These Member States were selected on the basis of a set of criteria which included population, availability of compliance rates, geography and regional vs national approaches.

By looking at the energy demand under three performance scenarios and the stock of buildings required to comply, estimates of missed energy savings were calculated for the reference year 2014. A framework to estimate missed energy savings for the entire EU-28 was developed using floor area and indicators of energy efficiency potential as differentials.

The missed energy savings are presented in absolute terms and relative to the energy savings that would have been achieved had a 100% compliance rate been observed.

For the avoidance of doubt, these missed energy savings, are in addition to any potential missed energy savings which may have resulted from the incorrect transposition of the EPBD into Member State legislation. This study has not sought to quantify the latter savings, where these may have occurred.

The missed energy savings have been established against a combined baseline scenario. Under this scenario, for all Member States where national requirements go beyond the cost-optimal levels, the national requirements are used. For all other Member States, the cost-optimal level has been used as a baseline. Under this scenario, the missed energy savings for the EU-28 for the year 2014 have been estimated to be in the region of **6.8 TWh (±4.0TWh)**[5][6]. The high uncertainty around this estimate (±4.0 TWh) is a reflection of the compliance rate ranges.

The total potential energy savings (i.e. the energy savings that would have been achieved if a 100% compliance rate had been achieved universally) were estimated to be 16.5TWh. As such, **overall, the annual energy saving achieved so far by Member States under the scenario described above is approximately 42% lower than it would have been if there had been 100% compliance with the MEP requirements.**

ES2.4 Recommendations

At present the Directive does not require Member States to monitor and report on compliance rates. Given that there is a very poor quality and quantity of data available with regards to actual compliance, introducing such a reporting requirement would push Member States to review their current

[5] Note that the estimate of missed energy savings only related to non-compliance with the MEP requirements and not to any of the EPC requirements. The missed energy savings are only linked to the application of national legislation and not to proper EU transposition. Also, this value only relates to 'Scenario 3', which represents the best requirement between national and cost-optimal.

[6] By way of comparison, 6.8 TWh equates the average annual production of 1000 x 2GW wind turbines, running at 30% load factor, or alternatively half a 2GW gas turbine station running at 70% load factor.

procedures. However, it is recognised that introducing a report requirement introduces a set of challenges around consistency of reporting and data collection methodologies, as well as considerations of administrative burden on Member States. The primary purpose of introducing such a requirement would be to enable the Member States to refine and prioritise their supporting activities and policies to achieve the most feasible and practicable routes to improving building energy performance. As such, firstly, opportunities should be explored to encourage better data collection and reporting. The focus should be on the most important requirements in terms of those that are currently resulting in the highest level of missed savings opportunities.

ES2.4.1 Recommendations related to MEP requirements

Recommendation 1: It would be valuable to provide additional guidance to Member States on how to derive compliance rates in a robust and consistent way. This guidance could be built around case studies of good and poor practice, together with the implications of both failures and successes in this area. Having accurate data and feedback on compliance will enable the Member States to adapt their implementation/enforcement strategies, as well as their broader national climate and energy policies, based on what is actually happening on the ground.

Recommendation 2: A lack of transparency of future policy direction has negatively affected the construction sector, which, still remains largely reactive; not planning for future increased energy performance requirements. In light of evidence that Member States with clarity around future evolution of requirements show higher compliance rates, Member States should continue to be encouraged to set out clear pathways to achieving near zero energy buildings. This should then cascade into positive signalling to national building supply chains.

Recommendation 3: Continued support for upskilling of the construction sector workforce, and general education and awareness around energy performance within the building sector should be pursued to increase compliance levels. This should be extended to building commissioners, managers and users as well as for enforcement authorities. Calls within Horizon 2020 could be used for this purpose, for example through capacity building.

Recommendation 4: This study has not investigated the detail of individual regional application for those Member States adopting such an approach. Further exploration could provide valuable insights into regional variation of compliance rates and the underpinning reasons for such outcomes.

Recommendation 5: It is acknowledged that compliance rates are being significantly affected by the nature of compliance checking and enforcement activities, particularly in relation to the use of penalties and sanctions. Supporting information on the types of schemes operating, and examples of good practice, should be distributed amongst Member States to encourage those not currently utilising these powers of enforcement.

Recommendation 6: The majority of Member States reported that financial support needs to be provided to encourage the uptake of measures to support further energy efficiency improvements within the built environment. It is recommended that this therefore be continued wherever possible.

Recommendation 7: It is recommended that further work be carried out to establish a correlation between compliance achievement and stringency or ambition of minimum energy performance requirements. This will be particularly useful in forecasting the likely achievement levels that can be anticipated as the EU moves towards near zero energy buildings.

ES2.4.2 Recommendations related to EPC requirements

Recommendation 8: A lack of clarity and specificity in the Directive has led Member States to follow different approaches to the application of the display EPC requirements. For those that closely followed the text of the Directive, checking compliance is proving very challenging in terms of determining which buildings should fall under the requirement. The simplified approach taken by Ireland and Greece appears to facilitate compliance checking, and should be researched further to establish if more specific direction could be extended to other Member States.

Recommendation 9: In addition, systems to monitor and enforce the requirement to display EPCs in public buildings and large buildings often visited by the public was found to be very limited across the EU. Further consultation with Member States would be useful to fully establish what the barriers are.

Recommendation 10: The study found that in many cases more emphasis and value is placed on an EPC with building owners than tenants, although this is not universal and it depends on the specific characteristics of the property market at particular points in time. It is also acknowledged that the rental market can be informal, and is not therefore a not always as well managed or monitored in comparison with the construction and sales of property. As a result the legal systems used for achieving and checking on compliance with the use and issue of EPCs in sales do not exist for a large proportion of tenancy agreements in most Member States. The EC should review the legislative requirements within this sector to ensure that it is practicable and will deliver meaningful results and changes.

Recommendation 11: There was also widespread evidence to suggest that the EPC was still not a primary tool in the decision making process due to:

- A lack of understanding and appreciation of the value of the EPC and what information it can provide over long term commitments;
- Concern with regards to its accuracy and overall relationship with actual usage, and
- The upfront cost to the building owner of getting an EPC produced, particularly during economically challenging periods as there is no guarantee that a building put up for sale or lease will result in a successful transaction.

The EC may wish to consider working further with Estate Agent, Building and Tenant Associations to assess the opportunities for increasing the value of EPCs for tenants and building owners in the sales and letting process.

Recommendation 12: Efforts to strengthen and harmonize EPC calculation methodologies and software should continue. Best practice can also be drawn from outside the EU where similar approaches to building certificate and software are in place.

Examples of Good Practice that should be replicated:

- In Denmark Building Class 2020 prepares Danish industry for future requirements almost 10 years in advance of when they will be enforced. This allows Danish industry to adapt their products to new standards. That is one of the reasons why new very energy-efficient components are mainstream today on the market
- In the UK, the Zero Carbon Hub (UK) has produced the “Builders Book” which illustrates detailed technical and practical solutions to help overcome those construction challenges which have a significant impact on building energy performance
- The introduction of a central exam for qualified experts in Flanders (known as Energy Experts) in 2013 reduced the overall number of Energy Experts, but had a positive impact on the general level of competence. The Flemish Energy Agency (VEA) is hoping for the same result with reporters (“verslaggevers”) who have also had to take a central exam since 2015. Investing in the continuous training of such experts is seen as a way of improving compliance, by building both the quality of EPCs produced and the confidence of stakeholders in the final EPC product.
- In Hungary, ensuring that an EPC is available in rentals transactions has been addressed by introducing a requirement for a have a lawyer to sign-off any rental agreement. This lawyer is then responsible for ensuring there is an EPC number associated with that contract. Lawyers, as well as building owners and tenants, who fail to comply with this requirement are subject to sanctions.
- In Hungary, a new EPC collection form has allowed public authorities to gather opinions of the controllers. All experts are asked to write a one page expert opinion in each control period. Several recommendations have already been forwarded to the responsible Ministry of Interior, including advice on improving domestic legislation.
- In the Brussels Capital Region, over one hundred real estate agencies have been checked by authorities at random between September 2013 and September 2014 to confirm the existence of energy performance indicators in material on display in the agency or on internet sites. At the end of 2014, the first administrative fine was issued and others are expected. In the future, targeted

controls will be undertaken focusing on agencies that have repeatedly been reported as not compliant. Similarly, in Portugal a fine system was established to penalise real estate agencies who do not advertising properties' energy performance. As a consequence, in 2014, the number of EPCs issued for existing buildings nearly tripled.

1 Introduction

This is the Final Report for the EPBD Compliance Study. The study was undertaken through Specific Contract No. MOVE/ENER/SRD.1/2012-409-lot3/ENER/C3/2014-542/SI2.701648. The call for tender was issued by Directorate-General for Energy (DG Energy) in the context of the Framework Contract (No. SRD MOVE/ENER/SRD1./2012-409-lot3 ICF) between ICF Consulting Ltd and DG Energy.

In the context of EU climate change and energy security challenges, improving energy efficiency in buildings is critical. The European Commission's Energy Union package, launched in February 2015, sets out a series of objectives and detailed actions related to improving the integration of the EU energy system and strengthening EU energy security, whilst retaining open energy markets with the EU 'neighbourhood'[7]. The package reiterated the key role of energy efficiency in achieving these objectives; it also built on the Commission's ambitious 2030 Framework for Climate and Energy Policies ("2030 Framework") which was agreed in 2014[8].

The building sector is responsible for around 40% of EU energy consumption and 36% of total CO_2 emissions[9]. The Energy Performance of Buildings Directive (EPBD), recast in 2010[10], is considered the main EU policy instrument for driving energy efficiency in the built environment.

The EPBD-recast (from now on referred to simply as the EPBD), requires Member States to ensure compliance with obligations enacted in their domestic legislation, including for the:

- energy performance certification of buildings;
- inspection of heating and air-conditioning systems;
- energy performance requirements set for
  - new buildings;
  - existing buildings that undergo a major renovation; and,
  - replaced or retrofitted building elements in existing buildings (both elements being part of the envelope and technical building systems).

Compliance is recognised as being of critical importance to ensure that the full energy efficiency and carbon savings potential of buildings are achieved; Member States are required to establish independent control systems for energy performance certificates (EPCs) and inspection of heating and air-conditioning systems to facilitate and demonstrate compliance.

Despite both the length of time in which the EPBD has been in force, and a number of EC-funded initiatives which have mapped how compliance is being tackled in various Member States, very little information on actual compliance rates has been collected and made available and the practical application of the EPBD's requirements 'on the ground' is not well understood. This has limited the ability of policy makers to fully assess the success of the EPBD across the EU-28.

The key aim of this study was for DG Energy to establish rates of compliance with the requirements of the EPBD and build a greater understanding of the extent to which different regulatory mechanisms for enforcement have driven compliance rates. This therefore

[7] European Commission (2015) *A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy*, COM/2015/080 final. Available from: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2015:80:FIN

[8] A policy framework for climate and energy in the period from 2020 to 2030. Brussels, 22.1.2014 COM(2014) 15 final

[9] European Commission (2008) *Communication from the Commission of 13 November 2008 - Energy efficiency: delivering the 20% target,* COM(2008) 772.

[10] Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0013:0035:EN:PDF. The original Directive, can be found here: Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:001:0065:0071:EN:PDF

involved establishing the extent to which the legal implementation of those requirements has been translated into actual application on the ground.

This information is a vital component of a broader review of the ongoing implementation and any future adaptation of the EPBD.

Throughout this study, when engaging with stakeholders, the term 'fulfilment' has frequently been used in place of 'compliance'. The change in emphasis reflected the fact that this study was not a compliance checking exercise in itself, but a way of building understanding about compliance checking systems to improve the implementation of the Directive across all Member States. The term 'compliance' often has negative connotations amongst certain stakeholders and it was felt that replacing this term with 'fulfilment' could increase the likelihood of obtaining higher response rates to the various consultation activities undertaken by ICF. However, in this report, the term compliance is used.

1.1 Study objectives

The primary objective of this study, was to address knowledge gaps around application of the EPBD across the EU-28. Specifically, this study aimed to provide the following:

- **Compliance rates:** understand compliance rates with minimum energy performance (MEP) requirements and various aspects of implementation of energy performance certificates (EPCs) (i.e. issue, quality and display). These are set out in Table 1.1. For the purposes of this study a reference number (from A1 to A3) was applied for each of the MEP requirements and also to each of the EPC requirements (B1 to B6). Reference is made to these throughout the report.
- **Compliance checking practices and Independent Control Systems (ICS):** build an understanding of the compliance checking systems and the ICS (for EPCs) and examine the influence of these systems and other framework conditions on observed levels of compliance. Provide recommendations to improve these compliance checking practices and independent control systems.
- **Estimates of missed energy savings:** provide an estimate of missed energy savings based on non-compliance with MEP requirements across the EU-28.

Table 1.1 Overview of the components of the EPBD within the scope of the study

Ref.	Article	Requirement under the EPBD
A1	Art. 6, para 1	**Application of minimum energy performance standards for new buildings:** New buildings must meet the MEP requirements set by the Member State.
A2	Art 7	**Application of minimum energy performance standards for existing buildings:** When a building undergoes major renovation[11], it must meet the MEP requirements set by the Member State.
A3	Art. 7.3, Art. 8	**Application of minimum energy performance standards for retrofitted building elements:** When a building element, that forms part of the building envelope or and has a significant impact on the energy performance of the building, is retrofitted or replaced, the building element must meet the MEP requirements set by the Member State – as far as this is technically functionally and economically feasible.
B1	Art. 12 (1)a	**Production of EPCs:** An EPC must be issued for buildings or building units that are constructed, sold or rented out to a new tenant.
B2	Art. 12 (1)b	**Production of EPCs – public buildings:** An EPC must be issued for buildings with a total useful floor area over 500m^2 (since 9 July 2015, 250m^2) that is occupied by a

[11] In accordance with the EPBD, Member States should be able to choose to define a 'major renovation' either in terms of a percentage of the surface of the building envelope or in terms of the value of the building, whereby the total cost of the renovation relating to the building envelope or the technical building systems is higher than 25% of the value of the building, excluding the value of the land upon which the building is situated; or more than 25% of the surface of the building envelope undergoes renovation.

Ref.	Article	Requirement under the EPBD
		public authority and frequently visited by the public.[12]
B3	Art. 12(2)	**Sharing and handover of EPCs:** When a building or building unit is constructed, sold or rented out, the EPC (or copy thereof) is shown to the prospective new tenant or buyer and handed over to the buyer or new tenant.
B4		
B5	Art. 12(4)	**Inclusion of EP indicator in advertising:** When a building with an EPC is offered for sale or for rent, the energy performance indicator or the EPC is stated in the advertisements in commercial media. (This also applies to a building unit in a building with an EPC, or a building unit with an EPC)
B6	Art. 13	**Display of EPCs in large buildings frequently visited by the public:** If buildings covered by Art. 12(1) the EPC must be displayed in a prominent place clearly visible to the public. This applies to buildings with a useful floor area >500m^2 occupied by a public authority and frequently visited by the public and any other building over this threshold frequently visited by the public.

1.2 Structure of this report

The report is structured as follows:

- Section 2 sets out the methodology used for the study.
- Section 3 presents the analysis of the different approaches taken by Member States regarding the application 'on the ground' of MEP requirements. These are presented alongside the associated levels of compliance reported.
- Section 4 focuses on the requirements around EPCs. It sets out the compliance rates reported and describes the different ways in which Member States have applied these requirements 'on the ground'.
- Section 5 reports on the framework conditions that influence compliance rates for MEP and EPC requirements.

A set of Member State annexes provide detail of the approaches and compliance rates for each Member State. Additional annexes provide further methodological detail and data tables.

[12] The main data collection period for this study ran from March to August 2015. As such, the primary focus was to assess the level of compliance with the 500m^2 threshold.

2 Methodology

The study employed a mixed-methods approach to data collection and analysis for the three key components of this study:

- establishing compliance rates;
- interpreting the compliance rates based on an understanding of the compliance checking systems, independent control systems and other framework conditions; and,
- establishing estimates of the missed energy savings associated with any non-compliance identified.

Figure 2.1 shows how the study is built around a data collection strategy (blue cells) containing six key elements.

The focus of the data collection was a direct consultation exercise with relevant stakeholders within the 28 EU Member States. The purpose of this was to collect information on the levels of compliance for each of the EPBD requirements. In addition, this consultation sought to build on information gathered from the literature on the approaches taken by Member States in the application of the MEP and EPC requirements as well as the characteristics of the compliance checking practices. In total, for 22 Member States a questionnaire response was received. A series of interviews and follow-up email exchanges and discussions were also conducted with representatives from 22 Member States.

Four online questionnaires were used to gather the perspectives from secondary sources including national associations of tenants, building owners, and estate agents, as well as building control stakeholders. These secondary sources enabled gaps in the Member State responses to be filled, and in some cases, the triangulation of findings from multiple sources.

In addition, fieldwork data collection was undertaken in seven Member States[13]. This field work did not seek to establish statistically significant findings. In total, 132 buildings were visited to gather insights into what was happening 'on the ground' regarding the requirement to display an EPC in large buildings frequently visited by the public. Interviews were also conducted with estate agents regarding the use of EPCs in the sales and letting transaction process.

The qualitative and quantitative data gathered fed into four main analytical steps (green cells). These encompass an integrated assessment of the reported compliance rates and the findings from a multi-criteria analysis of the MEP and EPC regimes in each Member State.

A second multi-criteria analysis was undertaken of country-specific monitoring and reporting methodologies in place. This incorporated the compliance checking and quality assurance infrastructure (including the prevailing independent control system) and was used to determine the level of "confidence" in the compliance rates reported. The MEP compliance rates reported by Member States were then adjusted based on the "confidence" levels derived.

This analysis fed into an estimation of the missed energy savings resulting from non-compliance with the MEP requirements. These missed energy savings were developed as ranges in order to reflect the differing levels of uncertainty related to the compliance rates reported.

[13] Belgium (Flanders), Greece, Ireland, Poland, Spain, Sweden, UK

Figure 2.1 Overview of data collection and analysis

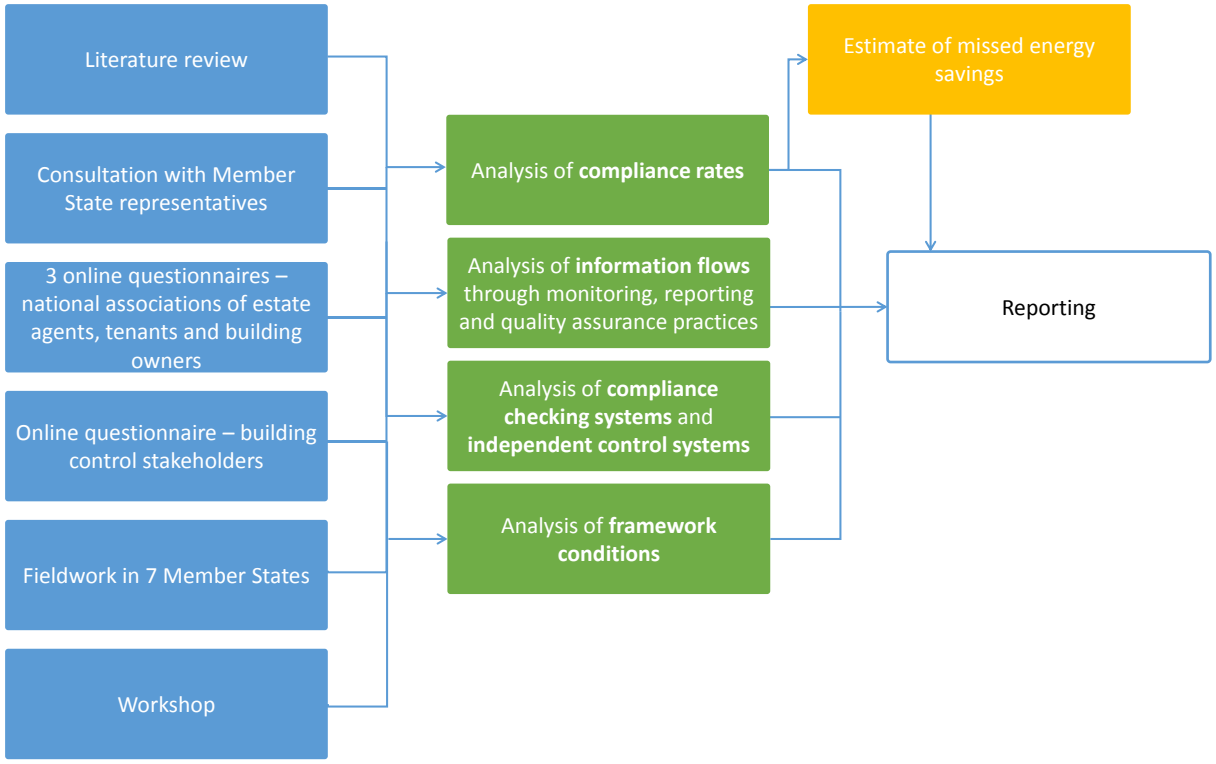


Table 2.1 sets out the components of the EPBD for which compliance rates were needed. This provides a clear definition of non-compliance and a proposed indicator of compliance for each of the relevant components of the EPBD being examined in this study. The aim of developing this framework was to ensure a common understanding across all stakeholders and to facilitate more accurate consultation responses. Table 2.1 also indicates how different data collection activities were utilised to contribute to the overall understanding of compliance.

Table 2.1 Description of non-compliance and the indicator of non-compliance for each of the compliance rates

Ref.	Article	Requirement under the EPBD	Definition of non-compliance	Indicator of compliance rate	Data collection activities					
					Lit. review	Member State consult	Survey: Agent, Tenant, Owner	Survey: Build. Cont.	Field -work	Work-shop
A1	Art. 6, para 1	**Application of minimum energy performance standards for new buildings:** New buildings must meet the MEP requirements set by the Member State	A new building constructed that does not comply with the energy performance technical requirements set by the Member State.[14]	Percentage of new buildings in a given year that, when completed, comply with the energy performance technical requirements set by the Member State.	✓	✓		✓		✓
A2	Art 7	**Application of minimum energy performance standards for existing buildings:** When building undergoes major renovation, it must meet the MEP requirements set by the Member State	A renovated building that does not comply with the energy performance technical requirements set by the Member State	Percentage of renovated buildings in a given year that comply with the energy performance technical requirements set by the Member State.	✓	✓		✓		✓
A3	Art. 7.3, Art. 8	**Application of minimum energy performance standards for retrofitted building elements:** When a building element, that forms part of the building envelope or and has a significant impact on the energy performance of the building, is retrofitted or replaced, the building element must meet the MEP	A building element, that forms part of the building envelope or and has a significant impact on the energy performance of the building, is used which does not meet the MEP requirements set by the Member State.	Percentage of instances where the retrofitting of a building element is compliant with the MEP requirements of the Member State.	✓	✓		✓		✓

[14] Note, for the MEP requirements, approval by appropriate authority may occur at different stages in different Member States. For example, Compliance checking and 'approval' may occur at one or more of the following stages: pre-build stage; during the build; and/or in the 'as-built' stage. The methodology applied by the Member State when establishing the compliance rate will therefore influence the compliance rate.

Ref.	Article	Requirement under the EPBD	Definition of non-compliance	Indicator of compliance rate	Data collection activities					
					Lit. review	Member State consult	Survey: Agent, Tenant, Owner	Survey: Build. Cont.	Field -work	Work-shop
		requirements set by the Member State – as far as this is technically functionally and economically feasible.								
B1	Art. 12 (1)a	**Production of EPCs:** An EPC must be issued for buildings or building units that are constructed, sold or rented out to a new tenant.	A valid EPC does not exist for a building or building unit that is constructed, sold or rented out to a new tenant.	Percentage of buildings or building units that, when constructed, sold or rented out to a new tenant hold a valid EPC.	✓	✓	✓			✓
B2	Art. 12 (1)b	**Production of EPCs – public buildings:** An EPC must be issued for buildings with a total useful floor area over 500m^2 that is occupied by a public authority and frequently visited by the public.	A valid EPC does not exist for buildings with a total useful floor area over 500m^2 that is occupied by a public authority and frequently visited by the public.	Percentage of buildings with a total useful floor area over 500m^2 (occupied by a public authority and frequently visited by the public) for which a valid EPC exists.	✓	✓			✓	✓
B3	Art. 12(2)	**Sharing and handover of EPCs:** When a building or building unit is constructed, sold or rented out, the EPC (or copy thereof) is shown to the prospective new tenant or buyer and handed over to the buyer or new tenant.	When a building or building unit is constructed, sold or rented out… No valid EPC is shown to the prospective new tenant or buyer.	Percentage of transactions (sales or rentals) for which a valid EPC is shown to the prospective new tenant or buyer.	✓	✓	✓		✓	✓
B4			When a building or building unit is constructed, sold or rented out… No valid EPC is handed over to the buyer or new tenant.	Percentage of transactions (sales or rentals) for which a valid EPC is handed over to the new tenant or buyer.	✓	✓	✓		✓	✓
B5	Art. 12(4)	**Inclusion of EP indicator in advertising:** When a building	When a building with an EPC is offered for sale or for rent,	Percentage of buildings advertised for sale / rental with	✓	✓	✓		✓	✓

Ref.	Article	Requirement under the EPBD	Definition of non-compliance	Indicator of compliance rate	Data collection activities					
					Lit. review	Member State consult	Survey: Agent, Tenant, Owner	Survey: Build. Cont.	Field -work	Work-shop
		with an EPC is offered for sale or for rent, the energy performance indicator or the EPC is stated in the advertisements in commercial media. (This also applies to a building unit in a building with an EPC, or a building unit with an EPC)	the energy performance indicator or the EPC is <u>not</u> stated in the advertisements in commercial media. (This also applies to a building unit in a building with an EPC, or a building unit with an EPC)	energy performance indicator or EPC stated in advertisements in commercial media.						
B6	Art. 13	**Display of EPCs in large buildings frequently visited by the public:** If buildings covered by Art. 12(1) the EPC must be displayed in a prominent place clearly visible to the public. This applies to buildings with a useful floor area >500m^2 occupied by a public authority and frequently visited by the public and any other building over this threshold frequently visited by the public.	For buildings with a total useful floor area over 500m^2 that is occupied by a public authority and frequently visited <u>no EPC</u> is visible to the public.	Percentage of buildings with a total useful floor area over 500m^2 that is occupied by a public authority and frequently visited by the public for which an EPC is visible to the public.	✓	✓			✓	✓
			For buildings with a total useful floor area over 500m^2 frequently visited by the public, <u>no EPC</u> is visible to the public.	Percentage of buildings with a total useful floor area over 500m^2 frequently visited by the public for which an EPC is visible to the public.	✓	✓			✓	✓

Table 2.2 presents the response rates obtained from the data collection activities set out in Table 2.1 above. Note the table includes a total of 30 Member States/regions as each of the three regions of Belgium has been treated separately. The term Member State is used to refer to all Member States and regions surveyed. In Table 2.2, data sources are divided between the interviews with the Member States representatives (referred to below as simply "Member States") and secondary sources. These secondary sources include real estate and tenant association responses to the online questionnaires and the information gathered by the study team via field visits and literature review. Each tick on Table 2.2 represents one independent source of information from which a compliance rate has been drawn. Black ticks represent information reported by interviewees and respondents, whereas blue ticks represent compliance rates derived by ICF from different sources – this refers to the field visits and literature review. Most of the secondary data is derived from the online questionnaires.

Member States are listed in rank order, based on the number of compliance rate data points obtained for each of them. In this arrangement, information provided by Member States representatives was given a greater weight than information provided by secondary sources. Austria and the Netherlands were the Member States for which the study team was able to collect the greatest amount of information. In these two countries it was possible to cover ten out of the eleven requirements encompassed by this analysis.

For three Member States - Bulgaria, Luxembourg and Latvia - it was not possible to obtain any compliance rate information. For Croatia, it was only possible to obtain a compliance rate relating to the EPC production for new buildings, estimated by the study team based on the literature review. A group of Member States (e.g. Portugal, Ireland, and Poland) were unable to report compliance rates although secondary sources were able to estimate several rates.

Table 2.3 shows the response rates per EPBD requirement. Overall, the average response rate of Member State representatives regarding MEP requirements was higher (43%) than that regarding EPC requirements (33%). Nevertheless, as shown in section 3.2 many Member States have reported 100% compliance rates for MEP requirements, based wholly on assumptions.[15]

Approximately two thirds (67%, nr=20[16]) of Member State representatives were able to report compliance rates for MEP requirements for new buildings, whereas only 37%, (nr=11) have reported MEP compliance rates for existing buildings. In the case of retrofitted/renovated building elements, most Member States (73%, nr=22) were not able to provide the compliance rate with the relevant MEP requirement suggesting that compliance checking and reporting systems for this requirement are much less developed.

With regard to the EPC requirements, 60% (nr=18) of Member State representatives were able to report the compliance rates for at least one of the EPC production requirements (for constructed, sold and rented buildings, or for public buildings). Among the other stakeholders (secondary sources), the highest response rates were in relation to the use of an EPC in building marketing materials and the EPC hand over to prospective buyers and tenants. The lowest response rate was in relation to the production of EPCs for sold buildings. Information regarding EPC production for public buildings was drawn only from the questionnaires and interviews performed with the Member State representatives. This is the requirement with the lowest level of available information.

[15] Such assumptions taken by Member States are factored into the analysis of reported compliance rates

[16] "nr" indicates the number of responses; in this case, the number of Member States

Table 2.2 Summary of responses per requirement – Member States and other secondary sources

EPBD Requirements	Application of MEP requirements						Production of EPCs								Use of EPCs								Total responses
	A1		A2		A3		B1.i		B1.ii		B1.iii		B2		B3		B4		B5		B6		
	New buildings		Renovated existing buildings		Retrofitted building elements		Constructed buildings/ units		Sold building/units		Rented buildings /units		Public buildings		Is an EPC shown to prospective tenant/ buyer?		Is an EPC handed over to prospective tenant/ buyer?		Buildings with EP or EPC stated in adverts		Display of EPCs in public buildings		
Source of information	Member States	Secondary sources	Member States	Secondary sources	Member States	Secondary sources	Member States	Secondary sources*	Member States	Secondary sources	Member States	Secondary sources	Member States	Secondary sources*	Member States	Secondary sources	Member States	Secondary sources**	Member States	Secondary sources**	Member States	Secondary sources*	
Netherlands	✓	✓✓		✓✓		✓✓	✓		✓	✓	✓	✓✓				✓✓✓	✓	✓✓✓	✓	✓✓✓	✓		25
Austria	✓		✓				✓			✓✓		✓✓✓	✓		✓	✓✓✓	✓	✓✓✓	✓	✓✓✓	✓		22
France	✓	✓		✓		✓			✓	✓✓	✓	✓✓✓				✓✓✓	✓	✓✓✓	✓	✓✓✓			22
Sweden	✓				✓		✓		✓	✓	✓	✓✓	✓			✓✓		✓✓✓	✓	✓✓✓		✓	19
Italy	✓		✓		✓		✓		✓	✓	✓	✓				✓✓	✓	✓✓	✓	✓✓			16
Belg. (Fl)	✓		✓		✓				✓	✓†	✓	✓✓††				✓✓††		✓✓††	✓	✓✓††		✓	16
UK		✓✓✓		✓✓✓		✓✓✓		✓		✓✓		✓✓				✓✓		✓✓		✓✓✓		✓	22
Denmark	✓	✓		✓		✓				✓✓		✓✓	✓			✓✓✓		✓✓✓	✓	✓✓✓			19
Slovakia	✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		11
Finland	✓				✓		✓			✓		✓✓	✓		✓	✓	✓	✓✓		✓✓✓			15
Slovenia	✓	✓	✓	✓	✓	✓	✓						✓		✓		✓		✓		✓		12
Greece	✓		✓						✓	✓✓		✓✓				✓✓		✓✓		✓✓		✓	14
Spain	✓		✓		✓		✓		✓				✓		✓							✓	8
Estonia	✓	✓	✓	✓		✓	✓						✓						✓		✓		9
Hungary	✓		✓		✓		✓		✓						✓		✓						7
Lithuania	✓		✓						✓				✓		✓		✓				✓		7
Malta	✓		✓				✓		✓				✓				✓				✓		7
Czech Rep							✓			✓	✓	✓	✓			✓		✓		✓	✓		9
Portugal		✓		✓				✓		✓✓		✓✓				✓✓		✓✓		✓✓			13
Ireland										✓✓		✓✓				✓✓		✓✓		✓✓		✓	11

EPBD Requirements	Application of MEP requirements						Production of EPCs								Use of EPCs								Total responses □
	A1		A2		A3		B1.i		B1.ii		B1.iii		B2		B3		B4		B5		B6		
	New buildings		Renovated existing buildings		Retrofitted building elements		Constructed buildings/ units		Sold building/units		Rented buildings /units		Public buildings		Is an EPC **shown** to prospective tenant/ buyer?		Is an EPC **handed over** to prospective tenant/ buyer?		Buildings with EP or **EPC stated in adverts**		Display of EPCs in public buildings		
Source of information	Member States	Secondary sources	Member States	Secondary sources	Member States	Secondary sources	Member States	Secondary sources*	Member States	Secondary sources	Member States	Secondary sources	Member States	Secondary sources*	Member States	Secondary sources	Member States	Secondary sources**	Member States	Secondary sources**	Member States	Secondary sources*	
Poland										✓		✓✓				✓✓		✓✓		✓✓		✓	10
Belg. (Wa)	✓									✓†	✓	✓†				✓†		✓†		✓†			7
Cyprus	✓						✓						✓								✓		4
Belg. (Brx Capital)	✓	✓		✓		✓				✓†		✓†				✓†		✓†		✓†			8
Romania		✓		✓		✓				✓		✓				✓		✓		✓			8
Germany	✓															✓		✓		✓			4
Croatia								✓															1
Bulgaria																							-
Luxembourg																							-
Latvia																							-

Notes: Member States are listed in rank order, based on the number of compliance rate data points obtained for each of them. Black ticks represent information reported by interviewees and respondents, whereas blue ticks represent compliance rates derived by ICF from different sources (i.e. field visits and literature review.)

** This question was not included in the online questionnaires*

*** Participants were asked to provide their views both over the sales and the rentals markets. A tick was accounted for whenever each participant has provided a rate to at least one of these markets.*

† One single answer, from the agents association, relating to the whole of Belgium.

†† One of the answers, from the agents association, relates to the whole of Belgium.

□ *The numbers in this column represent the absolute amount of responses referring to a given Member State. Therefore these numbers may not correspond to rank order of Member States on the table. This owes to the fact that in this this ranking information provided by Member States representatives was given a greater weight than information provided by secondary sources.*

Table 2.3 Response rates per EPBD requirement

Requirement		Provision of compliance rate data, per source		
		Member States	Secondary sources	Member State + Secondary sources
MEP	A1 – New buildings	67%	30%	67%
	A2 – Major renovations	37%	30%	50%
	A3 – Building elements	27%	27%	40%
EPC Production	B1.i – Constructed buildings	43%	10%	47%
	B1.ii – Sold buildings	37%	57%	63%
	B1.iii – Rented buildings	27%	57%	50%
	B2 – Public buildings	40%	0%	40%
EPC Use	B3 – EPC shown to buyer/tenant	23%	60%	67%
	B4 – EPC handed over to buyer/tenant	33%	60%	67%
	B5 – Energy performance in commercial media	33%	60%	57%
	B6 – EPC display in large buildings	30%	23%	47%

3 Application of minimum energy performance requirements and associated levels of compliance

3.1 Introduction

Building energy regulations, codes, strategies and certification schemes are seen as critical to achieve energy efficiency in building and lower energy consumption (Burman et al. 2014; Pan and Garmston, 2012; Pérez-Lombard et al., 2010). However, intended energy savings are not achieved when compliance rates are low. Robust enforcement and high compliance rates are seen as critical to achieving intended energy savings (Yu et al. 2014; Harper et al. 2012). Despite the EU's efforts to impose increasingly stringent building energy performance requirements, compliance rates across EU Member States are believed to be highly variable, rendering efforts to achieve energy efficiency in buildings less effective.

The practical application of the EPBD requirements 'on the ground' is not well understood and there is a need for a greater understanding of the mechanisms for regulatory enforcement and the relative impact that the varying mechanisms have in driving higher compliance rate. This includes the application and enforcement of minimum energy performance (MEP) requirements and the levels of compliance achieved as a result.

The Directive calls for Member States to introduce MEP requirements to the following:

- [A1] New buildings (Art. 6, para 1);
- [A2] Existing buildings which undergo major renovation[17] (Art. 7);
- [A3] Retrofitted building elements that form part of the building envelope and/or have a significant impact on the energy performance of the building (Art. 7.3, Art. 8) – this application is caveated in that the MEP requirements apply if technically, functionally and economically feasible.

The structure of the following section, as summarised by Figure 3.1, sets out the compliance rates reported by each Member State. It goes on to provide an overview of the different ways in which Member States have applied the Directive 'on the ground', collectively termed "**MEP requirement regimes**". An initial assessment of the mechanisms for MEP application, in terms of the scope of the requirements, the penalty and enforcement framework and any systems in place to support MEP compliance is undertaken to evaluate the "strength" of the regimes. The assessment does not consider the ambition of the MEP requirements[18], only the implementation framework for the MEP requirements.

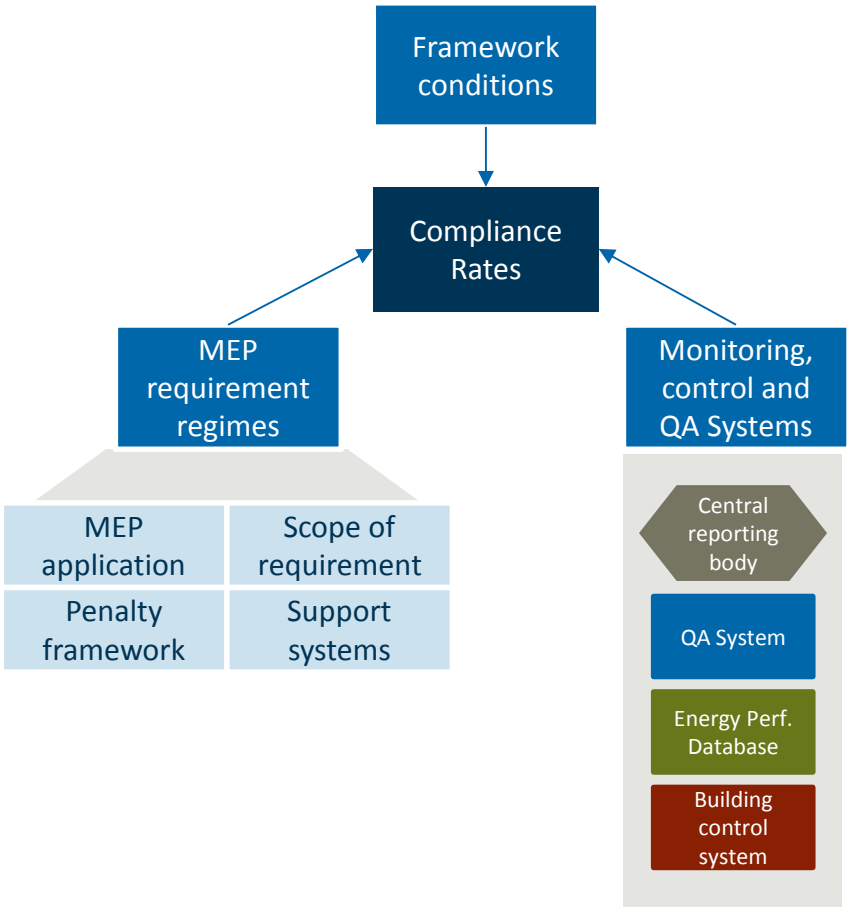
This is followed by an analysis of the **monitoring, control and QA systems** which enable the "confidence" of the compliance rates to be evaluated. This is subsequently used to generate adjusted compliance rates which form the lower-bound to the compliance rate ranges.

This section also presents compliance rates reported through consultation with secondary sources.

[17] In accordance with the EPBD Member States should be able to choose to define a 'major renovation' either in terms of a percentage of the surface of the building envelope or in terms of the value of the building, whereby the total cost of the renovation relating to the building envelope or the technical building systems is higher than 25 % of the value of the building, excluding the value of the land upon which the building is situated; or more than 25 % of the surface of the building envelope undergoes renovation.

[18] The term 'ambition' is used primarily to indicate the level at which energy performance requirements are set. For example, a requirement for buildings to achieve a lower energy consumption value (kWh/m2/year) would constitute greater levels of 'ambition'.

Figure 3.1 MEP analysis schematic



3.2 Compliance with MEP requirements

Figure 3.2, Figure 3.3 and Figure 3.4 present the compliance rates for the three MEP requirements. The charts show the following compliance rates:

- [A1] Percentage of new buildings in a given year that, when completed, comply with the energy performance technical requirements set by the Member State;
- [A2] Percentage of renovated buildings in a given year that comply with the energy performance technical requirements set by the Member State; and,
- [A3] Percentage of instances where the retrofitting of a building element is compliant with the MEP requirements of the Member State.

The underlying data values, as reported by Member State representatives, can be found in Annex 1.

As discussed in section 2 (and specifically Table 2.2), while two thirds (67%. nr=20) of Member States[19] provided compliance rates for new buildings [A1], only around a third (37%, nr=11) provided compliance rates for renovated existing buildings. For retrofitting of building elements, just over a quarter (27%, nr=8) of Member States reported compliance rates.

Figure 3.2 shows that over half of those Member States that reported MEP compliance rates for new buildings, provided values at or around 100%, primarily based on an assumption that the compliance checking system was 100% effective (i.e., there was an assumption that all non-compliant buildings are identified pre-occupation and brought into compliance). The

[19] In total 30 Member States or regions are covered by the scope of this analysis. All three Belgian regions are represented separately.

remaining Member States reported values based on other information sources, such as analysis of a database, or analysis of a sample of completed buildings to ascertain levels of compliance[20].

The different methodologies used by Member States to gather and report on levels of compliance have been analysed (see section 3.3).

It can be concluded that across the EU there were issues related both to the flow of information and the systems in place to gather reliable information on levels of compliance with the MEP requirements. These were also not necessarily issues that had been acknowledged by the Member State, which may be satisfied working on the assumption that having the legislation in place automatically results in compliance. As a result, few Member States were able to report accurately, and with confidence, on compliance with these requirements.

Given the issues resulting from many Member States reporting compliance rates of 100%, a qualitative assessment was also undertaken to develop more justifiable "adjusted" compliance rate values which took into account the level of "confidence" in the values reported based on the monitoring, control and quality assurance (QA) infrastructure in place (see section 3.4). This adjusted compliance rate was subsequently used to form a lower-bound for the compliance rate range, reflecting the level of uncertainty in the data. An adjusted mid-point in the compliance rate was also established.

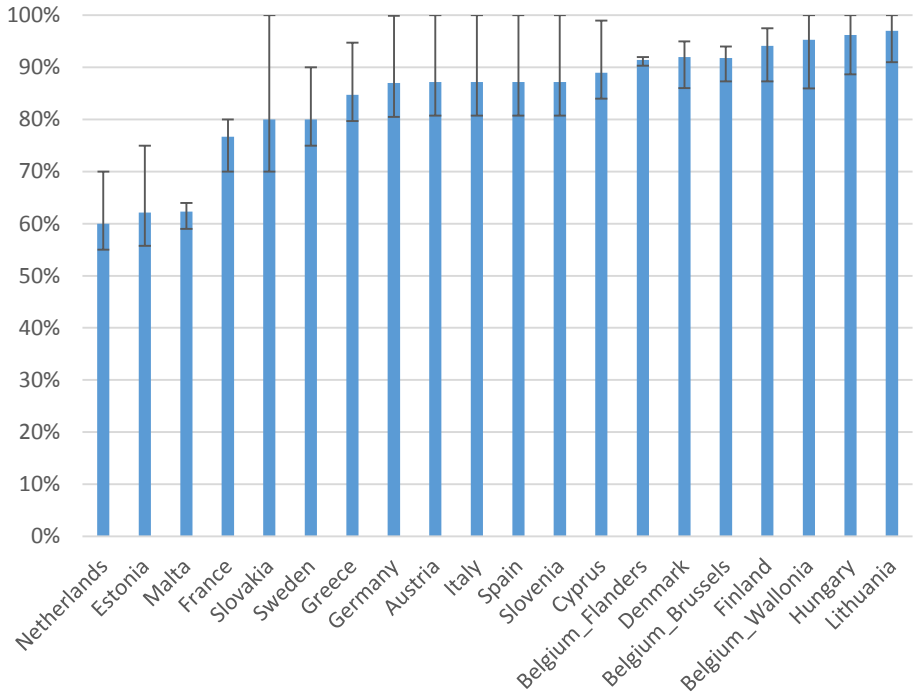
The details of the methodology used for the adjusted compliance rates are set out in Annex 6.

The results of this adjustment exercise for the compliance rate for new buildings [requirement A1] are illustrated in Figure 3.2. Here the upper-bound of the 'error bar' refers to Member State responses (and this clearly shows 100% compliance rates for nine Member States). The lower-bound of the error bar is the adjusted compliance rate. The range reflects the overall level of confidence. The top of each blue bar is the central case between the upper and lower bounds.

The range covered by the error bars may be very small (1 percentage point as in the case of Flanders) to very large (e.g. 30 percentage points for Slovakia). Overall, this adjustment illustrates that for those Member States reporting A1 compliance rates, adjusted compliance rate mid-points range from 60% (Netherlands) to 97% (Lithuania). For most Member States, A1 rates remain well above 80% even after adjustments.

[20] The study did not explicitly assess the statistical significance of sample sizes used by Member States.

Figure 3.2 MEP compliance rates – new buildings [A1]

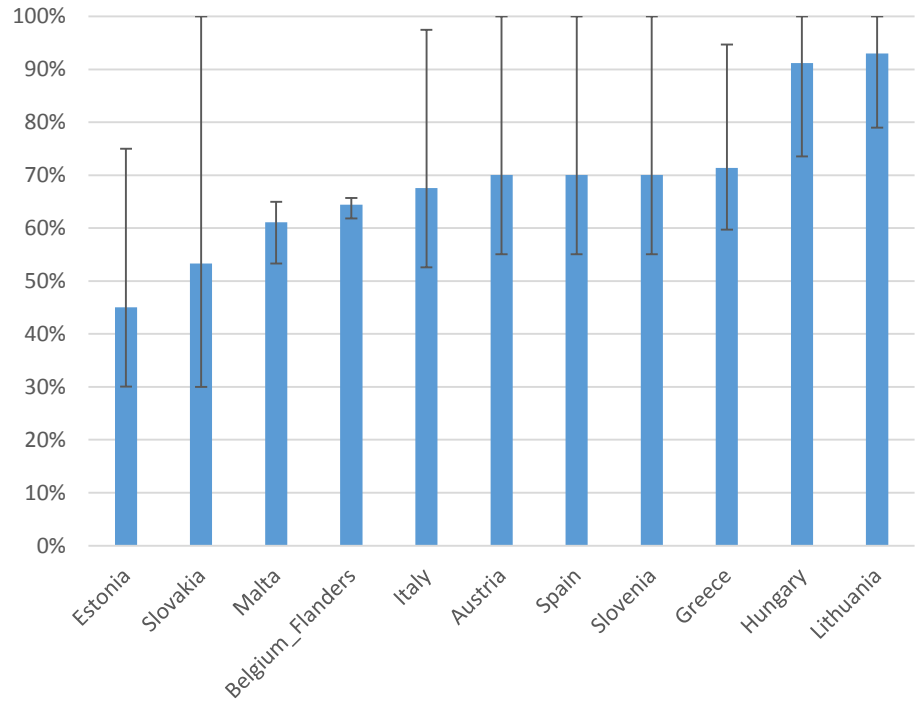


Source: ICF based on Member State consultation

Figure 3.3 presents the reported and adjusted compliance rates for MEP requirements for renovated existing buildings [A2]. It can be seen that there are far fewer data points than for Figure 3.2, with only 11 Member States reporting compliance rates. Six Member States reported compliance rates of 100%

The range covered by the error bars again differed between Member States. This ranged from around four percentage points in Flanders to around 45 percentage points for Estonia, Italy, Austria, Slovenia and Spain and up to 70 percentage points for Slovakia. This range reflects the level of confidence in the monitoring, reporting and quality assurance (QA) systems in place. For those Member States reporting A2 rates, the central case compliance rates were generally slightly lower than those for new buildings [A1]. For two Member States, A2 central case rates are at around 90% with another group of seven countries with rates of between 60% and 70%. The central case of the adjusted compliance rate ranged from 45% (Estonia) to 93% (Lithuania). For most Member States, A2 rates lie between 55% and 70%, after adjustments.

Figure 3.3 MEP compliance rates – renovated existing buildings [A2]



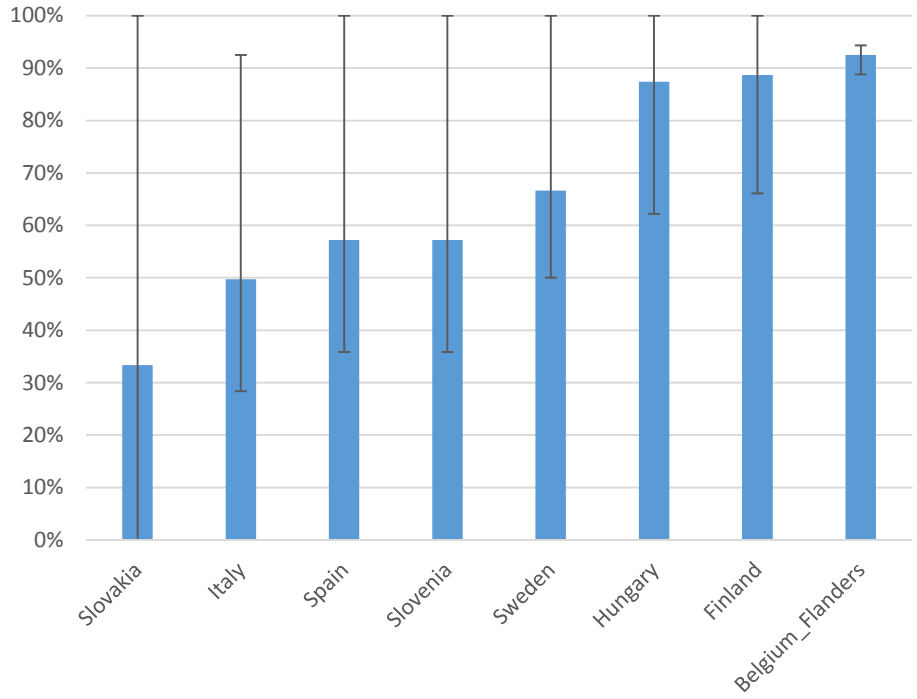
Source: ICF based on Member State consultation

Very low levels of reporting were seen in relation to compliance rates for MEP requirements for retrofitted building elements [A3]. Figure 3.4 shows that only eight Member States reported compliance rates and, as was seen for requirement A1, many reported compliance of 100%.

The upper and lower bound values for renovations and building elements requirements were much greater than for new build requirement. This represents the lower level of confidence in the reported values.

After adjustment, the central case level of compliance ranged from 33% (Slovakia) to 93% (Flanders).

Figure 3.4 MEP compliance rates – retrofitted building elements [A3]

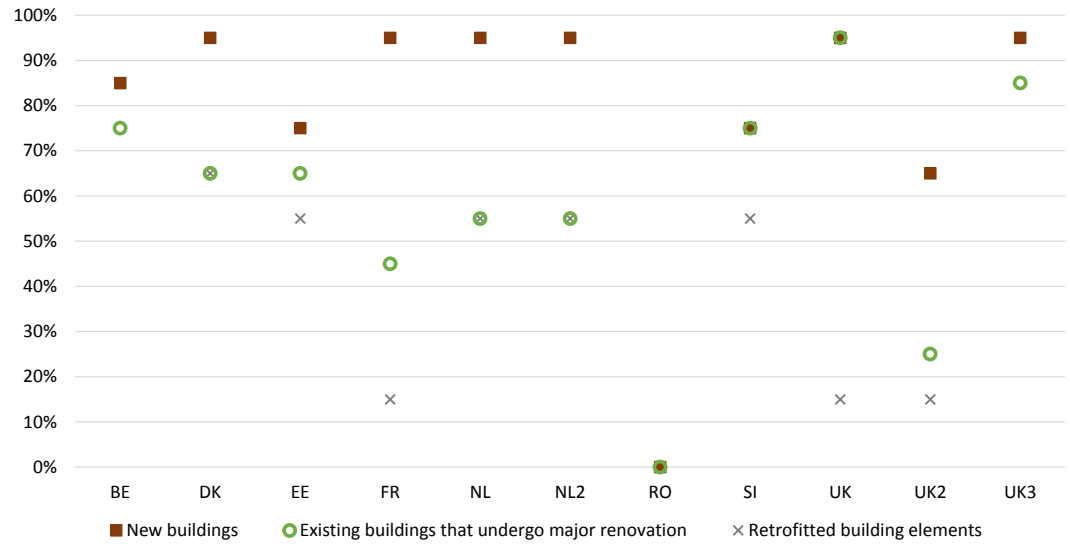


Source: ICF based on Member State consultation

Figure 3.5 shows compliance rates for all three MEP requirements as reported by building control experts (members of the Consortium of European Building Control - CEBC) covering eight Member States. This includes three responses for the UK and two for the Netherlands. The most complete responses are for rates for new and existing buildings. In general, these findings show broad alignment with the adjusted central case rates. In the case of the Netherlands, reported rates by CEBC association members are higher than those reported by the Member State.

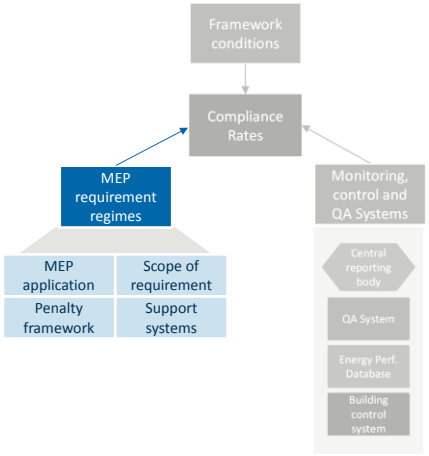
A benefit of Figure 3.5 is the insight it provides into the MEP compliance rates for the UK which did not provide any official response into this study. Overall, high rates (95%) are provided for new buildings [A1] by two UK respondents, offset by a third reporting 65% compliance. For existing buildings all three respondents perceived rates to be different, ranging from 95% down to 25%, suggesting much greater levels of certainty in the understanding of MEP implementation 'on the ground'.

Figure 3.5 Compliance rates for all three MEP requirements reported by building control experts



Source: Consultation with building control experts (members of the Consortium of European Building Control – CEBC). Note that the stakeholder for Romania reports that compliance rates were "not known", this is shown by the marker on the 0% point on the Y axis.

3.3 Assessing the ways Member States have applied the MEP requirements – the MEP regimes



Multi-criteria analysis was used to assess a number of components of the MEP regimes in each Member State. These components fall into four core thematic areas:

- Mechanisms for applying MEP requirements
- Scope
- The penalty framework
- The support structures

These thematic areas were selected based on their expected influence on the overall level of compliance in each Member State. The analysis of these components was used to establish a "strength" score for each Member States, with respect to their MEP regimes. The objective was to build an understanding of how variations in approaches used by the EU-28 influence the levels of overall compliance.

In the following section, a description of each of the four themes is set out in turn and, in each case, the range of different approaches used by Member States are presented. This is followed by a summary of the multi-criteria "strength" assessment, which aimed to provide an overview assessment of the MEP regimes. Due to the compliance data quality issues described in section 2 and section 3.2, it was not possible to quantitatively assess the relative influence of these components on compliance. Instead, a qualitative assessment has been conducted, with a focus on identification of best practice.

It is recognised that all Member States have approached these requirements from different starting points, for example in terms of factors such as the historic national regulatory context, the nature of the building stock and climatic conditions. While recognising this variance and acknowledging that no single solution is appropriate in all situations, the

research has extracted examples of best practice that could potentially be replicated throughout other EU Member States to achieve better compliance.

Finally, it should be noted that it is acknowledged that a key aspect driving compliance with the MEP requirements is the timing of building compliance checks – i.e. at which point in the building works process is building's energy performance checked against the MEP requirements. However, the timing of compliance checks was taken into account later in the "confidence" assessment against reported rates. In order to avoid any interference between the two assessments, the timing of compliance checks was not included under the "strength" analysis.

3.3.1 Mechanisms for applying MEP requirements

3.3.1.1 Primary mechanism

The research found two primary mechanisms for the application of MEP requirements. MEP requirements have been either embedded into existing regulatory requirements with regards to control of the built environment, or they are applied and enforced through a stand-alone piece of legislation/regulation, separate to other building control obligations. For some Member States employing stand-alone energy performance legislation, there was no historical regulation covering energy performance of buildings (for example, Cyprus, Malta and they Czech Republic); however in some cases the EPBD represented an upgrade to an existing stand-alone energy performance requirement (such as in Belgium and Bulgaria).

In Member States where MEP requirements are integrated into overall building regulation the compliance with the MEP requirements are likely to be subject to the same authorities, compliance checking systems, and penalty frameworks as infringements related to safety or other environmental building requirements. In addition, in such circumstances, the building sector is likely to be already accustomed to meeting such requirements. Such integrated frameworks could, in some cases, be considered to contribute to higher compliance rates (provided the other building requirements are already observed and complied with). However, if the compliance checking regime is better established and effective, it could lead to lower compliance rates, but with a higher level of confidence in rates reported.

In a number of the Member States with embedded primary mechanisms, compliance rates of 100% were reported based on the assumption that this must be the case given that it is a pre-requisite of overall building control. In some instances this is a plausible assumption - for example in Austria, Flanders, Estonia, and Lithuania where licences/permits to both build and operate are required and only issued upon proof of compliance with the MEP requirements.

However, in other Member States this assumption cannot be fully defended. In some Member States there are limited checks at key stages within the build process – either only at design, during build, or post completion. These limited checks are rarely enough to ensure compliance with the MEP requirements. This is the case in Wallonia and Czech Republic. In such cases, implementing MEP requirements independently from other building regulations and controls can sometimes be more effective at achieving high compliance rates.

Furthermore, officers responsible for checking compliance with non-energy aspects of buildings may not necessarily have the right level of experience and expertise to adequately assess compliance with energy-related requirements. In such cases, an independent MEP system can enable separate compliance checking and enforcement practices to be developed that might not be possible within the existing building control framework.

Some Member States have chosen to implement and enforce the EPBD through stand-alone primary mechanisms, with legislation and systems to integrate the MEP requirements into the practices of the building sector other than through building regulations. This includes: All regions of Belgium (Flanders, Wallonia, and Brussels Capital), Bulgaria, Cyprus, Czech Republic, Greece, Italy, Latvia, Luxembourg and Malta.

Best practice: Providing clarity for industry around future regulatory requirements

The Danish Building Regulations incorporate definitions of future low-energy classes for many years to come and this has been a great success in helping industry to achieve future targets and to create a strong domestic supply chain. Building regulation BR10 contains definitions of Low-energy Class 2015 and Building Class 2020 prepares Danish industry for future requirements almost 10 years in advance of when they will be enforced. This allows Danish industry to adapt their products to new standards. That is one of the reasons why new very energy-efficient components are mainstream today on the market.

This contrasts with the situation in the United Kingdom where there is little transparency around the detail of the future regulatory framework. This has been exacerbated by recent policy announcements such as the cancellation of UK's Zero Carbon Homes target.

3.3.1.2 *Currency of requirements*

The length of time that the building regulations have been in place and enforced was also assessed with regards to the overall level of compliance. Some Member States, such as Ireland, commented during interviews that they felt compliance was directly affected as a result of the time taken to train and upskill the building sector and in particular the smaller, local building contractors, in new regulation requirements

Member States which have well established building control regulations, with energy performance requirements included prior to the EPBD, included: Denmark (1961), France (1974), Finland (1976), Germany (1978), Hungary (1978), Luxembourg (1995), the Netherlands (1995), Sweden (2006/1942) and the UK (1984).

Conversely, example Member States where either building regulation control and/or energy performance requirements within the built environment were relatively new or introduced as a result of the EPBD include Bulgaria (2004), Flanders (2004), Ireland (2005), Italy (2005), Austria (2006), Slovakia (2006), Croatia (2007), Cyprus (2007) and Estonia (2015).

3.3.1.3 *Central versus regional implementation*

For a number of Member States the EPBD requirements, including the MEP requirements, are determined at a national level and are applied consistently throughout all regions irrespective of delivery and enforcement mechanisms. However, for a number of Member States both the MEP requirements, as well as the way these are checked and enforced, is devolved to a regional level. The study has already taken account of this for Belgium, splitting out the three key regions into separate entities within the study. It is worthwhile noting, however, that Austria, Germany, Italy and Spain, also have regional approaches and therefore have different applications throughout their respective countries. Consequently, in some cases, these Member States are able to call upon different compliance rates. However, in general, it was not possible within the scope of this study to investigate the specific characteristics of the MEP regimes at a sub-national level. As such, the compliance rates reported throughout this report represented the national average, unless otherwise specified.

An additional level of complexity is also introduced when gathering data on monitoring and reporting on compliance rates for Member States that have either differences in regional implementation, or devolved administration.

A number of Member States made particular reference to how monitoring of compliance, and enforcement, is restricted as a result of communication problems across departments, regions and authorities. For example:

- The Greek representative reported that currently, due to the lack of a centrally managed system the Ministry has to communicate individually with various departments and services such as the town planning authority. It was reported that this is expected to improve from 2016, when an electronic platform for issuing building permits will be introduced. This planned system is due to capture records of the building permits, and all details for new and renovated buildings, including EPCs.
- The Estonian representative commented that a lack of compliance is mainly a result of insufficient awareness by local authorities. Although local authorities have reportedly been informed of the new energy performance legislation, the lack of enforcement is seen to be related to lack of communication during Ministry staff changes associated with changes in governing political party.
- In Germany, responsibility for enforcement lies with each of the 16 Laender municipal authorities. The way in which this is implemented can vary as each operates independently. As such, at this stage, no unified system exists to check compliance and the central authority does not hold data on the Laender level[21].
- Similarly, in Hungary, the building authority responsible for issuing the building permit may vary geographically, according to the building type and depending on funding sources (some are subsidised for example by the national government). The creation of a central body to deliver the permits to every building is currently being considered by the authorities, in order to establish a simpler framework for issuing permits.

3.3.1.4 *Differentiated MEP requirements*

Building energy demands may vary according to factors such as the building type, the nature of its use, and its location, among others. Therefore, in Member States that allow different MEP requirements for new and existing building, and also for buildings that differ in other relevant aspects (e.g. geographical location, building type, size, use, etc.), requirements tend to be more appropriate to each building and more attainable. Member States which have not developed different standards for new and existing buildings include Denmark, Hungary, Malta, Netherlands, Slovakia, and Slovenia.

3.3.1.5 *Cost optimality of MEP requirements / future actions*

Assessing the ambition of the MEP requirements specified by each of the EU-28, in terms of the level of required energy performance improvement, is not within the scope of this report. This is a challenging area to assess, given both the unique baseline of each Member State and the contributing factors that impact upon energy performance within a particular geographic region.

However, it is difficult to ignore the obvious connections between the ambition of prevailing MEP requirements and the levels of compliance achieved within each of the EU-28. For example, it is acknowledged by Hungary that current national MEP requirements were set relatively low in terms of energy performance and were therefore easy to achieve or exceed. As a result, reported compliance rates were very high[22]. The methodology employed within this study therefore attempted to incorporate an element of qualitative analysis which takes into account this aspect, despite not being part of the study scope. This level of ambition has been inferred from the current position of each of the EU-28 with regards to the application of cost-optimality. The application of cost-optimality was introduced within the EPBD recast in 2010 as a means of benchmarking the MEP requirements set by the EU-28. The Directive requires that Member States shall ensure that MEP requirements for buildings are set “with a view to achieving cost-optimal levels” calculated in accordance with a comparative methodology.

[21] *Deutsches Institut für Bautechnik* (DIBt) do undertake random checks and then pass this information to the Lander to take enforcement action. DIBt are due to make their first report on this activity in 2017.

[22] Hungary reported compliance rates for A1 of 100%.

The Directive sets out that the MEP requirements established by each Member State shall achieve a cost-optimal level, and shall be approved by the European Commission. The majority of Member States have undertaken a cost-optimal study. Consequently, over half of the Member States have either revised their standards to a higher level of stringency pre-2015 or have confirmed that they are already in accordance with cost-optimal levels.

For some Member States the results of the study clearly identified that MEP requirements were not cost-optimal for all building types and were therefore likely to be less stringent than in other Member States. In these cases, the compliance rate could be expected to be higher. This includes Belgium Flanders (for major renovations), Croatia, Cyprus (non-domestic), Hungary, Ireland (non-domestic), Italy and Slovakia. There were also a few Member States, such as Greece, Lithuania and Malta, which had not yet established a cost-optimal level for the MEP requirements. This may lead to either higher or lower compliance rates, depending on how the current MEP level compares to the cost-optimal level. The low levels of confidence in the high compliance rates reported, undermined the ability of the study to test the strength of these relationships.

3.3.2 Scope of MEP requirements

Articles 6 and 7 of the EPBD set out that both new and existing buildings are to comply with the MEP requirements established by the Member State. Every new building is expected to comply with the MEP requirement, whereas, in the case of existing buildings, only those undergoing renovation or a retrofit of a specific building element[23] are required to comply with these requirements.

Nevertheless, at the time of writing, the majority of Member States had set MEP requirements for new buildings, buildings undergoing major renovations and buildings implementing building element refurbishment/ upgrades. Some Member States (such as Malta) had not set requirements for retrofitted building elements.

Therefore, compliance rates also have to be viewed in relation to the range of buildings and elements covered. This has implications for enforcement and quality checking of compliance, particularly in the case of Member States that have implemented requirements for building elements, where data collection and enforcement could be significantly more challenging, particularly given that it could extend to the do-it-yourself (DIY) market.

Best practice: Building element replacement in the UK

The UK has established the competent person schemes in order to ensure building elements retrofit and replacements, as well as small extensions, comply with the MEP requirements in place. Under this scheme a building owner interested in performing such interventions will hire a competent person in order to implement and self-certify the works. Such schemes aim to enhance compliance, through promoting training and skills in the industry while minimising costs to industry, authorities and the building owner. The competent person must be part of a relevant competence person scheme, such as the British Board of Agrément or the British Standards Institution. The certification issued by the competent person after performing will be among the documents required if the building / building unit is sold or rented.

3.3.3 Penalty framework

Although Member States are required by Article 27 of the Directive to establish “effective, proportionate and dissuasive” penalties “to infringements of the national provisions adopted

[23] A building element “forms part of the building envelope and has a significant impact on the energy performance of the building”.

pursuant to this Directive", there is no specific requirement for specifically applying these penalties. A penalty framework can encompass financial penalties (fines) as well as sanctions and warnings.

The research identified a number of different approaches to the subject of using penalty frameworks to enforce compliance. The majority of penalties imposed comprise of warnings, financial fines, and permit sanctions which may be summarised in the following typology:

- ***In place, enforced***: a number of Member States enforce compliance through warnings and fines. This includes Cyprus, Flanders and Wallonia, who all subsequently use money raised from financial penalties as a budget for enforcing furthering compliance. Estonia and Germany apply fines, but do not use these to cross-subsidise further EPBD enforcement.
- ***Considered as "not needed" - warnings issued, but financial penalties and sanctions not applied because corrective action is always taken***. This was the case for a number of Member States, including Austria, Lithuania, the Netherlands, Slovenia and Sweden, who reported that regardless of the formal penalty framework in place, most buildings owners comply because a building will not be granted a permit to occupy/use unless it is compliant with the MEP requirements. In these cases, the sanction of refusing a permit was regarded to be the highest penalty for a building. Most of these Member States had claimed compliance rates of 100%. However this can only really be justified if there are compliance checks at all stages of construction, including completion. For the Netherlands, for example, this was not currently the case. This issue is covered in more detail in section 3.4.
- ***In place but not enforced***: in a number of Member States a framework exists to issue penalties (generally financial), however they are not necessarily enforced. In some cases this is because issues are settled out of court, such as in Ireland; in others it is because the authorities cannot pursue the enforcement as they do not have the skilled staff and knowledge to pursue it through the legal system, such as in France[24]. In Italy, the penalty framework has not yet fully established the means to enforce it. All these scenarios are considered equivalent to those countries which have not established any penalty framework at all.
- ***None***: In some Member States there are no stated penalties for non-compliance with MEP requirements; in many cases (e.g. Czech Republic) this is because penalties are applied purely in relation to production of EPCs (which may be easier to enforce).

3.3.4 Support structures

It is considered that levels of compliance with MEP requirements are more likely to be achieved where support systems are in place. This includes both financial and technical support across sectors; from design through to construction and on to building operation. Almost all Member States reported some kind of financial incentive or technical support system.

3.3.4.1 Financial incentives

Financial incentives can play a key role in catalysing compliance with MEP requirements. In Member States, this type of support may take the form of direct grants, favourable loans, subsidies, tax relief, etc. Such incentives may also be key to incentivizing buildings going beyond the requirements. For example, Belgium Wallonia had established a specific grant but only for buildings that exceeded the MEP requirements. Other Member States which have implemented a similar support scheme include Cyprus, Germany, Slovenia, among others.

[24] However, this issue has been addressed by Article L 134-4 of Code de la construction et de l'habitation, as amended by article 27 of Loi 2015-991 of 7.8.2015 & implementation texts which has been announced for introduction in 2016.

A 2014 report produced by Concerted Action EPBD and IEE-supported Build Up skills project (CA EPBD BUS report, 2014)[25] investigated the use of national financial incentives as an instrument for stimulating the quality of the works. The report found that there were nine key categories of financial incentives (including grants, loans, tax credits and relief, ESCO financing, white certificates, metering tariffs) and that these incentives can be a good driving force for improving the quality of works and thus for compliance with MEP requirements. However, the report also pointed out that "the availability of a financing scheme is not necessarily a guarantee for success in actual projects".

In the CA EPBD BUS report, 69% of the reported incentive schemes were focused on private residential buildings, and of these, the largest share (89%) was for renovation of existing buildings. Public buildings followed with 17%, while social housing and enterprise buildings together represent 14%.

The majority of Member States responded positively that financial support continued to be provided, although nothing is currently provided in Denmark; and the only Member State for which it was not possible to obtain any current financial incentive information was Belgium Brussels.

3.3.4.2 *Technical support*

Technical support for parties implementing the MEP requirements can play an equally important role in catalysing compliance with related regulations in Member States. This is particularly true for Member States which did not have existing energy performance regulation prior to the EPBD; and also where the majority of building works are carried out by smaller, local building contractors. The quality of execution depends strongly on training and knowledge of those implementing the requirements.

In a number of Member States the training and upskilling of enforcement authorities has been highlighted as an issue. There were a number of Member States examples reported of enforcement and penalties not being pursued, or compliance not achieved, as a direct result of the lack of skills or understanding within the local enforcement authorities or bodies.

On this matter, key stakeholder groups include, but is not limited to:

- Architects, planners and engineers, involved in building design;
- Technicians and engineers, dealing with site supervision during building construction and provision of supporting means and materials for efficient building operation;
- Builders on-site undertaking the actual construction of a building; and,
- Building control inspectors who check and enforce compliance, both on-site and through documentary evidence.

The provision of workshops and training aimed at supporting the upskilling of the building sector was provided by the majority of Member States[26]. However, a number of Member States provided only very trade-specific training (for example France: heating installers, plumbing, carpentry and insulation installers; Italy: thermal coating system cortex; UK); and a number do not actively provide any 'hands-on' practical training, instead offering either guidance documentation or on-line web support only. This included Malta, Poland and Slovenia.

[25] CA EPBD BUS interaction report: 2014

[26] Training in the Netherlands is starting from September 2015

Best practice: practical technical support to the building industry

In the UK, the Zero Carbon Hub (UK) has produced the "Builders Book" which illustrates detailed technical and practical solutions to help overcome those construction challenges which have a significant impact on building energy performance[27].

The quality of the works and the skills of the workmanship directly contribute to the level of compliance achieved with the MEP requirements set by each Member State. Proactive steps must therefore be taken to move the workforce in the right direction.

Particular reference was made by a number of Member States to the success of the BUILD UP Skills initiative[28] which supports the provision of training to craftsmen and other on-site construction workers and systems installers in the building sector to ensure high quality construction works in terms of building energy performance.

3.3.5 Summary: Assessing the "strength" of the MEP regimes

In the context of MEP requirements, the term "strength" is used to collectively describe an analysis of key criteria described above. This includes the scope of the MEP requirements and the extent to which the enforcement and the financial and technical support systems are able to support compliance.

The results from the analysis of the "strength" of MEP regimes in place in Member States are presented in Table 3.1. The study does not seek to address the conformity of national laws with the European law, namely the Energy Performance of Buildings Directive (EPBD). Potential non-compliance of a specific country or regional legislation with the EU Directive falls outside the scope of this study.

The analysis shows that over 50% of MEP regimes are either high or very high "strength". Germany was the only Member State achieving a "strength" score of 100%, followed by Belgium (Wallonia), Finland, and Spain which all scored 93%. Annex 4 describes the methodology applied under this analysis, detailing the criteria applied under the scoring methodology and the main assumptions made.

Table 3.1 Results of the analysis of strength of MEP regimes

Strength	Member States (including regions in Belgium)
Very high	Belgium (Flanders), Belgium (Wallonia), Bulgaria, Cyprus, Finland, Germany, Portugal, Spain
High	Estonia, France, Hungary, Ireland, Lithuania, Luxembourg, Netherlands, UK
Medium	Austria, Belgium (Brussels), Croatia, Czech Republic, Denmark, Greece, Slovenia, Sweden
Low	Italy, Latvia, Malta, Poland, Romania, Slovakia

Of the seven criteria assessed, the key factors affecting compliance are the date the requirements were introduced, the characteristics of the penalty framework as well as the financial and technical support systems in place.

For instance, where the MEP requirements had been included within legislation pre-EPBD, the adjusted A1 compliance rate was higher at 82%, compared to a lower compliance rate of 73% in those Member States where MEP requirements were first introduced as a result of the EPBD. This appears to support statements provided by some Member State

[27] The Builders Book. Available from: http://www.zerocarbonhub.org/sites/default/files/resources/reports/Zero%20Carbon%20Hub%202015%20FINAL.pdf

[28] In 2014 there was a requirement for each Member State to produce a skills roadmap to 2020 and NZEB via this initiative, it is therefore anticipated that all Member States will at some point provide additional training and support for the construction sector, as per their gap analysis.

representatives and other stakeholders interviewed in regards to skills within the building sector influencing compliance rates; instances of non-compliance are not necessarily deliberate, rather a consequence of a lack of skills and knowledge within the construction industry. Where MEP requirements have more recently been introduced, the skills and knowledge in the construction industry can be less developed.

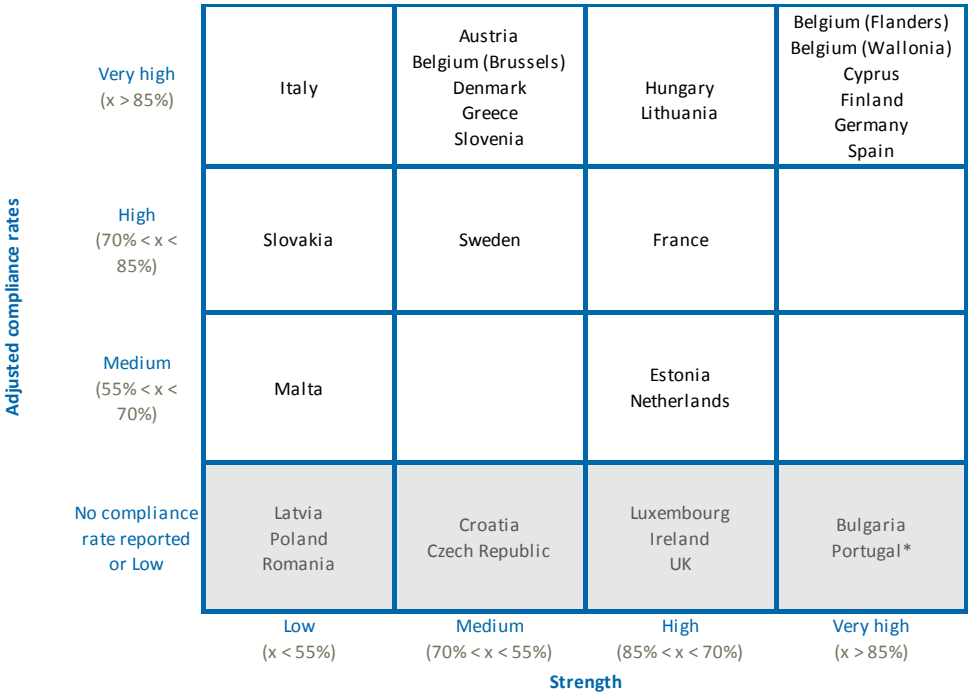
In contrast, the assessment of the adjusted central case compliance rates indicate that the nature of the primary mechanism (i.e., the piece(s) of legislation which implement the MEP requirement) does not directly and conclusively influence the rate of compliance. The average adjusted central case A1 compliance rate for Member States utilising an embedded approach is 84% (high value of 97% for Lithuania, down to 60% for Netherlands); for those using a stand-alone legislative framework this value increases slightly to 86% (ranging from a high value of 95% for Wallonia to 62% for Malta). It should be noted that most (67%, nr=20) Member States have used an embedded framework.

Furthermore, no conclusive evidence has been identified of higher compliance rates from Member States which establish different requirements for different types of buildings.

Figure 3.6 combines the results from the strength analysis of MEP regimes and the adjusted central case compliance rates for MEP requirements in new buildings [A1], presented under section 3.2. Member States which have not reported a compliance rate – and, therefore, for which it was not possible to establish an adjusted compliance rate – are presented on the bottom row of the matrix. The exception in that group is Portugal, for which the study team was able to estimate a compliance rate, based on information provided by the Member State representative.

An example of a Member State with lower “strength” MEP regime is Malta. Possible factors driving this scoring are the relatively recent introduction of energy requirements (2006) and the lack of a technical support system in place. This contrasts with a higher “strength” Member State, such as Germany, which scored highly due to a longer history of building energy regulations (since 1976), and with the presence of technical and financial support systems. Furthermore, the presence of MEP requirements for all types of buildings and the fact that MEP standards exceed those established by the cost-optimal methodology are indicators of the maturity of the German system for MEP requirements.

Figure 3.6 Combined results: strength of MEP regimes and central case adjusted compliance rates for new buildings [A1]



Source: ICF analysis and consultation with Member State representatives

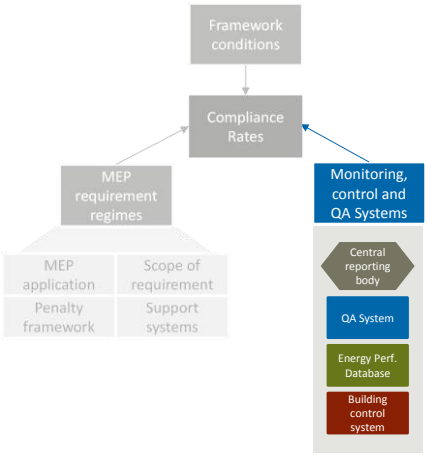
Note: For Member States marked with a star (*) the compliance rate has been estimated by the study team, based on country specific data on EPC production and building permits issued for new buildings and buildings undergoing major renovations.

Among the 16 Member States regarded as having a high or very high "strength" MEP regime, 11 reported a compliance rate for the MEP requirements. For all of these Member States except Estonia and the Netherlands, the central case adjusted compliance rate was higher than 75%. Lithuania, Hungary and Belgium (Wallonia), achieved the highest adjusted central case compliance rates.

Spain and Germany, two Member States which have adopted a regional approach to implementing the EPBD achieved a very high "strength" score and the same adjusted compliance rate of 87%. Austria and Italy, which also have regional approaches, have also achieved very high adjusted compliance rates, even though their MEP regime was classified as medium and low "strength", respectively. For Italy, this is primarily due to the MEP requirement levels not yet being cost optimal[29], which might also contribute to the a high compliance rate, if the current requirements are less stringent than cost optimal levels.

[29] As of the end of 2014.

3.4 Monitoring, control and quality assurance systems



An essential part of assessing the compliance rates reported requires validation of the legitimacy and confidence in source data used when reporting compliance. Therefore, understanding the information flows and the mechanisms for assessing, documenting and centralising compliance information is a central aspect to determine the confidence of the compliance rates provided by Member States.

The three key components of monitoring, control and quality assurance system are described in Figure 3.7 below.

Figure 3.7 Components of the monitoring, control and quality assurance systems

Quality Assurance (QA) System	The quality assurance (QA) system refers to any procedure aimed at checking the accuracy of the data input in the energy performance database (EP database).
Energy Performance (EP) Database	The energy performance (EP) database refers to any centralised platform which periodically or systematically gathers information on the energy performance of all new and renovated buildings (as a minimum).
Building Control System	The building control system refers to the system by which the buildings' energy performance is first checked.

Source: ICF

The **building control system** refers to the system by which building energy performance is first checked. It normally refers to the checks performed by subnational building control authorities when a building requires a permit to build or use/occupy. These checks can take place at different stages of the construction works (design, construction and completion stages) and be based on different approaches (desk based or on-site). Furthermore, on-site checks may encompass all or just a sample of buildings.

This aspect is key to determining the confidence of the compliance rates reported by Member States, as the final building energy performance can change substantially between the design and completion stages. As such, buildings regarded as compliant at the design stage may not be so at completion. Compliance rates based on data gathered under building control systems which involve onsite checks of all relevant buildings at completion are regarded as more credible than those stemming from other systems.

The **energy performance (EP) database** refers to any centralised platform which periodically or systematically gathers information on the energy performance of all new and renovated buildings (as a minimum). It may be an online platform or simply a spreadsheet

maintained by a central body. In some Member States with a regionalized approach, such as Italy and Austria, there are several regional databases, but there is no mechanism available for centralizing the information from these in order to build a national perspective. Therefore, in such cases, it was regarded that the systems do *not* include a central database as such.

The presence of an EP database can be key to determining accurate compliance rates. In the case of Flanders, for instance, data on buildings which had been subject to fines due to non-compliance with the MEP requirements was stored in a database. The compliance rates per requirement (e.g. U-value) were then estimated on the basis of the penalties applied. This allowed the building authority to map and address key aspects of non-compliance.

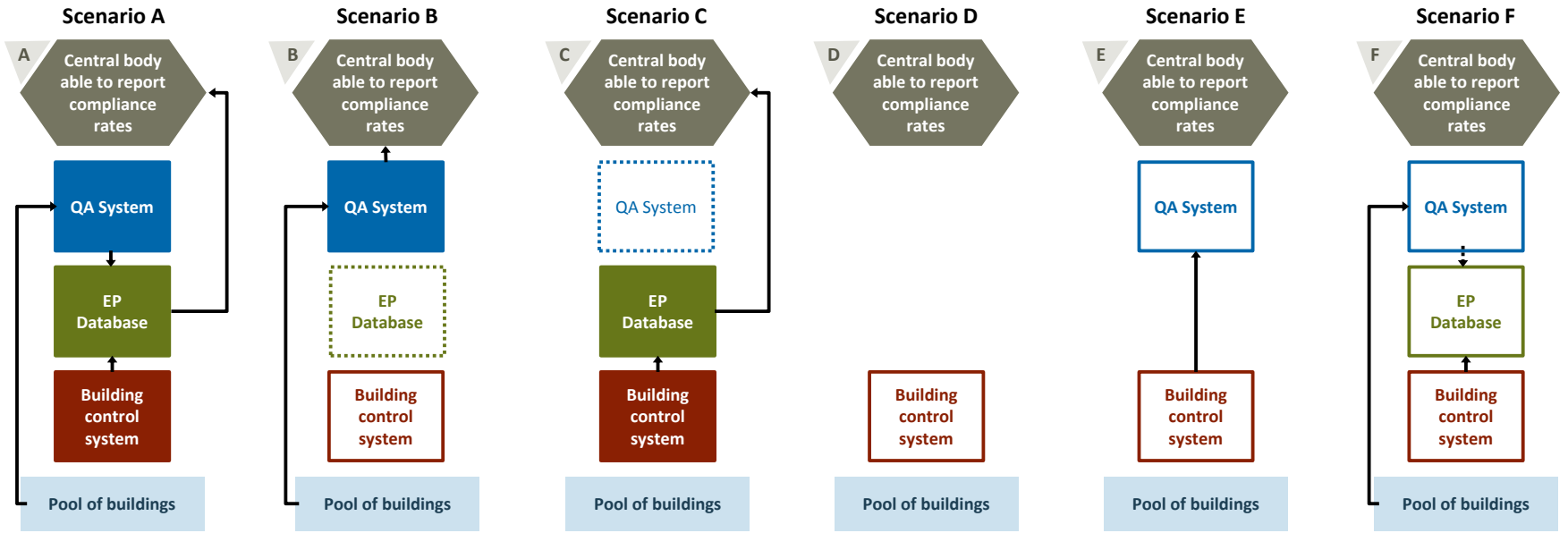
Finally, the **quality assurance (QA)** system refers to any procedure aimed at checking the accuracy of the data input in the energy performance database (EP database). This differs from the EPC database in that, in some Member States, the EPC database will not include buildings undergoing major renovations which are not required to issue an EPC. In the absence of a database, the QA system may refer to any procedure aimed at checking a sample of buildings for compliance with the MEP requirements. Where an EPC is required to demonstrate compliance with the MEP requirements, the Independent Control System (ICS), under which EPCs are randomly checked for their inputs, results and recommendations, may be considered a QA system. This is the case of Finland and Denmark, among others.

Overall, Member States' systems are composed of a combinations of one or more of these three components. Therefore, six scenarios were developed to reflect the different configurations of monitoring, control and quality assurance components applied by Member States (see Figure 3.8). The scenarios describe the systems Member States have developed that enable them to report on the level of compliance with MEP requirements.

A number of Member States gathered compliance information either from a national database or from quality assurance actions covering a sample of buildings. Often these Member States have reported lower compliance rates, but they are considered much more likely to be an accurate representation. They include: Belgium (Flanders and Wallonia), Cyprus, Estonia, France, Greece, Malta, the Netherlands and Sweden. Based on the characteristics of their system, these Member States have been classified under either Scenario A, B or C.

In Denmark, Finland, Hungary, Ireland, Italy, Lithuania, Romania, Spain, Slovenia, and the United Kingdom no specific data was compiled on compliance with the MEP requirements. All these Member States fell into Scenario D, with the exception of Denmark, Finland, and Hungary which fell into Scenario F due to the presence of an energy performance database.

Figure 3.8 Monitoring, control and quality assurance scenarios



The central body obtained information on the compliance rate from the comprehensive database. The information in the database has undergone a QA process.

BE-Flanders, BE-Brussels

The central body obtained information on the compliance rate only from the QA system which involved a check on a sample of buildings. From this information, the central body estimated the overall compliance rate.

CY, FR, MA, NL, SE

The central body obtained compliance information from the database. The database was fed with information provided by the building control body that is responsible for checking if new buildings are compliant with the MEP requirements.

BE-Wallonia, EE, EL

The central body had no information on which to base an estimate of the compliance rate. While the building control system involved undertaking some checks, there was no database or QA system to capture information on the level of compliance.

AT, IE, RO, UK, IT, LT, ES, SI

The central body had no information on which to base an estimate of the compliance rate. While the building control system involved undertaking some QA checks, there was no database or system to capture information on the level of compliance.

DE

The central body obtained information on the compliance rate from the comprehensive database. The information in the database had undergone a QA process. Nevertheless there was no monitoring system in place to process this information and translate it into compliance rates

DK, FI, HU, PT

Key:

This aspect was present in the Member State and information flowed from it to a central body able to report compliance rates

This aspect was present in the Member State but information **did not** flow from it to a central body able to report compliance rates. Dashed outlines indicate this aspect might or might not have been present in the Member State

As stated earlier, for over half of the Member States, the MEP compliance checking for new buildings was embedded in the building permit issuance process. As a result, most of these Member States reported compliance rates of around 100% based on an assumption that the compliance checking system is 100% effective – i.e., that *all* non-compliant buildings are identified and then brought into compliance. For example, in Austria and Lithuania, no specific studies or analysis into levels of compliance specifically with MEP requirements had been undertaken as they are an integral part of building regulation control, and therefore 100% compliance is an assumed value.

A claim of 100% is only justifiable however, if checks were made at all building phases: design, construction and completion. However, most Member States performed checks in two phases only and, in some cases such as Latvia and Malta, no checks were made at the building completion stage. A lower confidence must therefore be attributed to compliance rates reported by Member States in the latter group, as changes which could have occurred in the final construction phase may have significant impacts over energy performance and therefore the building's compliance. It is well documented that energy performance at completion can be significantly different from that at design stage.

The quality assurance of the MEP compliance checking system is also a feature that helps assess the effectiveness of such systems. Approaches implemented by Member States include checks made exclusively in a building database[30], field visits to a random sample of buildings, systematic checks from relevant authorities, amongst others. A more extensive and effective system of checks is likely to provide more accurate compliance data.

3.5 Conclusions

Systems for reporting compliance rates are not fit for purpose

Across the EU issues were identified related to the availability of on-the-ground information concerning levels of compliance with national MEP requirements. The systems in place to produce reliable data and the mechanisms through which that data can flow to a central body appear to be inadequate. As a result, few Member States were able to report accurately and with confidence on compliance with these requirements.

Compliance data availability was higher for new buildings [A1] than for major renovations [A2] or for building element upgrade and replacement [A3]. More Member States were able to provide compliance rates for the A1 requirement.

Where Member States fully embedded the application of MEP requirements for new buildings into overall building regulation and codes, their associated control checking systems have also been used (i.e. the same authorities and penalty framework as infringements related to safety or other environmental building requirements). This is an approach adopted by most (68%, nr=20) Member States. However, the systems for checking compliance for building renovations and building element replacement are less developed and less well integrated into existing practices. For example, in many Member States, no requirement for a post-renovation EPC existed. Despite the potential limitations of an EPC as an indicator of compliance, they can be a valuable tool for assessing the level of compliance by providing information to a central body.

The quality of the compliance rates that were reported is low

Many Member States reported compliance rates of 100% for the MEP requirements. An assumed reported compliance rate of 100%, particularly for Member States where there was no system in place for checking at all stages of construction does not appear credible. However, this issue was not currently acknowledged by some Member States as the assumption was that having the legislation in place automatically results in compliance.

[30] E.g., the energy performance of new buildings as stated in the database is checked against the energy performance requirements in force.

Adjusted compliance rates have been developed to help communicate the level of confidence in the compliance rates for each Member States. The multi-criteria analysis of the monitoring, reporting and quality assurance systems, taking into account factors such as the timing of compliance checks, resulted in compliance rate ranges. From these ranges a central case compliance rate was developed that can be considered as providing an indication of a more likely level of compliance.

Only limited quantitative analysis of this central case compliance rate is possible, due to the inherent uncertainties in the underlying data informing its development. As such, it has not been possible to derive robust quantitative conclusions on the precise factors that are influencing compliance. However, qualitative analysis and best practice recommendations have been drawn out.

Regional approaches can increase complexity of compliance rate data collection and reporting

An additional level of complexity is also introduced when gathering data on monitoring and reporting on compliance rates for Member State that have either differences in regional implementation, or devolved administration.

Compliance rates are lower for major renovations and building element replacement

Analysis of the central case adjusted compliance rates shows that for new buildings [A1] the compliance rates are typically higher than for major renovation requirements [A2] and those for building elements [A3]. This supports the conclusion that compliance checking practices for these requirements are less well developed than for new buildings. The issue of ensuring compliance with the building element requirement [A3] has been addressed in the UK through the introduction of schemes to allow the building professional to perform and self-certify certain non-major renovations, such as the insulation of a cavity wall.

Approaches used by Member States to apply the MEP requirements varied – as demonstrated by the strength analysis

Four core thematic areas of the MEP regimes introduced by Member States were qualitatively assessed for their relative influence on compliance: the mechanisms used for applying the MEP requirements; scope of MEP requirements; the penalty framework; and, support structures.

The mechanisms for applying the MEP requirements (i.e. whether the MEP requirements are embedded within existing building control systems alongside issues such as health and safety, or whether they are implemented as stand-alone requirements) did not appear to directly and conclusively influence the rate of compliance. However, as noted above, the length of time that energy performance requirements had been in place in some form did appear to align with higher levels of compliance.

Levels of compliance with MEP requirements were more likely to be achieved where financial and technical support systems are in place. Such systems are particularly important in Member States where energy performance regulations have relatively recently been introduced and both industry and compliance bodies are still building capacity to respond to these requirements.

A multi-criteria “strength” assessment, which aimed to provide an overview assessment of the MEP regimes, demonstrated the diversity in approaches used by Member States. This illustrated that over 50% of Member State MEP regimes were classified as either strong or very strong.

Guidance for Member States is needed to support compliance estimates

It would be valuable to provide additional guidance to Member States on how to derive compliance rates in a robust and consistent way. This guidance could be built around case studies of good and poor practice, together with the implications of both failures and successes in this area. Having accurate data will not only help the European Commission

moving forward, but will also help Member States to adapt national policies and implementation/ enforcement strategies based on what is actually happening on the ground.

There is scope to build skills across the sector

The length of time that MEP requirements have been in place does seem to affect the level of compliance observed. This suggests that, in order to increase compliance, it is necessary to boost skills and knowledge among all parties involved in building energy performance. For MEP regimes with an embedded primary mechanism, officers responsible for checking compliance with non-energy aspects of building may not necessarily have the right level of experience and expertise to adequately assess compliance with energy-related requirements.

Wilful non-compliance on the part of the building industry or building owner is not believed to be the most significant challenge. Awareness, skills and coordination between trades and stakeholders does however play a key role. Therefore, continued support is required to build skills and capacity in the workforce, as well as general education and awareness within the building sector. This is particularly important in Member States where the inclusion of minimum energy performance regulations is relatively immature. This should help to strengthen compliance levels. This should be extended to building commissioners, operatives and managers and enforcement authorities.

Particular reference was made by a number of Member States to the success of the BUILD UP Skills initiative which supports the provision of training to craftsmen and other on-site construction workers and systems installers in the building sector to ensure high quality construction works in terms of building energy performance.

4 Application of energy performance certificate requirements and associated levels of compliance

4.1 Introduction

Energy Performance Certificates (EPCs) represent a key instrument to enhance energy performance of buildings in Europe. EPCs were introduced to provide information to building owners, tenants and users about the energy performance of the building and also the opportunities through which performance could be improved.

The Directive sets out a number of requirements related to the production and use of EPCs:

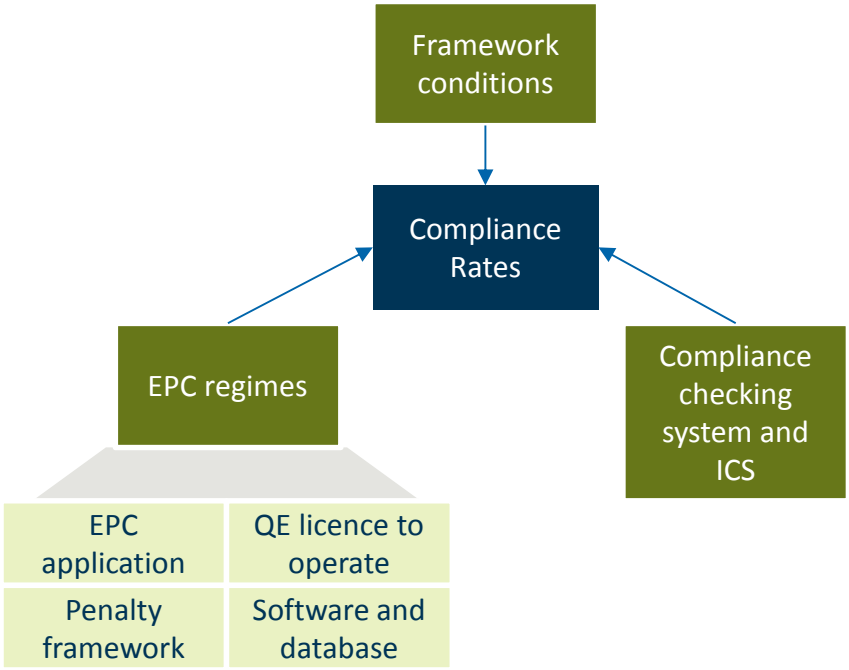
- [B1] Production of EPCs for buildings when they are constructed, sold or rented (Art. 12, (1)a);
- [B2] Production of EPCs for public buildings (Art. 12, (1)b);
- [B3] Showing EPCs to prospective new tenants or buyers (Art. 12(2));
- [B4] Handover of EPCs to new tenants or buyers (Art. 12(2));
- [B5] Inclusion of Energy Performance indicator in advertising (Art. 12(4)); and
- [B6] Display of EPCs in large buildings frequently visited by the public (Art. 13);

Critically, this information was designed to influence citizen and business decision-making at the point when a building (or building unit) is offered for sale or rental. In this way, EPCs have the potential to influence the building market and to support the transition of the building stock towards high energy efficiency.

However, a study from Balaras et al. (2014) suggests that a major struggle in the implementation of the EPBD is related to EPCs. The study, which undertook a comprehensive overview of EU-28 national EPC methodologies and experiences showed that *"most countries are still struggling with public acceptance and market-uptake, while data gaps, lack of quality control and limited access to data are preventing full exploitation of the EPC schemes"*.

There is need to tackle the issues that are affecting demand among the target end-users of EPCs. Such issues place a greater emphasis on the need to understand both the levels of compliance at a Member State level, and the systems being used to monitored, encourage and, where necessary, enforce EPC requirements.

The following section sets out the compliance rates reported by each Member State for the key EPC requirements described above. It then provides an overview of the different ways in which Member States have applied these requirements on the ground. This is followed by an assessment of the strength and weaknesses of these different EPC implementation systems.



4.2 Compliance with EPC requirements

This section presents the compliance rates for the various EPC requirements as reported by Member State representatives (red diamonds). Where available, these are set alongside compliance rates reported by other stakeholders that were consulted through online questionnaires which include:

- National Estate Agent Associations (blue triangles);
- National Tenant Associations (yellow squares); and
- Building Owner Associations (grey dots).

4.2.1 Production of EPCs for buildings built, sold or rented

Figure 4.1 presents the compliance rates for EPC production [B1] – the percentage of buildings or building units that, when constructed, sold or rented out to a new tenant hold a valid EPC. Member States and secondary sources had differing abilities to provide compliance rates for these three sub-obligations. Some Member State representatives were able to report on compliance for these separate requirements individually[31].

Findings are presented for 24 Member States[32], using data reported by both Member State representatives (nr=19) and secondary sources. Supporting data tables are available in Annex 1 and Annex 2.

More Member State representatives were able to provide rates for compliance with EPC production for building sales (11) [B1.ii] as opposed to new constructions (9) [B1.i] and rentals (6) [B1.iii]. However, this was offset by secondary sources that were more able to report on EPC production for rentals.

Figure 4.1 presents a composite chart combining compliance rates for all three sub-obligations. In instances where a Member State representative was able to report on

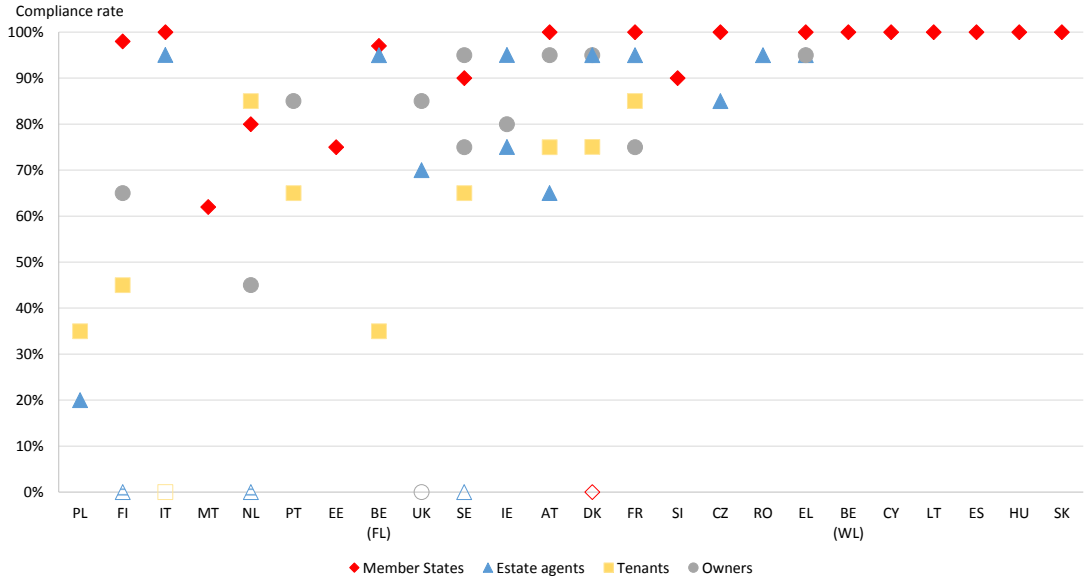
[31] Note, the requirement to produce an EPC for public buildings [B2] is addressed in this report in conjunction with the requirement for such buildings to display their EPCs [B6]

[32] The term Member State is used to refer to the 28 Member States as well as the three regions of Belgium which were each consulted independently. Therefore the total number of Member State representatives consulted was 30.

compliance for the three separate requirements individually, only the highest value is reported.

Of the 19 Member States who provided information on compliance rates, 15 reported rates of 90% or higher for requirement B1 overall, with 11 reporting compliance rates of 100%. The three remaining Member States, reported rates of between 80% and 60%. Denmark reported that the compliance rate was not known.

Figure 4.1 EPC compliance rates reported by Member States and other stakeholders – overall production of EPCs [B1] (covering buildings that are constructed [B1.i], sold [B1.ii] or rented [B1.iii])



Source: Consultation with Member State representatives and online questionnaire with national estate agents associations, national tenant associations, and national owner associations.

Compliance rate: B1: Percentage of buildings or building units that, when constructed, sold or rented out to a new tenant hold a valid EPC. [33].

Note: values at zero on the Y axis indicate where the stakeholder responded 'not known'.

In order to provide greater clarity about the compliance rates with the different sub-obligations, two further charts have been produced. Figure 4.2 shows the compliance rates for EPC production when buildings are constructed and sold, while Figure 4.3 shows compliance rates for rented buildings only.

Overall from these two charts, it can be seen that:

- compliance rates reported for sales (which average 88%) were generally higher than those reported for rentals (which average 73%);

[33] For four Member States, no stakeholders responded to this part of the consultation: Bulgaria (BG), Croatia (HR), Luxembourg (LU), and Latvia (LV)).

Belgium has been divided in three regions: BE Flanders, BE Wallonia and BE Brussels, however no responses were received from BE Brussels. In this chart, the response from the estate agent representative is at a country level and not only at regional (FL) level.

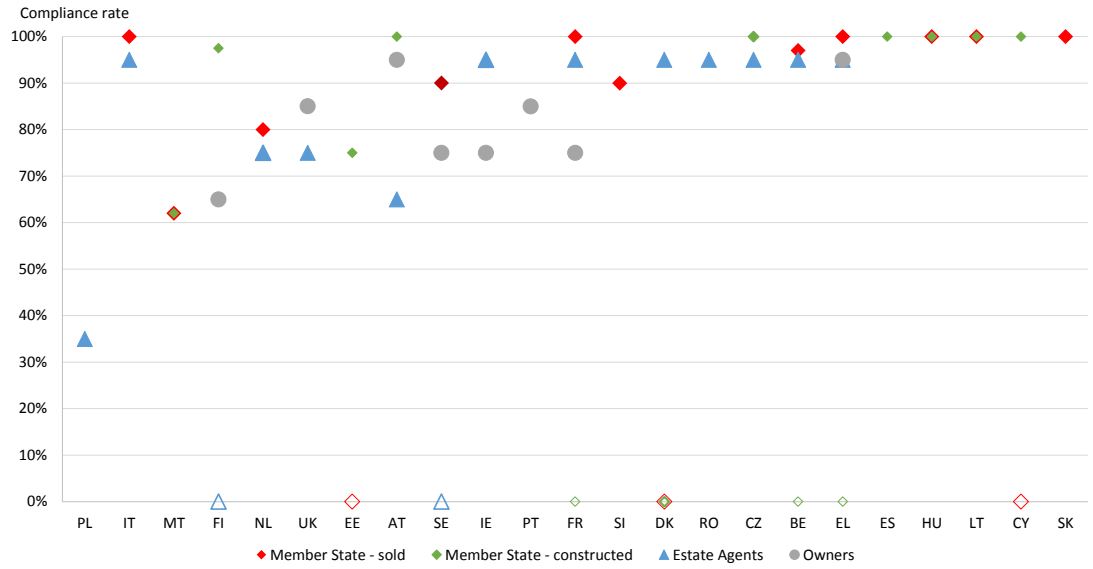
German (DE) tenant association replied to our questionnaire but did not know the response to this question, for this reason DE has not been displayed on the chart.

For the Netherlands (NL), the Member State representative provided different compliance rates for buildings that were sold (73%) and rented out to a new tenant (79%). Here we took the highest compliance rate. Similarly for France, the Member State representative provided a compliance rate of 100% for sold buildings, and 83% for building rented out to new tenant. The higher compliance rate has been reported in the chart.

- fewer Member State representatives were able to report on EPC production compliance in the rental market [B1.iii]. Only six Member States were able to provide a compliance rate for this requirement;
- there was a higher level of agreement among stakeholders when reporting compliance rates for sales than for rentals;
- rates reported by Member State representatives do not vary much between EPCs production for newly constructed [B1.i] and sold [B1.ii] buildings.

Overall, these charts demonstrate the value in consulting different groups of stakeholders. This enabled gaps in the reported coverage by Member State representatives to be filled. Additionally, it provided an opportunity to triangulate findings for some Member States. For example, in Figure 4.2, for newly constructed and sold buildings, EPC production compliance rates reported by at least three different stakeholders were closely aligned for some Member States, such as France and Greece.

Figure 4.2 EPC compliance rates reported by Member States and other stakeholders – production of EPCs for buildings that are newly constructed [B1.i] and sold [B1.ii] only



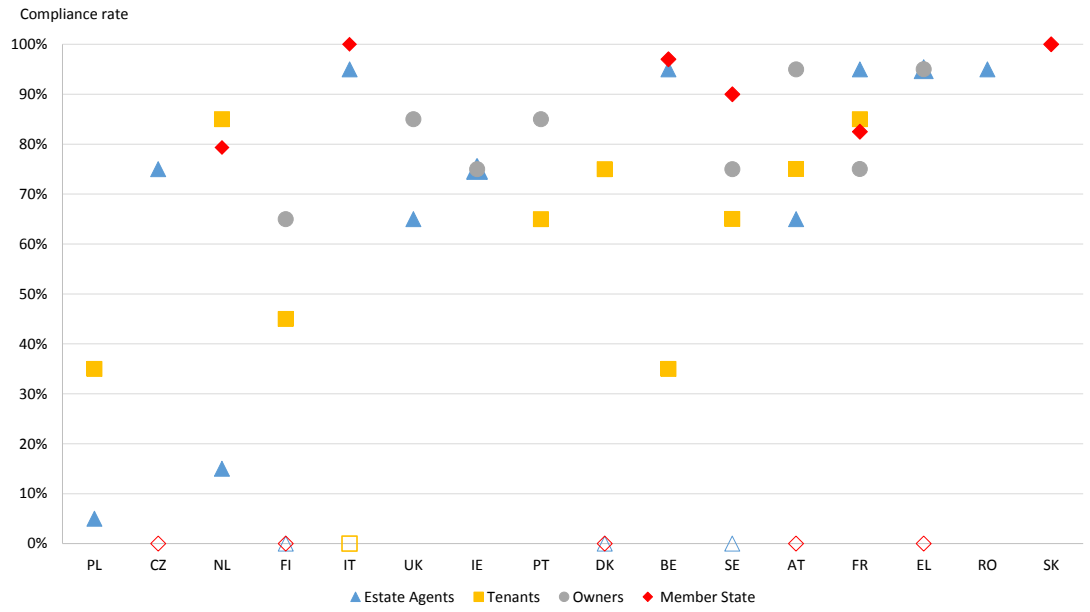
Source: Consultation with Member State representatives and online questionnaire with national estate agents associations and national owner associations.

Compliance rate: B1.i and B1.ii: Percentage of buildings or building units that, when constructed (B1.i) or sold (B1.ii) hold a valid EPC.

Note: values at zero on the Y axis indicate where the stakeholder responded 'not known'.

For rental buildings (Figure 4.3), EPC production compliance rates for France also showed good alignment, with at least four stakeholders reporting compliance rates between 75% and 90%. In such instances, one can have greater confidence in the indicative compliance rates as compared to instances where there is no third party perspective for the compliance rate reported. This is the case in Cyprus, Hungary, Lithuania, Slovakia and Spain.

Figure 4.3 EPC compliance rates reported by Member States and other stakeholders – production of EPCs for rented buildings [B1.iii] only



Source: Consultation with Member State representatives and online questionnaire with national estate agents associations and national owner associations.

Compliance rate: B1.iii: Percentage of buildings or building units that, when rented out hold a valid EPC.

Note: values at zero on the Y axis indicate where the stakeholder responded 'not known'.

Overall, these results suggest that EPC production in the rental market is less well monitored and controlled than in the new construction and building sales sectors. The legal systems in place used for achieving and checking on compliance with the use and issue of EPCs in sales and new construction does not exist for a large proportion of tenancy agreements in most Member States.

4.2.2 Use of EPC in sale and rental process

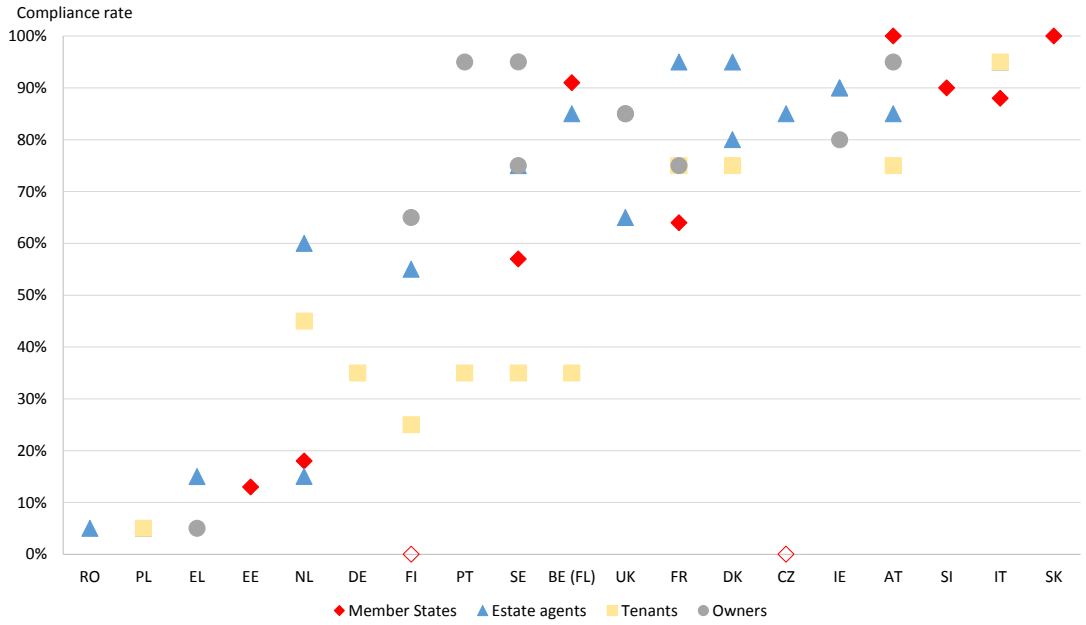
This section presents reported compliance rates for three requirements linked to the use of EPCs in the buildings sale and rental process. Presented in the order in which they are likely to occur, these are:

- [B5] Inclusion of Energy Performance indicator in advertising (Art. 12(4));
- [B3] Showing EPCs to prospective new tenants or buyers (Art. 12(2));
- [B4] Handover of EPCs to new tenants or buyers (Art. 12(2));

As noted above, these requirements are designed to provide information to key actors in order to influence decision-making at the point when a building is offered for sale or rental.

Figure 4.4 presents the compliance rates [B5]: Percentage of buildings advertised for sale / rental with energy performance indicator or EPC stated in advertisements in commercial media.

Figure 4.4 EPC compliance rates reported by Member States and other stakeholders – inclusion of EP / EPC indicator in advertisements in commercial media [B5]



Source: Consultation with Member State representatives and online questionnaire with national estate agents associations (A), national tenant associations (B), and national owner associations (C).[34]

Compliance rate [B5]: Percentage of buildings advertised for sale / rental with energy performance indicator or EPC stated in advertisements in commercial media.

Note: values at zero on the Y axis indicate where the stakeholder responded 'not known'.

Fewer Member States are represented by the findings for compliance with the inclusion of the EP indicator in commercial advertising [B5]. In total, findings are presented for 19 Member States (Figure 4.4). Only nine Member State representatives reported compliance rates.

The level of compliance varies significantly across Member States. Values reported by Member State representatives range from 100% (Austria, Slovakia) down to 13% (Estonia). For a group of six Member States (including Austria, Italy and Denmark), high compliance levels were reported with good degree of consistency between stakeholders with secondary stakeholders validating the values from the Member State representative in most cases. However, for Slovenia and Slovakia, high compliance rates were reported but no information was provided about the methodology used to establish the compliance rate. No secondary stakeholders provided data in order to validate these values.

For a second group of eight Member States (including Sweden, Belgium Flanders and Portugal), slightly lower compliance rates were reported on average, showing a wider range reported by different stakeholders. Belgium Flanders, Sweden and Portugal demonstrated most variance between stakeholders. For Sweden, stakeholders from both the tenant and owner associations reported compliance rates ranging from 35% to 95% respectively. In Belgium this ranged from 35% (tenant association) to 85% (estate agent association),

[34] Cyprus (CY), Hungary (HU), Spain (ES), Malta (MT), Lithuania (LT) did not reply to the stakeholder questionnaires but the Member States representative replied to their specific questionnaire without knowing the response to this precise question. They are therefore not represented in the chart.

For five Member States, no stakeholders responded to this part of the consultation: Bulgaria (BG), Croatia (HR), Luxembourg (LU), Latvia (LV) and Slovakia (SK).

perhaps suggesting regional variation within the Member State or differing interpretations of the requirements.

For a third group of five Member States, low compliance rates were reported.

The data suggest that more emphasis and value may be placed on EPCs among those buying a building, than by those renting a building, although this is not universal. The lower level of compliance stated by the Tenant Association in almost all Member States is in contrast to the higher levels stated by the Estate Agent and Owners. Both groups have different drivers for property selection and there were additional qualitative statements from the fieldwork suggesting that rental cost was a more important consideration than the running cost (energy expenditure). This is particularly true where rentals are inclusive of bills[35]. However, the sentiment from the fieldwork in London was slightly different with the competitiveness of the housing sales market meaning that energy performance was less of a concern than in the rental market.

During the fieldwork in seven Member States, a limited number of randomly selected estate agents were visited by the research team. Observations were made of the existence of an energy performance indicator with the properties advertised in the window display and, where possible, interviews were conducted with estate agent staff. Some respondents (for example in Ireland and Spain) reportedly struggled to get pre-sale EPCs produced by the seller/landlord as this was considered an outlay cost that they did not want to incur until they knew they had a sale/tenancy secured. Placing the obligation on to the real estate actors could be considered as a way of overcoming this. Example quotations from these fieldwork interviews are set out in Table 4.1. These indicate the level of awareness among buyers and tenants of the value of the EPC, which in many cases was very low. While emphasising that the sample size of this fieldwork is particularly small, and as a result it is not possible to draw strong conclusions, it can be noted that the findings presented in Table 4.1, do support the data presented in Figure 4.4.

[35] Note, however, that the qualitative interviews with estate agent staff were conducted on a very small sample size in only seven Member States.

Table 4.1 Findings from fieldwork visits to estate agent

Location	Was the EP indicator clearly visible in the window display			Example quotes from Estate Agents to the question: *Do tenants / buyers understand the added-value of an EPC and take it into consideration when making a decision in favour or against selecting a particular building / apartment?*
	Yes (or **all** properties on display	Yes, for **some** of the properties on display	No, for **none** of the properties on display	
Leuven, Flanders, Belgium	4	1		*'EPCs are catching peoples attention when their value is bigger than the average (i.e.300/350)'*
Athens, Greece		1	2	*'EPCs are irrelevant to their decision as most of them are not aware of their existence'*
Killarney, Killorglin, Cork, Tralee, Ireland		4	1	*'Buyers show more interest than tenants; with tenants there is very low interest'*
Warsaw, Poland			5	*'The figures displayed on the EPC do not tell consumers anything. Buyers do not understand it. It has no impact on the decision of prospect tenant/buyer'.*
Valencia, Spain		4[36]	1	*'Usually not'*
Stockholm, Sweden	1	2[37]	2	*'Most sales are apartments where buyers do not feel that they can do anything to change the situation of the energy performance of the building. However, buyers are more interested in the energy performance and the type of heating installed for villas [detached properties]'*
London, United Kingdom	5			*'Most tenants are interested in the property's energy performance - i.e., insulation, heating system – but just a few actually ask for the EPC rating (…) [In contrast], in the sales market, the energy performance is a factor that is not taken into consideration at all'*

Source: ICF fieldwork

[36] In three cases, the Estate Agency reported that the EPC is only displayed if one is already available. In all other cases, they are only produced once the property is sold or a rental agreed.

[37] For both cases, in the window advertisements no EPC information was displayed. However, the detailed property information folders included energy consumption and a copy of the actual EPC.

Tenants / buyers do not understand the added-value of an EPC

Most respondents (24 out of 35 respondents across all three online questionnaires conducted as part of this study) reported that tenants / buyers do not understand the added-value of an EPC and do not take it into consideration when making a decision in favour or against selecting a particular property.

Despite the perceived lack of added-value of the EPC, qualitative responses to the questionnaire revealed that tenant and buyer interest in their domestic energy bills is growing. In some countries, which experience a particularly large range of temperatures during the year (e.g. Romania), the cost of the heating and cooling for residents has a significant influence on their choice of home.

Figure 4.5 and Figure 4.6 present the compliance rates reported for the requirement to show the EPC to prospective new tenants and buyer [B3] and the requirement to handover the EPC once the sale or tenancy agreement is complete [B4], respectively. These two requirements play two distinct roles. The aim of requirement B3 is to help provide information to buyers about energy performance *before* they make their final decision. In many ways this is very similar to requirement B5, except that it also applies in circumstances when the prospective tenant/buyer is in an estate agent office being shown information about different properties. Requirement B4 on the other hand applies after the decision to purchase/ rent a property has been made. As such, the primary objective of B4 is to ensure that the recommendations report is available to the new owner / tenant.

Figure 4.5 EPC compliance rates reported by Member States and other stakeholders – Showing of EPC to prospective new tenants / buyers [B3]

Source: Consultation with Member State representatives and online questionnaire with national estate agents associations, national tenant associations, and national owner associations.[38]

Compliance rate [B3]: Percentage of transactions (sales or rentals) for which a valid EPC is shown to the prospective new tenant or buyer.

Note: values at zero on the Y axis indicate where the stakeholder responded 'not known'.

[38] For four Member States, no stakeholders responded to this part of the consultation: Bulgaria (BG), Croatia (HR), Luxembourg (LU), and Latvia (LV).

Figure 4.6, shows compliance rate [B4]: Percentage of transactions (sales or rentals) for which a valid EPC is handed over to the new tenant or buyer.

Figure 4.6 EPC compliance rates reported by Member States and other stakeholders – Handover of EPC to new tenants / buyers [B4]

Source: Consultation with Member State representatives and online questionnaire with national estate agents associations, national tenant associations, and national owner associations.[39]

Compliance rate [B4]: Percentage of transactions (sales or rentals) for which a valid EPC is handed over to the new tenant or buyer.

Note: values at zero on the Y axis indicate where the stakeholder responded 'not known'.

Both charts share a number of characteristics:

- Only very few Member States representatives reported compliance rates.
- High ranges of reported compliance are seen. Ranging from under 10% (Poland) to over 80% (for a group of around twelve Member States).
- Few Member States reported compliance rates and those that did tended to report 100% compliance.
  - Five Member State representatives have reported compliance rates of 100% for requirement B3 (Figure 4.5). In four of these cases (Hungary, Spain, Slovenia, Lithuania) no data from secondary sources was provided in order to validate the reported values. However, for Austria, data from secondary sources suggests that on-the-ground compliance rates are somewhat lower.
  - Six Member State representatives have reported compliance rates of 100% for requirement B4 (Figure 4.6). Again, in four of these cases (Hungary, Malta, Slovenia, and Lithuania) no data from secondary sources was provided in order to validate the reported values. However, again for Austria, but also Italy and Finland, secondary data suggests that on-the-ground compliance rates are somewhat lower.
- In general, there is less agreement among different stakeholders from the same Member State than for other EPC requirements. Tenant associations in many Member States reported compliance rates of around 30% for both requirements B3 and B4 and typically these were significantly lower than the rates reported by other stakeholders.

[39] For four Member States, no stakeholders responded to this part of the consultation: Bulgaria (BG), Croatia (HR), Luxembourg (LU), and Latvia (LV).

- However, for some Member States, high levels of compliance (at around 90%) are reported by all stakeholder groups.

As was seen for the requirement relating to the production of EPCs [B1], lower levels of compliance were observed within the rental sector. The rental market is not a well-managed or monitored sector in comparison with the construction and purchase of property. As a result, in most Member States the prevailing legal systems used for achieving and checking on compliance with the use and issue of EPCs in sales does not exist for a large proportion of tenancy agreements.

However, impact upon missed energy savings within this sector from these lower levels of compliance are likely to be low, given that tenants are also much less likely to implement any energy performance improvements due to the landlord / tenant split incentive.

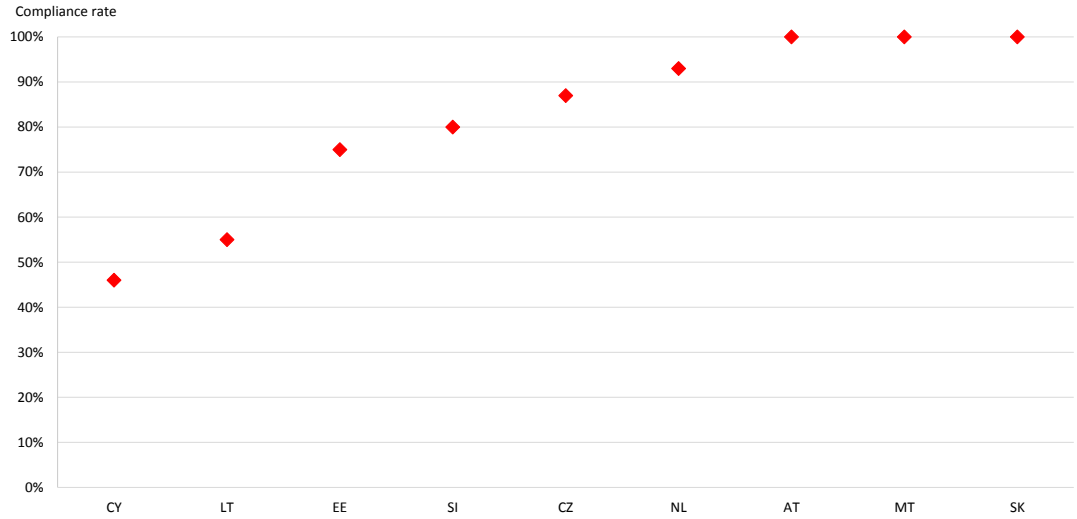
4.2.3 Display of EPC

Member States have interpreted and applied the requirement for the display of EPCs for large buildings in two different ways.

In Spain, Sweden, Poland and the UK for example, the requirements align closely with the text of the Directive. In large buildings that are not occupied by a public authority but are frequently visited by the public, an EPC should be on display only if an EPC has been produced (i.e. the buildings has been constructed, sold or rented out since the requirements came into force).

In Ireland and Greece, a simplified approach has been introduced where all large buildings (those with a total useful floor area over 500m^2 and since July 2015, over 250m^2) that are frequently visited by the public should have an EPC on display. This requirement applies irrespective of whether the building is occupied by a public authority.

Figure 4.7 EPC compliance rates reported by Member States – Display of EPC in large buildings frequently visited by the public [B6]



Source: Consultation with Member State representatives.

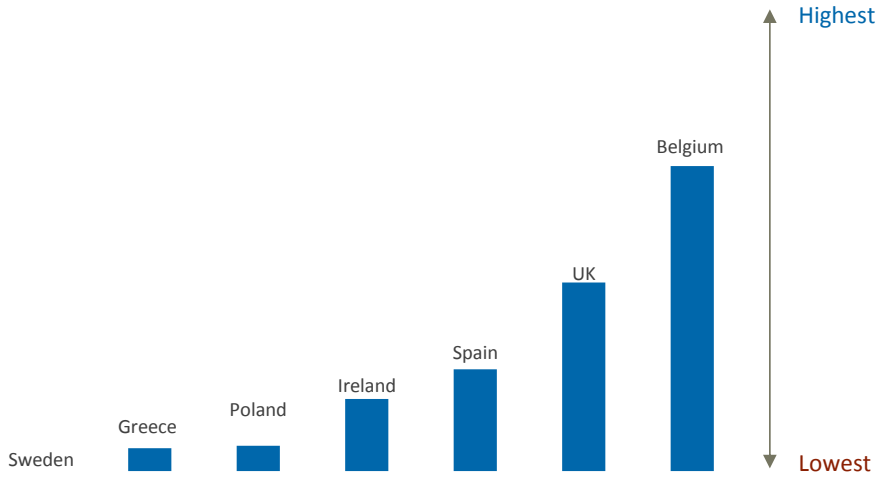
Only Member States representatives were asked the question on the display of EPCs in public buildings. Belgium (Flanders and Wallonia), Denmark (DK), Greece (EL), Spain (ES), Finland (FI), France (FR), Hungary (HU), Italy (IT), Sweden (SE) reported that they did not know the compliance rates for this requirement. All other Member States that are not on the chart did not reply to the questionnaire.

A limited number of Member States were able to report compliance rates for the requirement to display EPCs in large buildings frequently visited by the public. Eight Member States did

report compliance rates and these ranged from 45% (Cyprus) up to 100% (Austria, Malta and Slovakia).

Insights into compliance for this requirement were also gathered by the study team through fieldwork assessments in seven Member States. In total, across the seven Member States visited, around a quarter of buildings assessed had an EPC on display, a significantly lower level of compliance than reported in Figure 4.7. None of the Member States shown in Figure 4.7 were also covered by the fieldwork visits. The findings from the field work visits are presented in Figure 4.8 and in full in 0.

Figure 4.8 Summary of fieldwork assessment of requirement to display EPCs in large buildings frequently visited by the public [B6]



Number of buildings visited in each size category (m^2)							
>1000	11	13	14	17	4	16	18
500 - 1000	1	7	4	2	5	1	0
Subtotal	12	20	18	19	9	17	18

Source: ICF field visits

The y-axis deliberately does not have a scale indicated. Due to the relatively small sample size, the intention of the fieldwork was not to define specific compliance rates. However, it does indicate the relative levels of compliance. By way of indication around two-thirds of the buildings in Leuven (Flanders, Belgium) were found to be displaying the EPC in a place clearly visible to the public. In contrast, in Sweden, no compliance buildings were identified.

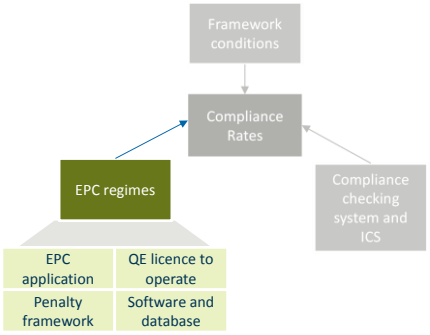
Key insights from the fieldwork in relation to the display of EPCs are set out below.

- Validity of EPC: Just over a fifth (nr=14) of the EPCs in the large buildings visited during the study were already expired. In the UK, this percentage was as high as 59%, with most certificates having expired less than two years earlier. In contrast, in Belgium, all displayed EPCs were up to date. This difference is likely to be resulting from the EPCs validity length set by each Member State. Whereas the British EPCs are required to be updated every year, in Belgium, EPCs have a 10 year validity. This suggests that there is little compliance checking or enforcement activity. It also suggests that there may be value in identifying a more appropriate validity period for EPCs.
- Awareness: 60% (nr=28) of the non-complaint building managers who were interviewed were not fully aware of the requirement to display an EPC. This indicates that awareness raising campaigns may be needed to promote compliance. Qualified experts, for instance, would be in a good position to raise awareness to this issue.

- Level of interest shown by public: Out of the fifty stakeholders providing their view on the level of interest shown by the public/ building users towards the EPC, nearly all reported low levels of interest. Only two stakeholders, both from Greece, reported a high and a medium level of interest by the public / building users. Again, this indicates an overall lack of awareness regarding the display of EPCs, which could be addressed through awareness raising campaigns.
- Compliance checks made: From a total 55 stakeholders able to report on this issue, only three declared that their respective buildings had been subject to some kind of compliance check or enforcement action. This figure, combined with the overall amount of buildings uncompliant with the EPC display requirement, suggests there is a need for further inspections to be undertaken by Member States, in order to raise compliance.
- Influence on energy management: Only five out of 41 stakeholders reported that the EPC was useful to the building's energy management efforts. This suggests stakeholders do not see value in the EPC recommendations report.
- Cost of EPC: Thirteen stakeholders interviewed were able to provide information on the cost of getting the EPC produced. The size and complexity of the building plays a large role in the cost of producing the EPC as well as labour costs. For those buildings that used external experts to produce the EPC, the costs ranged from EUR 350 for a ten storey public building in Poland to EUR 900 for a 1,200m^2 building in Leuven (Flanders, Belgium). In Leuven EPCs were produced for a series of public authority buildings by suitably certified internal staff.

The evidence presented above provide a snapshot of the status of displaying EPCs across the EU 28. However, in order to draw deeper insights into this issue, further investigation with larger sample size would be required.

4.3 Assessing the ways Member States have applied the EPC requirements – the EPC regimes



The research considered in the following section assesses the application of the different EPC requirements across Europe and how these influence the different compliance levels observed. The analysis focused in particular on those elements that are considered to have an influence on the compliance levels of these regimes, i.e.:

- The qualified experts' licence to operate
- The software and database
- The penalty system in place
- The compliance checking system and the introduction of an independent control system (ICS)

The narrative also includes extracts of good practice that have led to increased compliance at Member State level, and may be replicable throughout the EU.

4.3.1 EPC regulatory framework

The implementation of EPC compliance regimes is influenced by the institutional and administrative framework of the Member State. Different aspects of implementation are conducted at national or regional levels and by different types of organisation. While most EU Member States employ national compliance approaches, five countries rely on regional approaches for EPC quality assurance (Austria, Belgium, Spain, Italy and United Kingdom). In Germany, the quality assurance (QA) of EPCs is shared between the central government agency (German Institute for Building Technology – DIBt) and the regional authorities. The majority of Member States have strong involvement from Ministries / energy agencies when

it comes to the administration of compliance systems. For six countries (Belgium (Brussels), Croatia, Hungary, Latvia and the United Kingdom) this task is delegated to other bodies, such as accreditation bodies (United Kingdom) or professional organisations (Hungary).

4.3.2 Qualified expert's (QEs) licence to operate

There are a variety of requirements that have been introduced to ensure an appropriate level of qualification of those individuals producing and issuing EPCs. Ensuring EPCs are produced to a high standard is seen an important part of building confidence in the information EPCs provide. This is particularly important given their role in contributing to demonstrating MEP compliance in many Member States. These requirements range from holding certain minimum qualifications, voluntary or mandatory training and exams, through to maintaining up-to-date knowledge through continued professional development (CPD). Compulsory training courses are organised in 15 Member States. However, in a few countries an exam is not mandatory. In such cases, Member States often rely on a voluntary training scheme or on experience to ensure that candidates have the appropriate level of competence. In Spain, for example, the accreditation of a QE rests exclusively on the QE's academic or professional qualifications while professionalism is acquired through experience.

In many (nr=19) Member States, requirements exist for a periodic renewal of the QE licence. This often involves retaking an exam, as in Finland or Lithuania, but it can also involve a requirement for a QE to participate in refresher training programmes, as in Hungary. In other cases, QEs must attend additional courses and take an examination when there are major changes in the certification system, as is the case in the Brussels Capital region or in the Netherlands.

More than half (16) of the Member States have an accreditation system that involves minimum education requirements, compulsory examination, voluntary/mandatory trainings *and* CPD. Eight Member States have introduced CPD schemes and voluntary/mandatory training programmes, but have either no mandatory exam in place or minimum education requirements. Denmark and the United Kingdom are the only countries where no minimum education requirement is set.

Good practice: Investing in qualified experts to improve compliance

The introduction of a central exam for qualified experts in Flanders (known as Energy Experts) in 2013 reduced the overall number of Energy Experts, but had a positive impact on the general level of competence. The Flemish Energy Agency (VEA) is hoping for the same result with reporters (*"verslaggevers"*) who have also had to take a central exam since 2015. Investing in the continuous training of such experts is seen as a way of improving compliance, by building both the quality of EPCs produced and the confidence of stakeholders in the final EPC product.

4.3.3 Software and database

Software tools have been developed in all Member States to support QEs in producing and issuing EPCs. There is a mix of software being produced by either the central or regional authority, or private companies. The number of available software packages varies between countries.

In most countries the uniform and reliable interpretation and implementation of the calculation procedure of the software is guaranteed by an accreditation process. This can either be organized at government level (such as in Poland, Malta, UK or Italy) or by a voluntary commitment of the private software suppliers (such as in Germany). Official validation of the calculation methods used in the software packages by a central authority is designed to build customer confidence and ensuring consistency and accuracy in the results.

In a few countries such a system has not been implemented yet, which results in different software packages being available with potential for variations in calculation methodology. This poses the risk of EPC outputs varying due to the software used. Member States that have not yet implements an official software validation process includes Czech Republic, Estonia, Greece, Hungary, Portugal, Slovakia and Sweden. In Belgium, for example, the energy rating calculation for a given building can vary depending on the type of regional software that is used.

Credibility of EPC production tools

In their qualitative responses, representatives of building owners questioned the credibility of the EPC and its method of calculation. In model-based approaches to determining energy consumption, the EPC may lack credibility among the owners/tenants since it is not based on real energy consumption data and does not necessarily reflect real life use. In Finland, the EPC calculation methodology is perceived to unfairly penalise electric heating. This is having a negative impact on the value that citizens place on EPCs.

Where a validation process of the software calculation methodology is established, the software also usually includes an automatic quality check of the input data or a digital data protocol[40]. It was found that in 20 Member States, public or commercial software must pass through an accreditation process. Worryingly this indicates that over a third of Member States are using software that are not accredited and therefore consistency and robustness of EPCs cannot be assumed. This could also have implications with regards to consumer confidence in the EPC information, particularly the recommendations that are produced.

It is recommended that additional guidance on best practice for EPC software is issued, with specific reference to the need for collecting and collating data, quality checking, and how quality of output can impact upon consumer confidence. This best practice can also be drawn from wider than the EU as there are many non-EU countries with similar approaches to building certificate and use of software.

4.3.4 Penalty system

The introduction of a proper disciplinary system is an essential part of the compliance checking system. The EPBD recast (Article 27) requires that “Member States shall lay down the rules on penalties applicable to infringements of the regulation. Member States shall take all measures necessary to ensure that effective, proportionate and dissuasive penalties are implemented”.

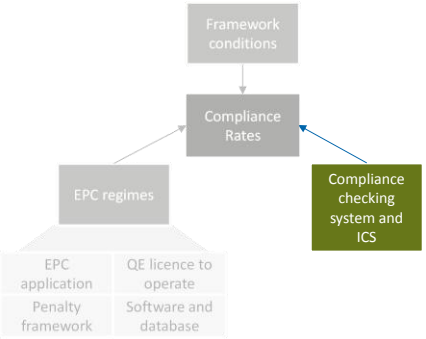
It was found that penalties may be imposed in the following circumstances among others:

- An EPC is not issued for a new building or major renovation;
- An EPC is not handed over during a sale or rental transaction;
- An EPC indicator is not displayed in advertisements in commercial media; and
- The EPC quality is poor.

A penalty system is prescribed by national legislation in almost all countries, most recently in Poland where it entered into force in early 2015. While most countries have imposed penalties in the form of warnings, fines and (temporary/permanent) suspension, five countries have not yet enforced obligations. In the Czech Republic, fines have only recently started to be imposed.

[40] In the former case, entry data are automatically corrected (e.g. France) or red flags are raised so as to ensure the coherency of entry values, and completeness of data provided by the QE. In the latter, an initial data validation process of certain data fields is conducted prior to submitting the EPC within the calculation software and/or EPC database (e.g. Lithuania, Slovakia).

4.4 Compliance checking system and Independent Control System (ICS)



It was found that there are a myriad of compliance checking systems within the Member States, covering different requirements and incorporating different selection methods for assessment (for example targeted vs. random selection). The majority, however, involve checks to ensure that EPCs are:

- Produced when they should be;
- Of suitable quality and consistency (this is the principle role of the Independent Control Systems – ICS); and
- Used in the way they should be (i.e. displayed as required on large buildings frequently visited by the public, used within advertising in commercial media and shown/passed to tenants/buyers at the right time).

Controls for the production of EPCs

For newly constructed and renovated buildings, it was found that in half of the Member States the EPC production process is linked to the controls in place to establish whether a building meets the minimum requirements for energy performance (e.g. Belgium, Bulgaria, Croatia, Czech Republic, Estonia, Finland, France, Latvia, Lithuania, Luxembourg, Poland, Portugal, Slovenia and Spain). In such cases the qualified expert (QE) may be involved during the design stage or on-site and have direct access to the building and systems data.

In most Member States the obligation to have an EPC produced[41] when a building or building unit is sold or rented out to a new tenant has been introduced in the national legislation. However, only a fraction of Member States have a robust control mechanism in place to ensure that these EPCs are actually in place when buildings are sold or rented.

In the majority of these countries, the EPC production and validity is checked primarily by notaries during the sale transaction[42]. Checks performed by notaries have proved to be a strong control system to enforce compliance during sale transactions. For the rental sector however, the transaction, is often concluded informally and so the transaction therefore bypasses any official controls. As a result compliance is not as easy to enforce and it can be difficult to collect data on compliance.

Good practice: ensuring EPCs are made available

It has been seen that ensuring an EPC is available in rentals transactions was a greater challenge for Member States. In Hungary, this issue has been addressed by introducing a requirement for a have a lawyer to sign-off any rental agreement. This lawyer is then responsible for ensuring there is an EPC number associated with that contract. Lawyers, as well as building owners and tenants, who fail to comply with this requirement are subject to sanctions.

Controls for the use of EPCs

The requirement to share EPCs with prospective new buyers / tenants and the requirement to include the Energy Performance indicator in commercial media are closely aligned. They aim to provide information to prospective buyers / tenants on energy performance and

[41] If a valid EPC is not already available

[42] In Estonia the Technical Surveillance Authority (TSA) performs these checks

therefore help to influence decision making, ultimately moving the market towards more efficient buildings.

As previously shown in Table 2.2 information availability on compliance with regards to the requirement to share / present EPCs as part of the sale and rental marketing process is significantly lower. This may indicate that in most countries, the compliance checking system fails to monitor and enforce requirements on real estate actors (agencies, owners and other stakeholders) or that there is simply no mechanism in place to collect information on compliance. This highlights the challenge of enforcement of this element within the legislation, suggesting that it is not currently fit for purpose and should be reviewed. Other elements which need to be considered within such a review are the value of use for an EPC within the rental market, and the up-front costs pre-sale/lease implications (as per section 4.2.2)

The display of EPCs in commercial media was generally found to be quite low across Europe. Only a few countries have started to enforce compliance measures. Among these, the Brussels Capital Region and Finland are both examples of good practices.

Good practice: Ensuring the inclusion of the energy performance indicator in commercial advertisements

In the Brussels Capital Region, over one hundred real estate agencies were checked by authorities at random between September 2013 and September 2014 to confirm the existence of energy performance indicators in material on display in the agency or on internet sites. At the end of 2014, the first administrative fine was issued and others are expected. In the future, targeted controls will be undertaken focusing on agencies that have repeatedly been reported as not compliant (CA EPBD, 2014). Similarly, in Portugal a system of financial penalties was established to penalise real estate agencies who do not advertise the energy performance of a property. As a consequence, in 2014, the number of EPCs issued for existing buildings nearly tripled.

Controls for the display of EPCs

As noted previously, a lack of clarity and specificity in the Directive has led Member States to follow different approaches to the application of the display EPC requirements. For those that closely followed the text of the Directive, checking compliance is proving very challenging in terms of determining which buildings should fall under the requirement. The simplified approach taken by Ireland and Greece would appear to create a more suitable environment for compliance checking.

Some Member States also reported that bringing public buildings to compliance can be a significant challenge, due to the lack of a comprehensive inventory of public buildings.

The costs associated with the production of EPCs for such a large number of buildings was also cited as a factor in Ireland contributing to low levels of compliance.

Others have reported issues with self-enforcement, meaning that many public buildings will not hold or display an EPC because the agent responsible for performing the checks is the very same public authority that is responsible for the buildings.

Systems to monitor and enforce the requirement to display EPCs in public buildings, and large buildings often visited by the public, were found to be very limited across the EU. This is reflected in the low number of responses from Member States on this issue as set out in Table 2.2. Only four Member States reported that they had enforced the controls in place (Belgium -Flanders, the Netherlands, Denmark and Portugal). In Denmark, for example, in 2013 the Danish Energy Authority (DEA) carried out 102 random checks of all buildings larger than 1000 m². This corresponds to 0.5% of all buildings in this category. Around 24% of the checked buildings did not comply with the display obligation.

Independent control systems

Since the EPBD recast, Member States are required to *"ensure that independent control systems for energy performance certificates (…) are established".*

The rules for verification are:

- "*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, including the recommendations made,*
- *c. Full check of the input data and the results, including the recommendations to improve the energy performance of the building or building unit, and on-site visit of the building, if possible, to check correspondence between specifications given in the energy performance certificate and the building certified or other equivalent measures".*

The research revealed that this obligation has been implemented in the majority of Member States. In 12 countries (including Belgium-Wallonia) these controls involved all types of options (input data, recommendations and on-site visits). In nine others only option A and B were applied. No responses were received from five Member States. The ICS approaches taken by each Member State are presented in Annex 4.5.

4.4.1 Summary: Assessing the strength of the compliance checking systems for EPC requirements

In the context of EPC requirements, the term "strength" is used to collectively describe a multi-criteria analysis of the factors describe above; the ways in which the EPC requirements have been implemented in a particular Member State. This analysis covers the systems to ensure that the individual producing EPCs has the necessary skills, the nature of the technical support, the penalty framework, and the various characteristics of the Independent Control System.

The study does not seek to address the conformity of national laws with the Energy Performance of Buildings Directive (EPBD). Potential non-compliance of a specific country or regional legislation with the EU Directive falls outside the scope of this study.

The results of ICF's analysis of the strength of EPC compliance checking systems are presented in Table 4.2. It is shown that approximately half of the Member States' compliance checking systems for EPC have been classified as either high or very high "strength".

Lithuania was the only Member State achieving a 100% scoring and was followed by six further Member States whose EPCs systems were classified as very high "strength", all of which scored 92%.

Annex 5 describes the methodology applied under this analysis, detailing the criteria applied under the scoring methodology and the main assumptions made.

Table 4.2 Results of the analysis of strength of EPC compliance checking systems

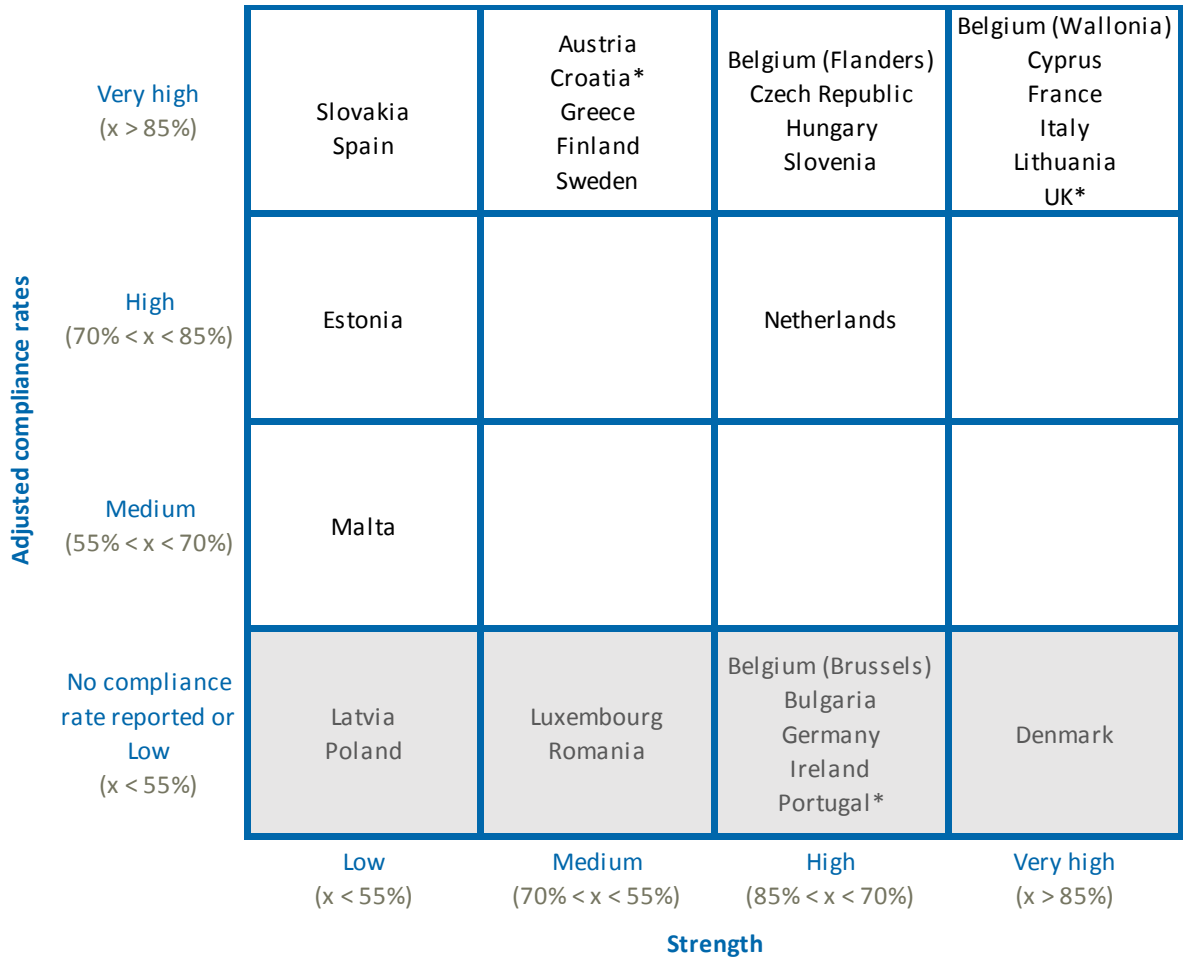
Strength	Member States
Very high	Belgium (Wallonia), Cyprus, Denmark, France, Italy, Lithuania, UK
High	Belgium (Brussels), Belgium (Flanders), Bulgaria, Czech Republic, Germany, Hungary, Ireland, Netherlands, Portugal, Slovenia
Medium	Austria, Croatia, Finland, Greece, Luxembourg, Romania, Sweden
Low	Estonia, Latvia, Malta, Poland, Slovakia, Spain

The EPCs compliance checking systems are believed to have a great influence on the EPC quality; they are also an underpinning aspect affecting compliance rates. It is expected that stronger compliance checking systems will contribute to more accurate EPCs, which ultimately will lead a greater reliability of these certificates. A greater reliability tends to

contribute to an increased perceived value of EPCs and, therefore, to increased compliance rates for EPC production.

Figure 4.9 combines the results from the strength analysis and the adjusted compliance rates for EPC production for constructed, sold and rented buildings, presented under section 4.2. Member States which have not reported a compliance rate – and, therefore, for which it was not possible to establish an adjusted compliance rate – are presented on the last row of the matrix. For some Member States which have not reported a compliance rate, the study team managed to estimate an EPC compliance rate. Portugal is the single Member State whose estimated compliance rate is under 55%. Therefore, it is allocated under the bottom row.

Figure 4.9 Combined results: strength of EPC compliance checking system and compliance rates for new, sold and rented buildings [B1]



Source: ICF based on Member States representative responses

Note: For Member States marked with a star (*) the compliance rate has been estimated by the study team, based on country specific data on EPC production and market statistics on new, sold and rented buildings.

Amongst the 17 Member States regarded as having either a high or very high "strength" EPC compliance checking system, just over half (9) have reported a compliance rate with the EPC production requirements [B1]. All of these nine Member States have reported compliance rates with EPC production requirements higher than 80%.

Even though the Spanish EPC compliance checking system has been classified as low strength, this Member State has reported a compliance rate of 100%. The low strength scoring for Spain was mostly due to lack of information regarding Spain's ICS. Spain's response to the European Commission's request for information regarding the implementation of Article 18 of the Directive has not been published.

The strength of Estonia's compliance checking system has also been classified as low (42% rating), although this Member State has reported a high compliance rate. This is due primarily to a less developed ICS and penalty system. Estonia's compliance checking system does not involve any on site verification. Furthermore, although Estonia has a penalty system in place for EPCs, it reported that no sanctions have been applied so far, as only small mistakes have been identified. This is regarded as a sign of low enforcement of the penalty framework.

Amongst the six Member States which have not reported a compliance rate and whose EPC compliance checking systems have been classified as low and medium strength, four are among the 25% of Member States with the lowest socioeconomic figures (gross domestic product per capita and human development index).

4.5 Conclusions

On average, levels of reported data by Member States representatives for EPC requirements are slightly lower than for MEP requirements, at 33% and 43% respectively[43]

Although levels of reported data from Member States was lower than for MEPs, the collection of a large amount of secondary source data has enabled wider coverage and triangulation of perspectives on EPC requirements. The availability of information on compliance rates does vary across the different EPC requirements. Most compliance rate data is available for the requirement to produce EPCs for newly constructed buildings, where 43% of Member States reported compliance rates. This compares to 37% of Member States for sales and 27% for rental buildings. This suggests that systems for monitoring and reporting compliance with EPC requirements are more developed for new buildings. This can be partly explained by the integrated role of EPCs in the building permitting process for new buildings and the lack of robust data on the building sales and lettings market. This is compounded by the fact that, in most cases, EPCs have a validity of ten years and a simple analysis of the EPC database in comparison to market data does not always enable compliance rates to be established.

A wide range in the level of compliance is seen across the EU

For each of the EPC requirements, compliance rates for different Member States range from very low levels (with many reporting under 10% compliance) to over 90%. As with the MEP requirements, many member states report 100% compliance, which in many cases is not credible as indicated by secondary sources that have suggested that actual compliance rates are lower than this.

The wide range suggests that significant strengthening of compliance checking approaches are required. The Member States exhibiting low compliance rates do vary depending on the specific requirement. However, Member States demonstrating lower compliance rates combined with lower "strength" EPC regimes tend to be from eastern and southern Europe.

There are signs that EPC regimes and compliance checking systems for requirements in the rental market are less developed

The lower compliance rates reported for EPC requirements in the rental market, combined with the lower number of data points particularly from Member State representatives,

[43] Note that for the purposes of this report, these statistics consider the three regions of Belgium as separate 'Member States'.

suggests that the monitoring and control systems employed in the new construction and sales markets do not extend to the rental sector. Improving these systems in the rental market is important. While investment in energy efficiency by tenants is arguably less likely than in the owner occupier sector, EPCs have the potential to play a key role in helping tenants identify buildings where running costs are lower.

A lack of clarity and specificity in the Directive has led Member States to follow different approaches to applying display EPC requirements

Some Member States (such as Ireland) have introduced a simplified approach whereby all large buildings (those with a total useful floor area over 500m^2 and since July 2015, over 250m^2) that are frequently visited by the public should have an EPC on display. This requirement applies irrespective of whether the building is occupied by a public authority.

Where Member States have closely followed the language of the Directive (such as in Poland, Spain, Sweden, the United Kingdom), in large buildings that are not occupied by a public authority but are frequently visited by the public, an EPC should be on display only if an EPC has been produced (i.e. the buildings has been constructed, sold or rented out since the requirements came into force). Implemented in this way, compliance checking and enforcement is extremely challenging and this partly explains why such little compliance checking and enforcement activity was reported. As such it is recommended that the language in the Directive be simplified to that approach used in Ireland.

Current findings suggest that there is a very low compliance rate with the display EPC requirement

The lack of clarity of the display requirements in the Directive was likely to be one of the key factors contributing to the levels of compliance seen for the display EPC requirement. It should be noted that, as demonstrated in the case of Ireland, a broader interpretation of the requirement did not lead to increased compliance. As suggested by the field visits and the lack of information on compliance rates from Member States, there is a need for broader and more intense compliance checking activities towards the display of EPCs in large buildings.

Another issue influencing the lower compliance rates with the display requirements is the lack of awareness. This affects building owners, building managers and the general public. On this issue, awareness raising campaigns aimed at all these stakeholders would be necessary.

Finally, enforcement of this requirement in buildings owned by the very same authorities which are responsible for performing such checks has also been raised as a conflict of interest affecting compliance. The introduction of schemes whereby municipalities are responsible to oversee one another might be a starting point to overcoming this self-enforcement issue.

There was a low focus on compliance checking regarding requirement to share EPC data with prospective owners / tenants

This was demonstrated by the low levels of reported compliance rate data points from Member State representatives. This is a challenging requirement for Member States to enforce and it lends itself well to the use of voluntary agreements where the Member State works closely with the industry to encourage a voluntary code of conduct.

Evidence suggests that the EPC is still not a primary tool in the decision-making process for buyers and tenants

Evidence from the qualitative interviews during the fieldwork and the online questionnaires with real estate stakeholders suggests that energy performance is still not proving to be a key component of the decision-making process for buyers and tenants. Trust in the accuracy and relevance of the data they contain, combined with low awareness are the key barriers reported. Ongoing efforts to improve the accuracy of the EPC calculation methodologies as well as the relevance of the associated recommendations should continue.

There was a low focus on compliance checking regarding requirement to share EPC data with prospective owners / tenants

This was demonstrated by the low levels of compliance rate data points from Member State representatives. This is a challenging requirement for Member States to enforce and it lends itself well to the use of voluntary agreements where the Member State works closely with the industry to encourage a voluntary code of conduct. Focusing enforcement activities on the requirement to advertise energy performance information of properties in media for the real estate market would be a simpler obligation to enforce. It may also provide more benefits as it helps raising awareness among prospective tenants and buyers, which allows energy performance to be considered when choosing a property.

5 Framework conditions and their influence on compliance

5.1 Introduction

As a result of the literature review, Member State consultations, surveys and field work, the study team has gathered information on other factors which are considered to influence compliance rates for both MEP and EPC requirements.

The following two sections seek to group these into a series of themes, illustrated with Member State examples.

5.2 The influence of framework conditions on MEP compliance

ICF's research identified several factors which influence MEP compliance levels across Europe. These include:

- Political control and localised implementation
- Social and cultural factors
- Financial factors including fuel prices and fiscal support
- Owner occupation
- Enforcement
- Costs of compliance to the construction sector
- Influence of construction sector skills and competence levels on compliance
- Loss of skilled workers from the sector
- Knowledge sharing and good practice guidance

Each of these factors is discussed below.

5.2.1 Political control and localised implementation

In Austria, the setting of MEP requirements and their implementation are under local control and a level of competition between regions has served to increase standards and raise achievement levels. Public authorities also lead by example which has helped wider public acceptance and a drive towards higher standards. For example, many local authorities have built according to Passivhaus standards and openly advertise this fact. Niederoesterreich (one of the Austrian Laender) set itself a target from 2008 that all public new buildings would be built according to Passivhaus standards (this applies to hospitals etc.).

In Belgium, it was reported that relatively few resources are committed by local authorities to MEP compliance matters (BE, CEBC member).

The level of political priority given to energy efficiency in buildings is seen as a key factor in influencing compliance. Conversely, political stability as well as more human/economic resources as well as Information Technology infrastructure within the Ministry responsible for implementation, are required to boost compliance in Greece. Cyprus also reported that compliance with MEPs (and the EPBD in general) is constrained by limited economic and human resources.

In some Italian regions there is low political priority given to energy efficiency combined with low levels of resource for local authorities.

5.2.2 Social and cultural factors

In Cyprus, where compliance is also high, social endorsement and acceptance has a major influence on compliance for such a small community. In contrast, while Greece agreed with this sentiment, it reported that "understanding around energy performance and culture is still low [and], this affects compliance rates". In the UK, cultural resistance to doing additional works which have been not planned was cited by one CEBC member.

5.2.3 Financial factors including fuel prices and fiscal support

In Greece, high energy prices are helping to improve compliance levels, but more so for existing buildings than newly constructed buildings. However, the financial costs associated with energy performance measures do hinder compliance.

While high compliance levels in Hungary are primarily a result of a lower level benchmark of energy performance for their building stock, over the last ten years natural gas prices in Hungary have increased three-fold. This has resulted in raised awareness of energy efficiency and led to widespread adoption of better insulation in Hungarian buildings.

Likewise, in Sweden, the higher energy prices experienced over the last few years (due to higher taxation) have increased the drive towards energy efficiency performance. Other factors which have influenced compliance positively include correlation with other policies (such as carbon taxes, energy taxes), financial subsidies for renovation, energy efficiency awareness and a developed housing industry with focus on insulation and ventilation.

Austria's subsidy scheme operates in a way that rewards higher energy performance of new build or refurbishment with higher funding levels. Austrian banks which provide financial aid for energy efficiency have also deployed energy advisors to raise awareness and facilitate support to consumers.

In Flanders, a key success factor is the alignment of support mechanisms with property tax reductions and subsidies.

In Germany the KfW financial support programmes for building energy efficiency are a huge success, to the extent that it is actually more common to talk about "KfW standards" than about energy efficiency requirements laid down in the EnEV and other legislations. A €1.8 billion package has been directed towards the issue. However, it is recognised that this sort of scale of financial support is not easily replicable across other Member States.

Under its social policies, the Hungarian government provides subsidies to households, in the form of cash payments given according to each family's number of children and the dwelling's overall energy performance. Although the subsidies are not large (equivalent to about €100) this is thought to be an additional factor contributing to a high compliance with the MEPs.

Another factor influencing compliance positively is the fact that in Lithuania, after building modernisation and retrofit of measures, a dwelling's value increases considerably.

According to one CEBC member, in the UK the main reason for non-compliance is financial (i.e. associated with the cost of works).

5.2.4 Owner occupation

In Italy, high levels of owner-occupiers have led to higher rates of compliance. Conversely, compliance levels are affected in Sweden by the low level of owner-occupation.

5.2.5 Enforcement

In Flanders, the combination of strict enforcement of controls of the 'as-built' situation and the imposition of fines for non-compliance has been a key element of the Region's success.

The introduction of MEP requirements for rental properties in the UK (covering both domestic and non-domestic) from 2018 should drive up compliance rates for poorly performing properties.

5.2.6 Costs of compliance to the construction sector

Overall, the construction lobby is felt to have had a strong influence on the EPB issue in Belgium. In a country where nearly 80% of tenants are owners of their building, the construction sector is apparently putting a lot of pressure on the government to reduce the

burden generated by the EPB regulation. The construction sector argues that (in Wallonia) the EPB regulation generates a cost which adds additional cost to buildings, resulting in lack of affordability and access to ownership for potential building purchasers.

This concern is also expressed by France, who stated that the costs of meeting the MEPs are often a barrier for small builders.

In contrast, Denmark has committed to long term standards for MEPs and has found that this has significantly driven the market for improved energy efficient building products.

5.2.7 Influence of construction sector skills and competence levels on compliance

In France, many smaller builders are not aware of the EPB requirements. Local inspectors need to communicate more with construction professionals ensuring that they are aware of the need to go through a thermal design office.

In Ireland, larger, professional house building contractors are considered to be better versed in the requirements and compliance than smaller, independent builders. Compliance has primarily been driven by industry professionals who are working to ensure that rigorous high standards are applied across the industry.

In Wallonia, a 'licence to operate' is given to existing professionals in different areas (e.g. architects, engineers etc.). However, a lack of specialisation in the energy performance in buildings profession has impacted negatively upon compliance rates in the Region. Similarly, lack of knowledge of project developers on the EPB regulation is thought to affect compliances rates (e.g. low compliance rates on ventilation requirements).

5.2.8 Loss of skilled workers from the sector

The economic recession and fall in levels of construction in Ireland since 2008 has also affected compliance, mainly because there has been a loss of skill sets within the industry as people have moved into other sectors. In Italy, the building sector has almost stopped since the start of the financial crisis so there are only very limited numbers of new buildings; and most of them are concentrated in the north of Italy.

5.2.9 Knowledge sharing and good practice guidance

A number of initiatives across Member States are helping to raise standards and improve compliance, including:

- In Finland, cooperation between the building and construction sectors and the active involvement of professionals in the field has ensured that the legislation and building codes are well complied with. Their early involvement has also ensured that measures developed together are readily accepted in the field.
- Flanders strongly supports voluntary actions within the construction sector including pioneering companies who test new processes and materials for improving building efficiencies. A successful pilot phase often leads to fast and wide acceptance by the sector.
- In Hungary, a new EPC collection form has allowed public authorities to gather opinions of the controllers. All experts are asked to write a one page expert opinion in each control period. Several recommendations have already been forwarded to the responsible Ministry of Interior, including advice on improving domestic legislation.
- In the UK, the Zero Carbon Hub (UK) has produced the "Builders Book" which illustrates detailed technical and practical solutions to help overcome those construction challenges which have a significant impact on building energy performance.

The box below summarises some overall perspectives gathered from eleven survey responses from CEBC members.

CEBC members views on framework conditions for MEP compliance

The consensus from members of the CEBC was that the expensive cost of building energy efficiency works energy efficient products were the main factors that drive down compliance rates. A cultural resistance to implement energy efficiency improvements were also mentioned in some Member States along with a lack of incentives to do so. CEBC members that commented also thought that, overall, EU policy in the area of energy performance of buildings could be improved by strengthening enforcement regimes and education of all professionals and those involved in the industry.

Source: ICF survey

5.3 The influence of framework conditions on EPC compliance

ICF's research identified several factors which influence EPC compliance levels across Europe. These include:

- Property type and ownership rate, building density and property values
- Public awareness and understanding of the EPC
- Incentives to act
- EPC calculation methodology
- EPC control system
- Regional variations

Each of these factors is discussed below.

5.3.1 Property type and ownership rate, building density and property values

The high property ownership rate in Austria represents an important incentive for investing in energy efficiency because owners are more inclined to implement the advice in the EPC report.

In Italy, the production of EPCs shows a clearly visible upwards trend, especially in 2014. Since the number of new buildings in Italy has been very low post the economic downturn in 2008, most of the EPCs are linked to existing buildings.

In Finland, professional inspection is much more costly for detached houses (nearly half of the building stock) than for apartments, whose tenants/owners can often share the costs. Therefore, owners of old single-family houses feel they are being treated unequally.

In Hungary, the requirement that the EPC number is included in any property sale/letting contract is a key driver for compliance.

In Sweden, the low population density in the north of the country, coupled with the large number of small houses (e.g. holiday homes) in some regions, makes energy certification very expensive. This has a negative impact overall on compliance[44].

In the Brussels Capital Region, compliance rates are affected by the price of the building. The more expensive a building, the higher the compliance rate.

5.3.2 Public awareness and understanding of the EPC

In Estonia, the requirement to produce an EPC is often seen by the population as a bureaucratic obligation and there is a lack of confidence in its utility and in the calculated energy performance which reportedly varies greatly from real-world usage. On the other hand, it is common practice amongst buyers and tenants to request a property's energy bills

[44] ICF understands that Sweden has decided that holiday homes are exempt from certain MEP requirements and therefore has sought to reduce the cost burden on owners of holiday homes.

in order to estimate future energy expenses. Therefore, despite a lack of trust in the information offered by EPCs, Estonians do demonstrate high levels of overall energy efficiency awareness. This greater awareness towards energy efficiency may be attributed to the recent rise in the prices of energy. As most buildings have been built long ago under Soviet rule, at a time when energy prices were low, and hence buildings tended to be quite inefficient.

In Lithuania, currently the awareness and value attributed to EPCs is greater for commercial renters than for residential rentals, because most commercial occupiers require the information presented in the EPC to make an optimal decision. For residential occupiers, most people are interested in understanding building energy demand, but do not see value in the EPC to provide that information, instead relying on a buildings' energy bills.

In Slovenia, the adoption of EPCs was late mainly because of a negative and bias image of EPCs portrayed by the Slovenian media (e.g. Will the EPC collapse the real estate market in Slovenia?[45]). The prevailing mood was also hostile in Slovenia because of a proposal for a new real estate tax.

In Wallonia, EPCs used to take a long time to be issued and even then provided little information (which made independent verification of a Qualified Expert's work difficult). For these reasons, landlords regarded EPCs as an additional burden. Consequently, efforts were made by the administration to simplify the EPC content and make it more understandable by the general public.

5.3.3 Incentives to act

In Italy, a tax rebate available for significant renovations might also have had an important impact on the compliance rate of EPCs for existing buildings and for refurbished building. This is because in order to qualify for the rebate a copy of the new EPC had to be included in the application.

In Portugal, the Fund for Energy Efficiency has provided incentives for certified dwellings to increase their energy efficiency. ADENE has also undertaken an information campaign, offering technical support on its website, where there is a FAQ section. It has also issued brochures and other marketing pieces aimed at raising awareness of the general population and real estate agencies towards the importance of the EPCs. This includes the creation of an online portal (http://www.casamais.adene.pt/[46]) inviting users to estimate their approximate energy consumption by inputting some straight forward data. This portal is used for promotional purposes only.

5.3.4 EPC calculation methodology

In Belgium, regional variations are observed because software and approaches for calculations differ across the three regions.

In Estonia, energy use estimates are often based on an assumption that room temperatures are actually lower than real conditions during winter months and higher than real conditions during summer months. However, changing the methodology in order to reflect this actual behaviour is not seen as sensible since it would penalise those users whose behaviours are more consistent with the methodology assumptions – i.e. who have more energy efficient habits.

In Finland, the energy performance calculation method is causing building owners resentment toward EPCs. Indeed, the chosen method multiplies energy performance by the national primary energy figure (electricity 1.7, oil 1.0, district heating 0.7, renewables 0.5 and district cooling 0.4). However, houses heated by electricity, which represent almost half of

[45] See for instance DELO http://www.delo.si/gospodarstvo/okolje/bo-energetska-izkaznica-zrusila-trg-nepremicnin.html

[46] Accessed July 2015.

detached houses, are penalised because the method results in EPC energy consumption that is much bigger than actual energy consumption. Finnish citizens find this very unfair.

In Portugal, the EPC overall is not regarded as a representative source of information of a dwelling's energy demand and related energy expenses. This is because the energy demand shown by the EPC represents only 45% of the average overall energy demand of a dwelling in Portugal. Due to the mild Portuguese weather, a large proportion of energy consumption in dwellings is attributable to electrical equipment.

5.3.5 EPC control systems

In Greece, severe resource constraints are limiting EPC checks. An increase in budgets could lead to an improved control system through mobilising more staff. Greece also suffers because interoperability is required to link up EPCs with building rentals (for example, coordinating with town planning authorities/tax offices).

In Italy, the level of usage of digital systems differs widely amongst regions. This has an impact on the registration of EPCs and the monitoring of compliance.

5.3.6 Regional variations

According to an Italian national report on the EPBD[47], the implementation of the Directive has been a very slow process and is still considered a "work in progress". Additionally, important differences in compliance and quality exist between Italian regions. The differences can be related to the following factors:

- The different interpretations and implementation of the EPBD at regional level;
- The difference in human and financial resources and technical competencies; and
- Differences in "administrative public authority culture" where some Italian regions are used to being more proactive in developing their own systems and enforcing compliance, while other regions have longer implementation times and prefer to introduce tried and tested systems.

5.4 Proposed tools and methods to assess and increase compliance

The literature describes a number of ways to understand and address compliance issues.

According to Pan and Garmston (2012), there seems to be a positive correlation between EPC compliance and compliance with energy building regulation. The results of their energy compliance profile suggest that the dwellings for which an EPC is issued are more likely to achieve compliance with the building regulation. These findings imply that EPCs might encourage the involvement of the suppliers (e.g. builders and developers) of new build homes and their energy consultants in the energy performance assessment process.

Luis Pérez-Lombard (2010) introduced and described two ways to achieve compliance, referring to either prescriptive or performance-based approaches. In the prescriptive path, the codes tend to provide a list of rules, prescriptions or requirements to assure easy compliance and enforcement. This approach is often criticised for its lack of flexibility to promote innovation, for reducing freedom of design and giving particular rules priority over global goals. The performance path, in contrast, is a "normative approach that gives goals priority over requisites". This approach has the advantage of encouraging innovative solutions and permits trade-offs with prescriptions. This path, however, requires the definition and quantification of the global goal and the determination of explicit and achievable targets.

Yu et al. (2014) have emphasised the need to evaluate compliance "in order to build trust among stakeholders and instil confidence in the market to deploy and invest in energy-efficient building technologies". Compliance evaluation commonly refers to "a set of

[47] CTI (2014) Attuazione della Certificazione Energetica degli edifici in Italia.

processes and procedures through which factual information is provided, assessed, and checked to determine whether buildings effectively meet respective energy code requirements". For the authors, a common methodology for compliance evaluation must be developed for purposes of accountability and credibility of the codes program. Another advantage of compliance evaluation is its ability to assist states in tracking the progress of energy performance codes implementation.

The need to integrate measurement and verification into the EPBD has been emphasised by Burman et al. (2014). This is said to ensure that measured energy performance is consistent with the intended performance under identical operating conditions.

As far as EPC evaluation is concerned, Buratti et al. (2014) have stressed the fact that revisions to certificates are often too costly and time-consuming. To solve this problem, they have proposed a fast and less expensive method to perform building inspections called Neural Energy Performance Index (NEPI). This is said to be capable of identifying with a degree of certainty when there is a perfect correlation between EPC data and the overall energy performance of a building.

For Pan and Garmston (2012), a key to addressing the lack of compliance with building energy regulations is training. In addition, the awareness of building energy regulations must be raised with both builders and building controls. Also, policy must be strengthened in terms of giving mandatory directions in place of suggested guidance (2013).

6 Missed energy savings

6.1 Overview

The study has used the findings of research and consultations with Member States, regarding levels of compliance with national legislation, to generate estimates of the missed energy savings associated with any non-compliance that was identified. These estimates covered the whole of the EU-28 and related to non-compliance with the three MEP requirements set out in section 3. It does not encompass any missed energy savings that may occur as a result of non-compliance with any of the EPC requirements covered by this study. Similarly, it does not assess any missed energy savings stemming from national transposition measures resulting in incomplete or not fully conform transposition of the legal requirements in the EPBD as these were not covered by this study. The requirements covered by these estimates are set out below:

- Application of MEP requirements for new buildings: new buildings must meet the MEP requirements set by the Member State [A1];
- Application of MEP requirements for existing buildings: when a building undergoes major renovation, it must meet the MEP requirements set by the Member State [A2]; and,
- Application of MEP requirements for the replacement and/or retrofit of building elements: when a particular building element is retrofitted or refurbished, it is required to meet the MEP requirements set by the Member State [A3].

The missed energy savings were estimated under three scenarios, namely:

- **Scenario 1**: missed energy savings based on national energy performance requirements;
- **Scenario 2:** missed energy savings based on cost-optimal level of requirements, as calculated under Article 4 and Article 5 of the EPBD-recast; and,
- **Scenario 3:** combining Scenarios 1 and 2 and selecting the highest missed energy savings arising from those two scenarios. This scenario was incorporated to account for Member States that had already implemented national energy performance requirements that went beyond the cost optimal levels.

The basis for the missed energy savings calculations across the EU-28 was an analysis of five building types, covering residential and non-residential buildings, in seven Member States: Belgium, France, Italy, Netherlands, Portugal, Spain and Sweden. These Member States were selected on the basis of a set of criteria, namely:

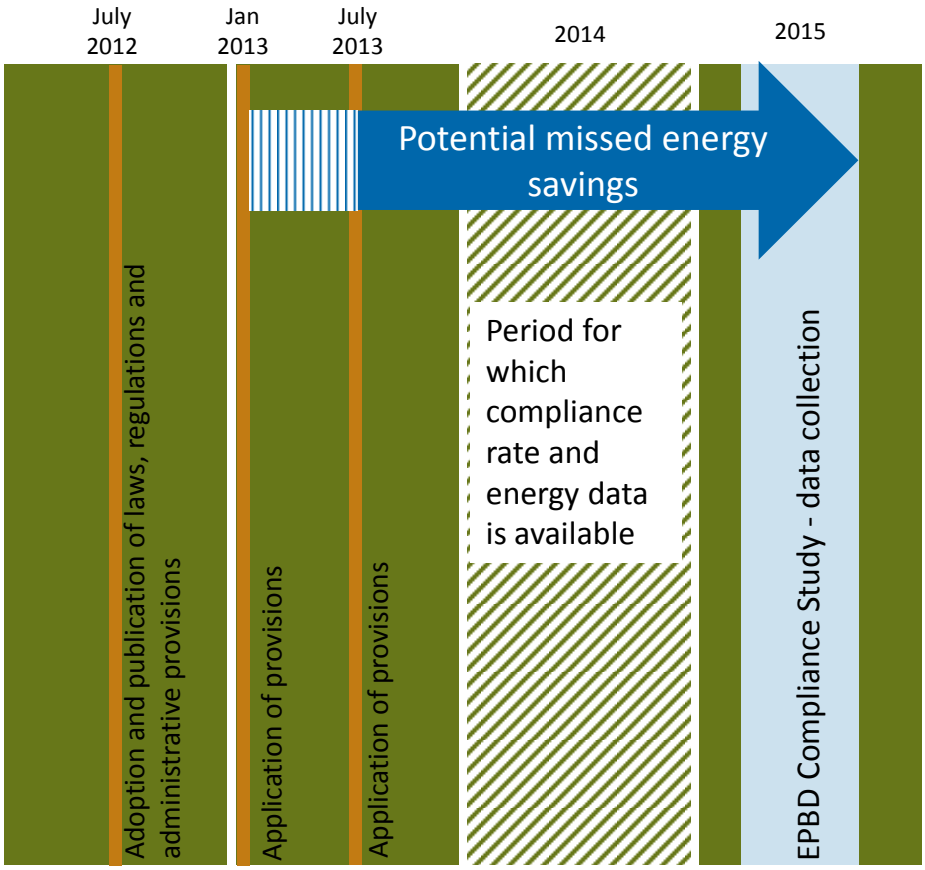
- Availability of compliance rate data for the three requirements[48]
- Availability of cost optimal reports
- Geographical diversity
- Size diversity
- MEP implementation approach

Figure 6.1 sets out the implementation timeline of the Directive, starting from July 2012 when Member States needed to have completed adoption and publication of relevant laws and regulations. Certain key requirements of the Directive needed to be fully applied by January and July 2013.

[48] All Member States in the sample had compliance rate data available for at least one of the requirements. For those gaps in the compliance rate coverage estimated compliance rates were used. These were derived based on an analysis of compliance data from Member States sharing characteristics such as “strength”, geography, economy, and population).

In theory, missed energy savings could have occurred in the period since these dates, as indicated by the blue arrow. Under this study, however, the focus of the missed energy savings estimates was the calendar year 2014. With the main consultation period for this study taking place in the summer of 2015, the year 2014 was the period for which most Member States and other stakeholders were able to provide compliance rates. It was also the most recent year for which other data sets used in the modelling were available.

Figure 6.1 Schematic showing the temporal scope of missed energy savings



6.2 Results

The missed energy savings have been established against a combined scenario (Scenario 3). Under this scenario, for all Member States where national requirements go beyond the cost-optimal levels, the national requirements are used. For all other Member States, the cost-optimal level has been used for comparison against the reference case. Under this scenario, the missed energy savings for the EU-28 for the year 2014 have been estimated to be in the region of **6.8 TWh (±4.0 TWh)**[49]. The high uncertainty around this estimate (±4.0 TWh) is a reflection of the compliance rate range.

The total potential energy savings (i.e. the energy savings that would have been achieved if a 100% compliance rate had been achieved universally) were estimated to be **16.5 TWh**. As such, overall, the annual energy saving achieved so far by Member States is approximately **42% lower** than they would have been if there had been 100% compliance with the MEP requirements.

The box below shows the detailed results for all three scenarios.

[49] By way of comparison, 6.8 TWh equates the average annual production of 1000 x 2GW wind turbines, running at 30% load factor, or alternatively half a 2GW gas turbine station running at 70% load factor.

For Scenario 1 (**national energy performance requirements**), the missed energy savings for the **EU-28** for the year 2014 have been estimated to be in the region of **6.7 TWh (±3.8 TWh).**

For Scenario 2 (**cost optimal requirements**), the missed energy savings for the **EU-28** for the year 2014 have been estimated to be in the region of **6.4 TWh (±3.7TWh).**

For Scenario 3 (**highest of Scenarios 1 and 2**), the missed energy savings for the **EU-28** for the year 2014 have been estimated to be in the region of **6.8 TWh (±4.0 TWh).**

For the avoidance of doubt, the missed energy savings estimated under this study are in addition to any potential missed energy savings which may have resulted from the incorrect transposition of the EPBD into Member State legislation. This study has not sought to quantify the latter savings, where this may have occurred.

As mentioned above, it should be underlined that these results are highly influenced by underlying factors that trigger the application of the minimum energy performance requirements and resulting energy savings. These include the activity rate in the construction and building sectors in the Member States as a result of economic considerations (e.g. effect of the crisis), availability of financing for renovation at an accessible interest rate, stage of development of the national energy service markets, rate of new vs. renovated buildings, etc. This applies also to the uncertainty ranges identified below. As detailed in the following section, new construction and renovation rates were static. On average, these were estimated to be around 0.5% across all Member States. However, higher rates would be desirable in order to contribute to the EU achieving energy and greenhouse gases emission targets until 2020[50].

6.3 Methodology

The approach illustrated in Figure 6.2 below was used to estimate the missed energy savings for the national energy performance requirement and cost-optimal level requirement.

Before estimating the missed energy savings, it was necessary to define the three cases covered by the model: the reference case, the minimum energy performance case and the cost optimal case. The reference case describes a building in a given target Member State that is not compliant with the MEP requirements set by the national legislation. In the minimum energy performance case, the building is fully compliant with the MEP requirements set by the national legislation. Finally, under the cost optimal case, the representative building's energy performance is in line with the cost optimal levels for the energy requirements[51].

As shown in Figure 6.2, the methodology adopted to model missed primary energy savings is divided into five steps. These are detailed in the sections below.

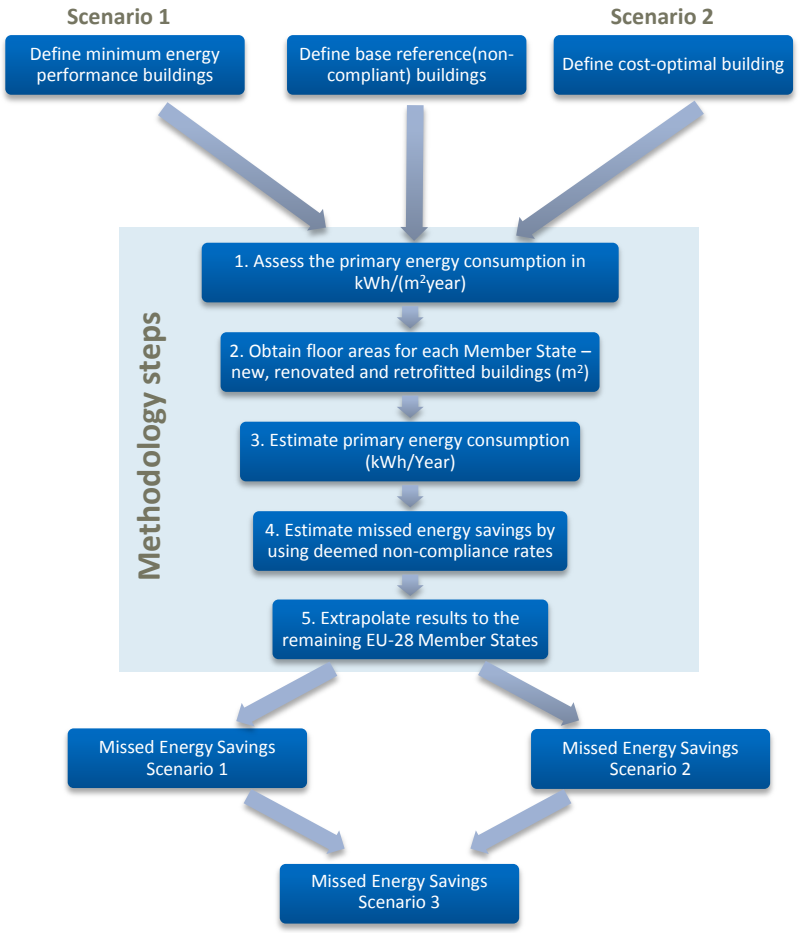
[50] European Commission (2008). Energy efficiency: delivering the 20% target. COM(2008) 772 final. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0772:FIN:EN:PDF [Accessed: 04 December 2015]

BPIE (2011). Europe's buildings under the microscope. A country-by-country review of the energy performance of buildings. Available at: http://www.institutebe.com/InstituteBE/media/Library/Resources/Existing%20Building%20Retrofits/Europes-Buildings-Under-the-Microscope-BPIE.pdf. [Accessed: 04 December 2015]

ECOFYS (2012). Renovation tracks for Europe - what are the choices?. Available at: http://www.eurima.org/uploads/ModuleXtender/Publications/90/Renovation_tracks_for_Europe_08_06_2012_FINAL.pdf [Accessed: 04 December 2015]

[51] As estimated by the national governments, following the methodology set under Articles 4 and 5 of the Directive.

Figure 6.2 The approach used for estimating the missed energy savings for national energy performance requirements



Source: ICF, 2015

6.3.2 Step 1: Assess the specific primary energy consumption in kWh/(m²year)

The specific primary energy consumption was estimated for the reference case, minimum energy performance case and the cost optimal buildings case, based on information provided in individual national reports on energy performance requirements[52]. These values were estimated for different buildings types, as shown in Table 6.1 below and are representative of different climatic conditions in each of the target Member States. The different building types for both new and existing buildings cover residential and non-residential buildings.

Table 6.1 List of building types covered

Non-Residential	**Residential**
Office Building	Single-Family Home
Commercial Building	Apartment Building
Sports Facilities	

[52] http://ec.europa.eu/energy/en/topics/energy-efficiency/buildings

6.3.3 Step 2 & 3: Obtain floor areas for each Member State – new, renovated and retrofitted buildings (m^2) – and estimate primary energy consumption (kWh/year)

The data on floor area of the building stock was obtained per building type, in each of the target Member States, using information available from the Building Performance Institute Europe (BPIE). In order to estimate the share of this area which relates to new constructions, major renovations and building element retrofits under each Member State (the target floor areas), a wide range of sources were consulted. These included the Intelligent Energy Europe Project "EPISCOPE", the websites of national statistic institutions and the websites of trade associations. It was not possible to identify consistent and comparable data on new constructions, major renovations and building element retrofit rates for all Member States.

In the case of new buildings, country specific data was applied where available. The weighted average of the new construction rates identified was estimated to be 0.5%. This value was applied across the Member States for which such country specific data was not available. The major renovation rates were the same as the new construction rates. Finally, as regards building element retrofits, values were obtained for building element retrofit for those Member States where data was available. The weighted average value was 6.6% and this estimate was applied consistently across the EU-28.

These rates were applied to estimate the target floor area subject to each one of the three requirements. The target floor area was then used to estimate the annual energy demand (kWh/year) by buildings in the reference case as well as in the minimum energy performance and the cost optimal cases.

6.3.4 Step 4: Missed energy savings estimation using deemed non-compliance rates

The missed primary energy savings for Scenario 1 were obtained by first estimating the difference between the primary energy consumption of the minimum energy performance case and that of the reference building. The resulting value was then multiplied by the non-compliance rate (i.e., the share of buildings which are non-compliant with a given requirement). This generated the missed energy savings arising from a given requirement in each of the target Member States. Similarly, the missed primary energy savings from Scenario 2 were calculated based on the difference between the primary energy consumption of the cost-optimal building and the non-compliant/reference building as well as using the non-compliance rates.

This procedure was applied to estimate the missed energy savings for every building type under each target Member State. The results were then aggregated to obtain Member State wide missed primary energy savings for the seven target Member States.

The non-compliance rates were drawn from the data available from the consultations with Member States.

6.3.5 Step 5: Extrapolation to the remaining EU-28 Member States

The missed energy saving results obtained for the seven target Member States were extrapolated to the entire EU-28 applying indicators of energy efficiency potential and floor area as differentials. The underlying hypothesis was that the missed energy savings would be higher in Member States with a larger building floor area and a larger energy efficiency potential. An unknown variable was also introduced in the model, in order to capture the impact of all other unknown parameters, including compliance rates, on the final missed energy savings estimates. It is worth noting that while floor areas and the indicators of energy efficiency potential are different for all Member States, the unknown parameter applied to all the remaining 21 Member States is static and is obtained as an average of the unknown parameter for the seven target Member States.

7 Recommendations

At present the Directive does not require Member States to monitor and report on compliance rates. Given that there is a very poor quality and quantity of data available with regards to actual compliance, introducing such a reporting requirement would push Member States to review their current procedures. However, it is recognised that introducing a report requirement introduces a set of challenges around consistency of reporting and data collection methodologies, as well as considerations of administrative burden on Member States. The primary purpose of introducing such a requirement would be to enable the Member States to refine and prioritise their supporting activities and policies to achieve the most feasible and practicable routes to improving building energy performance. As such, firstly, opportunities should be explored to encourage better data collection and reporting. The focus should be on the most important requirements in terms of those that are currently resulting in the highest level of missed savings opportunities.

7.1.1 Related to MEP requirements

Recommendation 1: It would be valuable to provide additional guidance to Member States on how to derive compliance rates in a robust and consistent way. This guidance could be built around case studies of good and poor practice, together with the implications of both failures and successes in this area. Having accurate data and feedback on compliance will enable the Member States to adapt their implementation/enforcement strategies, as well as their broader national climate and energy policies, based on what is actually happening on the ground.

Recommendation 2: A lack of transparency of future policy direction has negatively affected the construction sector, which, still remains largely reactive; not planning for future increased energy performance requirements. In light of evidence that Member States with clarity around future evolution of requirements show higher compliance rates, Member States should continue to be encouraged to set out clear pathways to achieving near zero energy buildings. This should then cascade into positive signalling to national building supply chains.

Recommendation 3: Continued support for upskilling of the construction sector workforce, and general education and awareness around energy performance within the building sector should be pursued to increase compliance levels. This should be extended to building commissioners, managers and users as well as for enforcement authorities. Calls within Horizon 2020 could be used for this purpose, for example through capacity building.

Recommendation 4: This study has not investigated the detail of individual regional application for those Member States adopting such an approach. Further exploration could provide valuable insights into regional variation of compliance rates and the underpinning reasons for such outcomes.

Recommendation 5: It is acknowledged that compliance rates are being significantly affected by the nature of compliance checking and enforcement activities, particularly in relation to the use of penalties and sanctions. Supporting information on the types of schemes operating, and examples of good practice, should be distributed amongst Member States to encourage those not currently utilising these powers of enforcement.

Recommendation 6: The majority of Member States reported that financial support needs to be provided to encourage the uptake of measures to support further energy efficiency improvements within the built environment. It is recommended that this therefore be continued wherever possible.

Recommendation 7: It is recommended that further work be carried out to establish a correlation between compliance achievement and stringency or ambition of minimum energy performance requirements. This will be particularly useful in forecasting the likely achievement levels that can be anticipated as the EU moves towards near zero energy buildings.

7.1.2 Related to EPC requirements

Recommendation 8: A lack of clarity and specificity in the Directive has led Member States to follow different approaches to the application of the display EPC requirements. For those that closely followed the text of the Directive, checking compliance is proving very challenging in terms of determining which buildings should fall under the requirement. The simplified approach taken by Ireland and Greece appears to facilitate compliance checking, and should be researched further to establish if more specific direction could be extended to other Member States.

Recommendation 9: In addition, systems to monitor and enforce the requirement to display EPCs in public buildings and large buildings often visited by the public was found to be very limited across the EU. Further consultation with Member States would be useful to fully establish what the barriers are.

Recommendation 10: The study found that in many cases more emphasis and value is placed on an EPC with building owners than tenants, although this is not universal and it depends on the specific characteristics of the property market at particular points in time. It is also acknowledged that the rental market can be informal, and is not therefore a not always as well managed or monitored in comparison with the construction and sales of property. As a result the legal systems used for achieving and checking on compliance with the use and issue of EPCs in sales do not exist for a large proportion of tenancy agreements in most Member States. The EC should review the legislative requirements within this sector to ensure that it is practicable and will deliver meaningful results and changes.

Recommendation 11: There was also widespread evidence to suggest that the EPC was still not a primary tool in the decision making process due to:

- A lack of understanding and appreciation of the value of the EPC and what information it can provide over long term commitments;
- Concern with regards to its accuracy and overall relationship with actual usage, and
- The upfront cost to the building owner of getting an EPC produced, particularly during economically challenging periods as there is no guarantee that a building put up for sale or lease will result in a successful transaction.

The EC may wish to consider working further with Estate Agent, Building and Tenant Associations to assess the opportunities for increasing the value of EPCs for tenants and building owners in the sales and letting process.

Recommendation 12: Efforts to strengthen and harmonize EPC calculation methodologies and software should continue. Best practice can also be drawn from outside the EU where similar approaches to building certificate and software are in place.

Examples of Good Practice that should be replicated:

- In Denmark Building Class 2020 prepares Danish industry for future requirements almost 10 years in advance of when they will be enforced. This allows Danish industry to adapt their products to new standards. That is one of the reasons why new very energy-efficient components are mainstream today on the market
- In the UK, the Zero Carbon Hub (UK) has produced the “Builders Book” which illustrates detailed technical and practical solutions to help overcome those construction challenges which have a significant impact on building energy performance
- The introduction of a central exam for qualified experts in Flanders (known as Energy Experts) in 2013 reduced the overall number of Energy Experts, but had a positive impact on the general level of competence. The Flemish Energy Agency (VEA) is hoping for the same result with reporters (“verslaggevers”) who have also had to take a central exam since 2015. Investing in the continuous training of such experts is seen as a way of improving compliance, by building both the quality of EPCs produced and the confidence of stakeholders in the final EPC product.

- In Hungary, ensuring that an EPC is available in rentals transactions has been addressed by introducing a requirement for a have a lawyer to sign-off any rental agreement. This lawyer is then responsible for ensuring there is an EPC number associated with that contract. Lawyers, as well as building owners and tenants, who fail to comply with this requirement are subject to sanctions.
- In Hungary, a new EPC collection form has allowed public authorities to gather opinions of the controllers. All experts are asked to write a one page expert opinion in each control period. Several recommendations have already been forwarded to the responsible Ministry of Interior, including advice on improving domestic legislation.
- In the Brussels Capital Region, over one hundred real estate agencies have been checked by authorities at random between September 2013 and September 2014 to confirm the existence of energy performance indicators in material on display in the agency or on internet sites. At the end of 2014, the first administrative fine was issued and others are expected. In the future, targeted controls will be undertaken focusing on agencies that have repeatedly been reported as not compliant. Similarly, in Portugal a fine system was established to penalise real estate agencies who do not advertising properties' energy performance. As a consequence, in 2014, the number of EPCs issued for existing buildings nearly tripled

ANNEXES

Annex 1 Compliance rates reported by Member State representatives

Table A1.1 MEP compliance rates reported by Member States

EPBD Requirements		Austria	Belgium_Brussels	Belgium_Flanders	Belgium_Wallonia	Cyprus	Czech_Rep	Denmark	Estonia	Greece	Spain	Finland	France	Germany	Hungary	Italy	Lithuania	Malta	Netherlands	Sweden	Slovakia	Slovenia	**Adjusted Overall Rating**	**Adjusted Indicator of data availability**
A1	MEP - **new build.**	100%	94%	92%	100%	99%	u/a	95%	75%	95%	100%	98%	80%	100%	100%	100%	100%	64%	70%	90%	100%	100%	**93%**	**95%**
A2	MEP – **renovation**	100%	u/a	66%	u/a	u/a	u/a	u/a	75%	95%	100%	u/a	u/a	u/a	100%	98%	100%	65%	u/a	u/a	100%	100%	**91%**	**52%**
A3	MEP – **retrofitted** building elements	u/a	u/a	94%	u/a	u/a	u/a	u/a	u/a	u/a	100%	100%	u/a	u/a	100%	93%	u/a	u/a	u/a	100%	100%	100%	**98%**	**38%**

Source: Information provided by Member States through e-mail questionnaires and telephone interviews performed by the research team.

u/a = Information unavailable.

No compliance rate data was provided by nine Member States: Bulgaria, Croatia, Ireland, Luxemburg, Latvia, Poland, Portugal, Romania, UK.

Table A1.2 EPC compliance rates reported by Member States – requirements related to the production of EPCs

EPBD Requirements		Austria	Belgium (Brussels)	Belgium (Flanders)	Belgium (Wallonia)	Cyprus	Czech Republic	Denmark	Estonia	Greece	Spain	Finland	France	Germany	Hungary	Italy	Lithuania	Malta	Netherlands	Sweden	Slovenia	Slovakia	Adjusted Overall Rating	Adjusted Indicator of data availability (%)
B1.i	Production of EPCs for newly **constructed** buildings	100%	u/a	u/a	u/a	100%	100%	u/a	75%	u/a	100%	98%	u/a	u/a	100%	100%	100%	62%	u/a	90%	90%	100%	**93%**	**62%**
B1.ii	Production of EPCs for **sold** buildings	u/a	u/a	97%	u/a	u/a	u/a	u/a	u/a	100%	100%	u/a	100%	u/a	100%	100%	100%	62%	80%	90%	90%	100%	**93%**	**57%**
B1.iii	Production of EPCs for **rented** buildings	u/a	u/a	97%	100%	u/a	0%	u/a	u/a	u/a	u/a	u/a	83%	u/a	u/a	100%	u/a	u/a	79%	90%	90%	100%	**82%**	**43%**
B2	Production of EPCs for **public buildings**	100%	u/a	u/a	u/a	40%	53%	99%	75%	u/a	31%	98%	u/a	u/a	u/a	u/a	55%	100%	u/a	0%	70%	100%	**75%**	**52%**

Source: Information provided by Member States through e-mail questionnaires and telephone interviews performed by the research team.

u/a = Information unavailable.

No compliance rate data was provided by nine Member States: Bulgaria, Croatia, Ireland, Luxemburg, Latvia, Poland, Portugal, Romania, UK.

Table A1.3 EPC compliance rates reported by Member States – requirements related to the use of EPCs

EPBD Requirements		Austria	Belgium (Brussels)	Belgium (Flanders)	Belgium (Wallonia)	Cyprus	Czech Republic	Denmark	Estonia	Greece	Spain	Finland	France	Germany	Hungary	Italy	Lithuania	Malta	Netherlands	Sweden	Slovenia	Slovakia	Adjusted Overall Rating	Adjusted Indicator of data availability (%)
B3	Use of EPCs - EPC **shown** to prospective new tenant / buyer.	100%	u/a	u/a	u/a	u/a	u/a	u/a	u/a	95%	100%	79%	u/a	u/a	100%	0%	100%	u/a	u/a	u/a	100%	100%	**86%**	**43%**
B4	Use of EPCs - EPC **handed over** to the new tenant / buyer.	100%	u/a	u/a	u/a	u/a	u/a	u/a	u/a	98%	u/a	79%	90%	u/a	100%	100%	100%	100%	25%	u/a	100%	100%	**90%**	**52%**
B5	**EP indicator stated in advertise-ments**	100%	u/a	91%	u/a	u/a	u/a	75%	13%	u/a	u/a	u/a	64%	u/a	u/a	88%	u/a	u/a	18%	57%	90%	100%	**70%**	**48%**
B6	**Display of EPCs** in public buildings	100%	u/a	u/a	u/a	48%	87%	u/a	75%	u/a	u/a	u/a	u/a	u/a	u/a	u/a	55%	100%	93%	u/a	80%	100%	**82%**	**43%**

Source: Information provided by Member States through e-mail questionnaires and telephone interviews performed by the research team.

u/a = Information unavailable.

No compliance rate data was provided by nine Member States: Bulgaria, Croatia, Ireland, Luxemburg, Latvia, Poland, Portugal, Romania, UK.

Annex 2 Compliance rates reported by other stakeholders

Table A2.1 EPC compliance rates reported by other stakeholders - Production of EPCs for constructed/ sold/ rented buildings or building units [B1]

	Austria	Belgium (Flanders)	Czech Republic	Germany	Denmark	Greece	Finland	France	Ireland	Italy	Netherlands	Poland	Portugal	Romania	Sweden	United Kingdom
Estate agent associations	65%	95%*	85%		95% & 95%	95%	u/a	95%	95% & 75%	95%	u/a & 45%	20%		95%	u/a	70%
Tenant associations	75%	35%		u/a	75%		45%	85%		u/a	85%	35%	65%		65%	
Owner associations	95%					95%	65%	75%	80%	u/a			85%		75% & 95%	u/a & 85%

Source: Questionnaire A: Estate Agents association, Questionnaire B: Tenants association, Questionnaire C: Owner association.

Question: Please provide an indicative estimate of the fulfilment rate for buildings / building units that when constructed or sold / rented out hold a valid EPC (QA.5&6, QB.5, QC.5&12).

**: In this table, the response from the estate agent representative is at a country level and not only at regional (FL) level.*

u/a: not known

Blank cell: no response received

Representatives from associations in five Member States did not respond to any of the questionnaires: Bulgaria (BG), Croatia (HR), Luxembourg (LU), Latvia (LV) and Slovakia (SK).

For the Netherlands (NL), Member State representative provided different compliance rates for buildings that were sold (73%) and rented out to a new tenant (79%). Here we took the highest compliance rate.

Table A2.2 EPC compliance rates reported by other stakeholders - use of EPCs - Percentage of transactions (sales or rentals) for which a valid EPC is shown to the prospective new tenant or buyer [B3].

	Austria	Belgium (Flanders)	Czech Republic	Germany	Denmark	Greece	Finland	France	Ireland	Italy	Netherlands	Poland	Portugal	Romania	Sweden	United Kingdom
Estate agents associations	70%	95%*	80%		95% & 60%	45%	u/a	95%	95% & 95%	95%	60% & 15%	15%		30%	75%	70%
Tenants associations	45%	25%		25%	25%		u/a	85%		65%	25%	5%	25%		5%	
Owners associations	90%					95%	65%	95%	85%				5%		u/a & 68%	u/a & 60%

Source: Questionnaire A: Estate Agents association, Questionnaire B: Tenants association, Questionnaire C: Owner association.

Question: Please provide an indicative estimate of the fulfilment rate for transactions where an EPC is shown to the prospective new buyer / new tenant. (QA.9&10, QB.7, QC.7, 8, 14&15).

**: In this table, the response from the estate agent representative is at a country level and not only at regional (FL) level.*

u/a: not known

Blank cell: no response received

Representatives from associations in five Member States did not respond to any of the questionnaires: Bulgaria (BG), Croatia (HR), Luxembourg (LU), Latvia (LV) and Slovakia (SK).

Table A2.3 EPC compliance rates reported by other stakeholders - Use of EPCs - Percentage of transactions (sales or rentals) for which a valid EPC is handed over to the new tenant or buyer [B4]

	Austria	Belgium (Flanders)	Czech Republic	Germany	Denmark	Greece	Finland	France	Ireland	Italy	Netherlands	Poland	Portugal	Romania	Sweden	United Kingdom
Estate agent associations	80%	95%*	85%		95% & 60%	95%	u/a	95%	85% & 85%	95%	65% & 45%	5%		50%	95%	70%
Tenant associations	25%	25%		25%	25%		35%	85%		65%	25%	5%	45%		5%	
Owner associations	90%					95%	65%	95%	73%				95%		75% & 60%	u/a & 85%

Source: Questionnaire A: Estate Agents association, Questionnaire B: Tenants association, Questionnaire C: Owner association.

Question: Please provide an indicative estimate of the fulfilment rate for transaction where an EPC is handed over to the new buyer / new tenant. (QA.11&12, QB.8, QC.9, 10, 16&17).

**: In this table, the response from the estate agent representative is at a country level and not only at regional (FL) level.*

u/a: not known

Blank cell: no response received

Representatives from associations in five Member States did not respond to any of the questionnaires: Bulgaria (BG), Croatia (HR), Luxembourg (LU), Latvia (LV) and Slovakia (SK).

Table A2.4 EPC compliance rates reported by other stakeholders - Use of EPCs - Percentage buildings with EP indicator or EPC stated in advertisements. [B5]

	Austria	Belgium (Flanders)	Czech Republic	Germany	Denmark	Greece	Finland	France	Ireland	Italy	Netherlands	Poland	Portugal	Romania	Sweden	United Kingdom
Estate agent associations	85%	85%*	85%		95% & 80%	15%	55%	95%	90% & 90%	95%	60% & 15%	5%		5%	75%	65%
Tenant associations	75%	35%		35%	75%		25%	75%		95%	45%	5%	35%		35%	
Owner associations	95%					5%	65%	75%	80%				95%		75% & 95%	85% & 85%

Source: Questionnaire A: Estate Agents association, Questionnaire B: Tenants association, Questionnaire C: Owner association.

Question: Please provide an indicative estimate of the fulfilment rate for buildings advertised for sale / rental with energy performance indicator or EPC stated in advertisements in commercial media.(QA.7&8, QB.6, QC.6&13).

**: In this table, the response from the estate agent representative is at a country level and not only at regional (FL) level.*

u/a: not known

Blank cell: no response received

Representatives from associations in five Member States did not respond to any of the questionnaires: Bulgaria (BG), Croatia (HR), Luxembourg (LU), Latvia (LV) and Slovakia (SK).

Annex 3 Summary of findings from fieldwork data collection and observation

This section sets out the findings from the fieldwork conducted in seven Member States to establish insights into compliance with the requirement to display EPCs in large buildings frequently visited by the public.

A3.1 Overview of findings

The preparation for the fieldwork revealed that Member States have interpreted and applied the requirement for the display of EPCs for large buildings in two different ways.

In Spain, Sweden, Poland and the UK, the requirements align closely with the text of the Directive. In large buildings that are not occupied by a public authority but are frequently visited by the public, an EPC should be on display only if an EPC has been produced (i.e. the buildings has been constructed, sold or rented out since the requirements came into force).

In Ireland and Greece, an arguably more simplistic approach has been introduced where all large buildings (those with a total useful floor area over 500m^2 and since July 2015 over 250m^2) that are frequently visited by the public should have an EPC on display.

Although buildings with a total floor area between 250m^2 and 500m^2 were also targeted as part of the fieldwork, no results have been reported in this interim analysis for this category. The reason being that the regulation for this lower threshold came into force on 9 July 2015 and since the fieldwork was carried out from mid-July to beginning of August there was not enough time for such buildings to comply.

A more detailed presentation of the findings from the fieldwork is presented in the following sections for each Member State.

A3.2 Ireland

Based on national regulation[53], all buildings over 500m^2 and frequently visited by the public need to display an EPC. This requirement applies regardless of whether or not the building is occupied by a public authority. In line with the EPBD, this threshold fell to 250m^2 on 9 July 2015. In Ireland, this kind of EPC is known as a Display Energy Certificate (DEC) and is based on operational data. However, for the purposes of this report the term EPC is being used.

The public authority responsible for the implementation of these EPBD requirements, Sustainable Energy Authority Ireland, does not hold data on buildings for which an EPC is visible to the public. Therefore, triangulation of the fieldwork findings with inputs provided by the respective authority in Ireland could not be carried out.

A3.2.1 Buildings characteristics

The cities of Tralee, Cork, Killarney and Killorglin were visited and in total 20 buildings were selected for investigation. They included from public administration buildings (e.g. town halls, court house), hospitals, as well as educational, cultural and leisure buildings (e.g. colleges, libraries, opera house, shopping malls). Overall, 10 of the buildings visited were occupied by a public authority with the rest being either semi-public buildings (4 buildings) or commercial sector buildings.

[53] European Union (Energy Performance of Buildings) Regulations 2012 (S.I. 243 of 2012). Available from: http://www.seai.ie/Your_Building/BER/EPBD/SI_243_of_2012_EPBD.pdf

The majority of them had a total floor area over 1,000m^2 with only two buildings falling under the category 500m^2 - 1,000m^2 and one below the 500m^2 threshold (with the latter excluded from further reporting as explained in the previous sections leading to an overall sample of 19 buildings).

The estimated year of construction varied from 1853 to 2008 with 90% of the buildings being more than 10 years old.

Moreover, information on EPCs display was supplemented by interviews and discussions with 14 building managers and or staff members.

A3.2.2 Findings

A3.2.2.1 Compliant buildings

Evidence from the fieldwork in the three counties in Ireland showed that few (21%, nb=4[54]) buildings visited were fulfilling the requirement for the display of EPCs. In three cases the EPCs were located in the main reception and were clearly visible to the public and for one building, an EPC was found displayed but in a less visible location.

- **EPC validity**
  Three of the four EPCs that were observed on display had already expired. These EPCs had been on display since 2011, 2012 and 2013. Of the EPCs observed on display only one was still valid; it had been issued in July 2015 and was valid until 2016.

- **EPC costs**
  Only one building representative interviewed was able to provide information on the cost of an EPC. In this instance, a cost of €500 was reported for a building over 1,000m^2.

- **Level of public interest**
  In most cases it was not possible to obtain information from the building representative regarding the level of interest shown in the EPC by members of public or users of the building. One building representative reported that there had been no interest whatsoever in the EPC from the public or from building users.

- **Checks for EPC on display and enforcement of requirement**
  Two of the interviewees responded that no one has ever sought to check whether an EPC has been on display and enforce the requirement. No information was available for the other two buildings with EPCs on display.

- **EPC as a driver of better energy performance and actual savings achieved**
  The EPC has reportedly helped drive better energy performance in the case of only one building visited. The energy manager reported that €20k of energy expenditure savings were achieved and the building had won an award as a result. In one building the EPC was reported to have had no impact on energy performance and no information was available for the remaining two cases.

A3.2.2.2 Non-compliant buildings

In total, 15 buildings visited in Ireland did not have an EPC on display representing 79% of the sample.

There were only two buildings for which an EPC had been produced but was not on display as reported by the interviewees. In one case the staff member stated that they *"would put it back in the wall straight away"*. There were another six buildings for which an EPC had not been issued (to the best of the staff knowledge).

- **Level of awareness among staff members**

[54] nb = number of buildings

Only four building managers and/or staff members interviewed were aware of the requirement to produce and display and EPC. In five cases staff were unaware with one noting that they *"had never heard anything about it"*. No information was reported for the remaining six cases.

- **Energy management measures in absence of EPC**
  Despite the absence of certificates though, the energy management of the building is considered in other ways for five of the buildings visited as indicated by the building managers/staff primarily through LED lighting and less frequently through collaboration with the Sustainable Energy Authority of Ireland or in the form of audits by city councils energy offices. In three cases the interviewee reported that no specific energy efficiency improvement activity was taking place and no data was reported for the remaining buildings.

- **Checks for EPC on display and enforcement of requirement**
  Eight interviewees reported that no-one has sought to check that an EPC is on display and enforce the requirement. No information was reported for the remaining seven buildings.

Other valuable insights from the fieldwork in Ireland relate to the lack of sufficient resources or finance to justify the production of EPCs; especially given that they are valid for only one year as stated by a hospital manager. Moreover, due to significant cut backs in the health, safety and environment sector, energy certificates were not considered a priority. Another interesting issue raised by one of the one of the interviewees in an outlet centre mall is the difficulty they face in finding external assessors. This is evident in cases where units are rented out and they are still struggling to get an EPC.

A3.3 Spain

Unlike Ireland, Spain has interpreted the display requirements of EPBD differently. More specifically, for large buildings frequently visited by the public that are not occupied by a public authority, only those that have had to produce an EPC (i.e. because the building has been constructed, sold or rented out since the requirements were introduced) should have an EPC on display.

The public body in charge of the relevant regulation does not hold data on display of EPCs in large buildings frequently visited by the public.

A3.3.1 Buildings characteristics

In total, 19 buildings were visited in the city of Valencia ranging from buildings occupied by ministries, city halls, hospitals, public schools and the police to buildings in the leisure sector such as cinemas, shopping malls and hotels. Out of these, nine were actually required to produce and display an EPC.

Out of these, five buildings had a floor area over 1,000m^2 followed by four buildings with an overall floor area between 500m^2 and 1,000m^2.

The majority of them (seven in total) were occupied by public authorities and services, with the two remaining being commercial sector buildings.

Moreover, during the data collection, face to face interviews with building managers or other members of the staff were held in all cases with valuable insights presented in the following sections.

A3.3.2 Findings

A3.3.2.1 Compliant buildings

The results of the fieldwork showed that few (22%, nb=2) of the buildings visited were compliant with the EPC display requirement. In both cases the EPCs were placed in a clearly visible location by the main entrance or at reception.

- **EPC validity**
  The EPCs were issued in 2013 and have been on display ever since with a validity period of 10 years.

- **Level of public interest**
  Regarding the level of interest shown in the EPC by members of public, no interest has been reported for the two compliant buildings as indicated by the interviewees.

- **Checks for EPC on display and enforcement of requirement**
  No one has sought to check that an EPC is on display and enforce the requirement in both cases of complaint buildings.

- **EPC as a driver of better energy performance**
  Discussions with the maintenance managers and the staff showed that to the best of their knowledge the EPCs have not been used to drive better energy performance of the building.

A3.3.2.2 Non-compliant buildings

The fieldwork found that 78% (nb=7) of the buildings visited did not have an EPC on display.

Only one of the buildings visited had a valid EPC at the time of visit which had not been on display. Two of the buildings were in the process of obtaining an EPC and the remaining four properties had not produced EPCs.

- **Level of awareness among staff members**
  Of those non-compliant buildings, discussions with building managers or other members of the staff showed that in the case of four buildings, the interviewees were not aware of the requirement to display an EPC. A typical response was that *"no one has told us that we need this certificate".* However, for two buildings, the representative mentioned that they were aware of the requirement and were in the process of obtaining an EPC for the building (both were occupied by a public authority). In one instance, the interviewee who mentioned that they believe it is not necessary to display the EPC as they own it.

- **Energy management measures in absence of EPC**
  Energy management is not considered in any way for most of the non-compliant buildings. Nevertheless, there were two exceptions; one where the building had been certified to an ISO standard (but it was not possible to establish which ISO standard was being referred to), and another case where all lights have been replaced with LED lamps.

- **Checks for EPC on display and enforcement of requirement**
  Lastly, based on the interviewees, in five of the non-compliant buildings visited, no one has ever sought to check that an EPC is on display and enforce the requirement. Only the two buildings for which the production of EPC had been planned indicated that they believed it to be requirement of the new government without necessarily stating that they had been inspected and asked to comply.

A3.4 Poland

Poland has interpreted the requirement for the display of EPCs in a similar way to Spain, UK and Sweden. For large buildings not occupied by a public authority, only if an EPC has been produced, does it need to be displayed.

No data has been reported by the relevant public authority in the Member State consultation in terms of the display of EPCs in public buildings.

A3.4.1 Buildings characteristics

In total 24 buildings were visited in Poland all located in the city of Warsaw. The selected sample covered a wide range of buildings from ministries, hospitals and courthouses to cinemas, museums and shopping malls.

Six of the buildings visited were deemed ineligible for inclusion due to their status as "historic monuments", which, in Poland, are not required to obtain an EPC. As such, the initial sample of 24 buildings was narrowed down to 18 buildings.

Most (nb=14) of the buildings visited were over the 1,000m^2 threshold. The remaining four buildings between 500m^2 and 1,000m^2. The sample was evenly distributed between buildings occupied by public authorities and properties under private sector occupancy. In terms of the year of construction, only three buildings were developed after 2007 with more than 80% (nb=15) of the sample being more than 20 years all.

During the site visits, face to face interviews were held with 10 building managers or members of staff. The results of the fieldwork along with the various insights gained from the interviews are presented in greater detail in the following section.

A3.4.2 Findings

A3.4.2.1 Compliant buildings

During the data gathering, only one of the 18 buildings visited had an EPC on display, resulting in a compliance rate for the sample of 6%.

The compliant building was a 1950 courthouse with an overall floor area of over 1,000m^2 which had undergone a major renovation and expansion in 2013 and 2014.

- **EPC validity**
  The EPC was issued in early 2015 and has been on display ever since. It is valid until 2025.

- **EPC costs**
  The cost for issuing the EPC was reported to be approximately €350.

- **Level of public interest**
  After a discussion with the building manager, it was concluded that no interest has been expressed by the public in terms of the EPC.

- **Checks for EPC on display and enforcement of requirement**
  No one has sought to check that an EPC is on display and enforce the requirement. However, the interviewee mentioned that they had received two letters from the Ministry of Infrastructure urging them to display an EPC in a visible place.

- **EPC as a driver of better energy performance**
  It was also stated that the issuing of the EPC has also helped drive better energy performance in the building to some extent as the EPC encouraged them to look at the building's lighting and water utilisation. However, it is just one of the things that they

need to take under consideration with the cost of energy being the top priority. No further information in terms of the actual energy savings achieved could be provided.

A3.4.3 Non-compliant buildings

As noted above, 17 buildings were found to have no EPC on display representing 94% of the overall sample.

Out of the 17 non-compliant cases, EPCs have been produced for two of the buildings visited but have not been put on display; a 2007 shopping centre and a public services building. Moreover, in the case of one ministerial building, a member of the staff stated that they are planning to apply for an EPC shortly after an independent audit control is carried out as part of an application for funding from the National Fund of Environmental protection where both audits and production of EPCs are among eligible activities that can receive up to 100% funding. However, even in the event of not receiving the funding they will still go ahead with the production of the EPC which is estimated to cost between 10-40k PLN depending on the subcontractor.

- **Level of awareness among staff members**
  Interestingly, only in the case of two buildings where staff members were interviewed were they aware of the requirement to display an EPC. One of the building managers was confused with the existing law and was not sure whether EPC was an obligation under the current legislative framework. One manager admitted that they were totally unaware of the relevant requirement. No further information was reported for 13 of the non-complaint buildings either because there was no one suitable was available for interview.

- **Energy management measures in absence of EPC**
  Despite the absence of an EPC, energy management is under consideration for just two of the 17 non-complaint buildings both occupied by a public authority. Based on the interviews held, they are planning an energy audit which in one case will be co-financed by the EU. No information has been reported for the other 15 cases.

- **Checks for EPC on display and enforcement of requirement**
  Only in one case was it reported that the Polish National Energy Conversation Agency had carried out a compliance check *"some time ago"*.

A3.5 Belgium

Final clarification on the interpretation of the regulation in ongoing.

During the Member State consultation, no information has been reported for any of the regions in Belgium (i.e. Brussels, Flanders, Wallonia) in terms of the compliance rates for display of EPCs in public buildings and buildings frequently visited by the public.

A3.5.1 Buildings characteristics

In total, 18 buildings were visited in the city of Leuven in Belgium with properties occupied mainly by public administration buildings (i.e. city halls, police stations), hospitals as well as leisure and cultural establishments (i.e. sport centres, museums, and theatres).

The majority of the buildings visited (13 buildings) were occupied by a public authority whereas five of them were under private occupancy.

In terms of size, all the properties had an overall floor area of over 1,000m^2. The age of the buildings ranged significantly with only six buildings constructed after 2003 and the rest of the properties being more than 20 years old.

All the buildings visited during the fieldwork were assessed as meeting the criteria for having to display an EPC.

During the fieldwork, interviews with members of the staff were held for 14 of the buildings visited.

A3.5.2 Findings

A3.5.2.1 Compliant buildings

Based on the findings of the site visits, 67% (nb=12) of the buildings had an EPC on display in a clearly visible location (such as next to the main entrance, by the lifts or next to the front desk) and 11% (nb=2) of the buildings had an EPC in a less visible location (i.e. a secondary room) leading to a number of 14 complaint buildings representing 78% of the overall sample.

- **EPC validity**
  The EPCs were issued between 2008 and 2014, are all valid for 10 years and have been on display since the date they were issued.

- **EPC costs**
  Production costs were reported only for four buildings with costs ranging from €800 (for two buildings with a floor area circa 5,000m^2 and one building over 10,000m^2) to €943 (for a building size over 1,000m^2). Interestingly, four of the buildings occupied by a public authority had issued an EPC at no cost whatsoever as the certificate was produced internally by specialised staff.

- **Level of public interest**
  Based on the feedback received from the interviews with the building managers and members of the staff, the level of interest for the EPC showed by the public was low in 13 cases with the manager of another building stating that despite having an EPC on display in the main hall no one had ever looked at it.

- **Checks for EPC on display and enforcement of requirement**
  Twelve of the interviewees replied that no one had ever sought to check whether an EPC was on display and enforce the requirement with no responses received in the remaining five cases.

- **EPC as a driver of better energy performance**
  The EPC has indirectly led to better energy performance for only one of the compliant buildings with negative responses received for 11 buildings and no information reported for two buildings.

  Among those that do not consider EPC as a driver for improving buildings energy performance, three hospital managers mentioned that their energy policy was based on a much more comprehensive energy audit which is compulsory and is conducted every four years.

A3.5.2.2 Non-compliant buildings

The field work concluded that there were four buildings not complying with the EPC display requirement representing 22% of the buildings visited in Leuven.

There was only one building visited which had issued an EPC but had not displayed it in a prominent place.

- **Level of awareness among staff members**
  During discussions held with the staff members of the buildings, two managers were aware of the requirement to display EPCs, and one of them was the building manager of the property for which an EPC had been issued but was not displayed. No replies were received for the remaining buildings visited due to unavailable of the person in charge.

- **Energy management measures in absence of EPC**

The building manager of one of the non-complaint buildings visited stated that they do consider energy management in other ways despite the absence of EPC. More specifically, the main actions taken are focused on LED lighting which was recently introduced to reduce energy consumption along with a programme adopted a few years ago aiming to optimise electricity and water use. Efforts to replace windows with high insulation glazing have also been made. No further information was reporting for the other two cases for which an EPC had not been produced.

- **Checks for EPC on display and enforcement of requirement**
  Two of the building managers reported that no checks had been made and no information was reported for the remaining buildings.

A3.6 Sweden

Sweden has interpreted the requirement for display of EPCs in the same way as Spain and the UK. Considering large buildings that are not occupied by a public authority but are frequently visited by the public an EPC must only be displayed if it has been produced during construction, sale or rental.

The supervising body in Sweden does not hold any data in terms of the number of EPCs displayed in public buildings or those frequently visited by the public. As such, no triangulation of data gathered from the fieldwork could be carried out.

A3.6.1 Buildings characteristics

The capital of Sweden, Stockholm, was visited and 15 buildings were initially selected for further investigation of the requirement to display an EPC.

The targeted properties covered mainly commercial leisure and cultural buildings such as spa, galleries, cinemas, theatres and museums representing 87% (nb=13) of the buildings visited with only two buildings occupied by public authorities.

The vast majority of them had a total floor area over 1,000m^2 with two buildings falling under the range 500m^2 – 1,000m^2 and three buildings below the 500m^2 threshold.

In terms of age, all the buildings visited were developed prior 1990 and in a few cases buildings had undergone major renovations and/or extensions after 20-60 years of construction.

Out of the 15 buildings visited in Sweden, the final sample was narrowed down to 12 as due to the recent introduction of the regulation for buildings between 250m^2 and 500m^2 the three buildings visited under this category were excluded from this analysis given the short transition period. Hence, findings in the following sections are reported for a total of 12 buildings and are underpinned by insights gathered during face-to-face interviews and follow-up calls with staff members for all the 12 buildings under scrutiny.

A3.6.2 Findings

A3.6.2.1 Non-compliant buildings

Stockholm was the only city for which none of the buildings targeted were actually complaint leading to a 0% compliance rate.

Among the buildings visited, it was found that eight buildings had produced an EPC but did not have it on display. The certificates had been issued during the period 2008-2011 and were valid for 10 years. No further information was found for the rest of the buildings.

- **Level of awareness among staff members**
  None of the members of staff interviewed during the visits were aware of the requirement to display an EPC including those managing buildings for which an EPC had already

been issued. There were only two exceptions where members of the staff were aware of such requirement. The first case was a manager who although being aware of the display requirement, was unclear whether an EPC had been produced for the building or not. The second case was a building for which an EPC had been produced with contradicting levels of awareness among its staff members (the caretaker appeared to be aware of the requirement whereas the building manager was unsure).

- **Energy management measures in absence of EPC**
  No information has been gathered on this matter for nine of the buildings visited. The other replies received varied from positive (being the case of one building without specifying actions taken) to unclear and not applicable (for the remaining two cases respectively).

- **EPC display checks and enforcement of requirement**
  The interviewees stated that no one has ever sought to check that an EPC is on display and enforce the requirement.

A3.7 Greece

Based on the national regulation[55] for buildings energy performance, all buildings over 500m^2 (and since 9 July 2015 the threshold has been lowered to 250m^2) that are occupied by a public authority and frequently visited by the public need to display their EPC.

However, the Greek Ministry of Productive Reconstruction, Environment and Energy which is responsible for the enforcement of the regulation could not provide any information in terms of the number of public buildings where EPCs are displayed as this is something that is not checked during the audits carried out for the EPCs.

A3.7.1 Buildings characteristics

The capital of Athens was selected for the fieldwork and a total of 20 buildings were visited during August.

The buildings covered a wide range of usage varying from public administration buildings such as ministries, city halls and town planning authorities to hospitals, museums, theatres, hotels and shopping malls.

Around 70% (nb=12) of the targeted buildings were occupied by a public authority with only five buildings from the private sector.

Moreover, 13 of the buildings had a total floor area over 1,000m^2 whereas the rest of the sample was above the 500m^2 threshold.

In terms of age, the buildings were evenly distributed among properties more than 15 years old and buildings constructed after 2000.

Insights were also gained from 11 interviews carried out primarily with building managers and other members of staff where available with fieldwork findings presented in the following sections.

A3.7.2 Findings

A3.7.2.1 Compliant buildings

There was only one building fulfilling the requirement to display an EPC in a visible location resulting in a compliance rate of 5% for the whole sample.

[55] KENAK – Greek Regulation for the Energy Performance of Buildings No 4122, Gazette No 42, 19 February 2013, Available from: http://www.buildingcert.gr/N4122_2013.pdf

More specifically, the compliant building was the Ministry of Productive Reconstruction, Environment and Energy (in charge of the EPBD enforcement regulation across Greece) constructed in 2002 with an overall floor area over 1,000m^2 and had an EPC clearly displayed by the main entrance.

- **EPC validity**
  The EPC was issued in February 2013, is valid for a period of 10 years expiring in 2023 and the date of display was not disclosed (as no discussion was held with any member of the staff but it could be assumed to be on display since date of production).

- **EPC costs**
  Information on EPC production cost could not be collected due to unavailability of the building manager.

- **Level of public interest**
  A member of the staff at the reception office stated that no interest has been expressed by the public in terms of the EPC issued for the ministry.

- **Checks for EPC on display and enforcement of requirement**
  No reply received due to unavailability of the building manager.

- **EPC as a driver of better energy performance and actual savings achieved**
  No reply received due to unavailability of the building manager.

A3.7.2.2 Non-compliant buildings

The fieldwork showed that 95% (nb=19) of the buildings visited had no EPCs on display.

Interestingly, only one of the buildings visited (a public hospital) had issued an EPC which was not on display. More specifically, the EPC had been produced as part of a grant application for partial building renovation in 2011 under the National Strategic Reference Framework. Although issued in 2011 the EPC was kept in the application folder and has not ever been displayed.

One building representative reported that they had just launched a tendering procedure for the selection of a subcontractor to produce the certificate.

Two non-compliant buildings were occupied by ministries which had been sold or leased out in 2014 to the real estate branch of two major private banks as part of a privatisation package of public real estate property[56] introduced by the Greek government. However, no EPCs were found on display for those two ministries although an EPC should have been produced as part of the transaction process.

- **Level of awareness among staff members**
  Five of the interviewees stated that they were aware of the requirement to display an EPC, six replied that were not aware whatsoever with no information reported for the remaining eight buildings visited.

- **Energy management measures in absence of EPC**
  No relevant information was reported for 14 cases. However, there were four cases where interviewees mentioned that energy management has not been a top priority primarily due to budget constraints imposed by the Greek government and one interviewee who mentioned that an energy performance study was currently underway and suggestions for better improvement would be made upon completion.

- **Checks for EPC on display and enforcement of requirement**

[56] http://www.tovima.gr/finance/article/?aid=488411

Eleven interviewees replied that no one had ever sought to check that an EPC was on display and enforce the requirement with no replies received for the remaining buildings.

7.1.3 UK

The UK has interpreted the requirement for the display of EPCs in a similar way to Spain and Sweden. For large buildings not occupied by a public authority, only if an EPC has been produced (i.e. the building has been constructed, sold or rented since the obligation came into force), does it need to be displayed.

No information on the number of public buildings having an EPC on display has been provided by the British Authorities.

7.1.3.1 Buildings characteristics

In total 18 buildings were visited in London, including hospitals, universities, libraries, local administrations and cultural buildings. One of these buildings, a local administration building, could not be evaluated due ongoing refurbishment.

Almost all visited buildings (nb=16) were larger than 1000 m^2, with only one bearing an area between 500-1000m^2.

Among the buildings visited, there were four local administrations, five universities and schools, five cultural centres, two hospitals and one leisure centre.

Due to unavailability of building managers, it was only possible to perform four interviews.

A3.7.3 Findings

A3.7.3.1 Compliant buildings

Although all visited buildings had an EPC, only 53% (nb=9) of them had an EPC on display. Out of those, seven buildings had the EPC displayed in a clearly visible place.

Out of the nine EPCs on display, five were expired, with one of them having been expired for over two years. At least two buildings had not been subject to any checks.

One building manager has reported the EPC has helped set the benchmark in order to improve future building energy performance.

7.1.3.1.1 Non-compliant buildings

The fieldwork showed that 47% (nb=8) of the buildings did not display an EPC, although all of them have produced one. Among those, five EPCs (62%) were expired for less than two years. There were no EPCs which had been expired for longer than two years.

For one of the uncompliant buildings, the EPC had just been removed from display due to its expiry date and the building manager stated that new EPC was being prepared. For another building, the building manager was unaware of the requirement to display the EPC.

Annex 4 MEP and EPC strength scoring methodology

A4.1 MEP scoring methodology

The regimes in place in Member States to support the implementation of the MEP requirements have been qualitatively analysed, as described under section 3. Based on the qualitative analysis, a scoring system was established in order to support a general overview of the MEP regimes across the EU-28.

The analysis of the MEP regime considers the scope of the requirements in place and the enforcement and incentives systems that exist to support compliance with the MEP requirements. Seven criteria[57] have been assessed in order to support this analysis, namely:

1. Timing of MEP regulation introduction
2. Buildings to which MEP requirements apply
3. Cost optimality of MEP requirements / future actions
4. MEP penalties framework
5. Financial incentive
6. Technical support
7. Differences in MEP requirements for new/existing buildings

For every Member State, each criteria set above is rated as either high, medium or low strength, according to Table A4.1 below. A quantitative rating system has been established and approaches under each criteria were rated two, one or zero, depending on their classification as either high, medium or low strength.

[57] It should be noted that these criteria do not cover the timing when buildings are checked for compliance with the MEP requirements. Although this criteria is regarded as relevant for safeguarding compliance, it was decided that this it should be included within the confidence rating, rather that under the strength rating. The rationale behind this decision was that the timing of compliance checking is regarded as having a greater relative influence in the confidence of the rates reported by the Member States than on the strength of their MEP systems.

Table A4.1 Criteria for Member States scoring – strength of MEP implementation system

#	Criteria	High Strength (Rating = 2) The approach is considered strong if…	Medium Strength (Rating = 1) The approach is considered medium strength if…	Low Strength (Rating = 0) The approach is considered low strength if…
1	When was the MEP regulation established?	…the MEP regulation was established before 1st January 2006, which was the deadline established under EPBD 2002	…the MEP regulation was established before 1st January 2008, 2 years after the deadline established under EPBD 2006	…the MEP regulation was established after 1st January 2008
2	Which are the buildings to which MEPs apply?	… MEP requirements apply to new buildings, buildings undergoing major renovations and buildings implementing building element refurbishment/ upgrades	… MEP requirements apply to new buildings and buildings undergoing major renovations, only.[58]	…MEP requirements apply to new buildings only
3	Did the Member State establish a cost-optimality study and was the cost-optimal level applied?	…the cost optimal level was established and adopted prior to 31 Dec 2013.	…the cost optimal level was adopted between 31 Dec 2013 and 1 Jan 2015 or a study has been carried out and a date has been set for implementing the new cost optimal level.	…the cost optimal level has not yet been established
4	Does the Member State use a MEP Penalties framework?	…there is a penalty framework and warnings, sanctions and fines are applied when needed.	-	…there is a penalty framework but it is not enforced; or if there is no penalty framework
5	Are there financial incentives to support MEP compliance? These include subsidies, grants, loan with special conditions, etc.	…there are financial incentives for projects whose final energy performance goes beyond the MEP requirements	…there are financial incentives but projects are not required to go beyond the MEP requirements	…there are no financial incentives.
6	Is there any technical support for parties implementing the MEP requirements?	...there are trainings and/or workshops in place to support upskilling of stakeholders. These are provided either by the State or by universities or other technical institutions.	…there are only guidance documents available to provide technical support.	…there is no technical support.
7	Does the regulation allow for MEP requirement differences between new/existing buildings?	…the MEP regulation establishes the MEP requirements may vary between new and existing buildings and according to other criteria, such as regional differences or building use.	…the MEP regulation establishes the MEP requirements may vary between new and existing buildings only.	…the MEP regulation does not foresee different requirements depending on building characteristics.

In the scoring system, each criteria was assigned the same weight. Therefore, in order to make up the total percentage score of each Member State, the scores under each criteria have been summed up and then divided by the maximum attainable score for this analysis, which is 14 (i.e. two times seven).

Table A4.2 below presents the scoring attributed to each Member State under each criteria. The sources of information applied for scoring the Member States were mainly the answered

[58] Alternatively, where MEP apply to new buildings and either major renovations or building elements retrofit)

questionnaires by Member States representatives, the interviews conducted with some of these representatives as well as literature review[59]. To a lesser extent, information from field work and from the stakeholder workshop has also been taken into account. Despite the study team information gathering efforts, in a few cases, it was not possible to answer the scoring questions. In those cases (10% of the scoring questions) the study team made some assumptions to allow a consistent scoring across the Member States.

Table A4.2 Strength analysis of MEP regime - final scoring

Member State	Primary mechanism	Buildings captured	Are standards in line with cost-optimal	MEP differs for new/ existing builds	Specific MEP penalties	Financial Incentives	Technical Support	Strength Scoring
Austria	0	2	0	2	2	2	2	71%
Belgium Flanders	2	2	1	1	2	2	2	86%
Belgium Wallonia	1	2	2	2	2	2	2	93%
Belgium Brussels	1	2	1	1	2	0	2	64%
Bulgaria	2	2	1	2	2	1	2	86%
Croatia	1	2	1	2	0	1	2	64%
Cyprus	1	2	1	2	2	2	2	86%
Czech Republic	1	1	2	1	2	1	1	64%
Denmark	2	1	2	0	2	0	2	64%
Estonia	1	2	2	1	2	1	2	79%
Finland	2	2	2	2	2	1	2	93%
France	2	2	2	2	0	1	2	79%
Germany	2	2	2	2	2	2	2	100%
Greece	2	2	0	0	2	1	2	64%
Hungary	2	2	1	0	2	1	2	71%
Ireland	2	2	1	1	2	1	2	79%
Italy	2	2	0	2	0	1	0	50%
Latvia	0	2	1	0	0	1	2	43%
Lithuania	2	2	0	1	2	2	2	79%
Luxembourg	2	2	1	1	2	2	2	86%
Malta	1	1	0	0	2	2	0	43%
Netherlands	2	2	2	0	2	1	2	79%
Poland	1	1	1	2	0	1	0	43%
Portugal	1	2	2	2	2	1	2	86%
Romania	1	2	0	1	0	1	0	36%
Spain	1	2	2	2	2	2	2	93%

[59] Key sources consulted during literature review encompassed the Concerted Action EPBD reports, EPBD Building Platform reports, BPIE (2014), CEBC (2006), the Build-up portal and the websites from Member States' ministries.

Slovakia	1	2	0	0	0	1	2	43%
Slovenia	0	2	2	0	2	2	0	57%
Sweden	1	1	2	0	2	1	2	64%
UK	0	2	2	2	2	1	2	79%

A4.2 EPC scoring methodology

The regimes in place in Member States to support the implementation of the EPC requirements have been qualitatively analysed, as described under section 4. Based on the qualitative analysis, a scoring system was established in order to support a general overview of the EPC regimes across the EU-28.

The analysis of the EPC regime considers the systems in place to support the production of EPCs and enforce the EPC requirements as well as the independent control system (ICS) in place for EPCs. Six criteria have been assessed in order to support this analysis, namely:

1. QEs' license to operate
2. Software and database
3. Penalty system
4. ICS – Sample selection process
5. ICS – Sample significance
6. ICS – Audit system

For every Member State, each criteria set above is rated as either high, medium or low strength, according to Table A4.3 below. A quantitative rating system has been established and approaches under each criteria were rated two, one or zero, depending on their classification as either high, medium or low strength.

Table A4.3 Criteria for Member States scoring – strength of EPC implementation system

#	Criteria	**High Strength (Rating = 2)**	**Medium Strength (Rating = 1)**	**Low Strength (Rating = 0)**
		The approach is considered strong if…	The approach is considered medium strength if…	The approach is considered low strength if…
1	How do Member States ensure that individuals producing EPCs have the adequate skills and expertise?	…the authorisation of a QE to issue an EPC is based on the following components: minimum education requirements, (voluntary/mandatory) training requirements, passing an exam and continuous professional development (e.g. min 5 years). These components can either be centrally organized or delegated to regional authorities or professional bodies.	…the authorisation of a QE to issue an EPC is based on the following components: minimum education requirements, (voluntary/mandatory) training requirements, and passing an exam. However, this does not include continuous professional development (CPD). These components can either be centrally organized or delegated to regional authorities or professional bodies.	…the authorisation of a QE to issue an EPC is based on the already mentioned components (education, training, and exam) but one or several criteria are missing. Also, continuous professional development (CPD) is not required. These components can either be centrally organized or delegated to regional authorities or professional bodies.

2	Which technical support is provided to QEs to produce EPCs?	…the EPC production is supported by one or several (public or commercial) software, which provide for an automatic quality check or are supported by a digital data protocol. The uniform and reliable interpretation and implementation of the calculation procedure of the software(s) is guaranteed by an accreditation process organized at governmental level or by a voluntary commitment of the private software suppliers.	…the EPC production is supported by one or several (public or commercial) software, which provide for an automatic quality check/digital data protocol. There is no assurance system in place (nor at government level, nor at private sector level) to guarantee the uniform and reliable interpretation and implementation of the calculation.	…the EPC production is supported by one or several (public or commercial) software. There is no assurance system in place (nor at government level, nor at private sector level) to guarantee the uniform and reliable interpretation and implementation of the calculation. Also, no automatic quality check/digital data protocol is provided.
3	Penalty framework: is there any penalty framework in place/in use for non-compliance?	…there is a penalty framework and warnings, sanctions and fines are applied when needed.	-	…there is a penalty framework but it is not enforced; or there is no penalty framework
4	Independent Control System: What is the ICS selection process?	…the Member State's ICS is based on a random check or a mix of random and targeted checks	…the Member State's ICS is based on targeted checks only	…the Member State's ICS selection process is not in place yet

#	Criteria	High Strength (Rating = 2)	Medium Strength (Rating = 1)	Low Strength (Rating = 0)
		The approach is considered strong if…	The approach is considered medium strength if…	The approach is considered low strength if…
5	Independent Control System: Is the random sample statistically significant (with respect to a 95% confidence)?	…the ICS is based on a statistically significant random sample	…the ICS is based on a random sample that is **not** statistically significant	…the Member State's does not carry out random checks
6	Independent Control System: How is the EPC audit performed?	…the ICS involves all options A, B and C in various samples - full check of the input data of the building used to issue the EPC, full verification of the results stated in the EPC (option A), including the recommendations made (option B), and on-site visit of the building, if possible, to check correspondence between specifications given in the energy performance certificate and the building certified (option C)	…the ICS involves both options A and B to different samples OR at least option C to one sample - check of the input data and verification of the results of the energy performance certificate, including the recommendations made	…only option A OR B is performed - validity check of the input data of the building used to issue the energy performance certificate and the results stated in the certificate

In line with the MEP strength methodology described above, under section A4.1, each criteria was assigned the same weight in the EPC strength analysis. Therefore, in order to make up the total percentage score of each Member State, the scores under each criteria have been summed up and then divided by the maximum attainable score for this analysis, which is 12 (i.e. two times six).

Table A4.4 below presents the scoring attributed to each Member State under each criteria. The sources of information applied for scoring the Member States were mainly the answered questionnaires by Member States representatives, the interviews conducted with some of these representatives as well as literature review[60]. To a lesser extent, information from field work and from the stakeholder workshop has also been taken into account. Despite the study team information gathering efforts, in a few cases, it was not possible to answer the scoring questions from the data sources consulted. In those cases (4% of the scoring questions) the study team had to make some assumptions.

Table A4.4 Strength analysis of EPC regime – final scoring

Member State	QEs' license to operate	Software and database	Penalty system	ICS – Sample Selection process	ICS – Sample significance	ICS – Audit system	Strength Scoring
Austria	0	0	2	2	2	2	67%

[60] Key sources consulted during literature review encompassed the Concerted Action EPBD reports, BPIE (2014), and the websites from Member States' ministries.

Member State	QEs' license to operate	Software and database	Penalty system	ICS – Sample Selection process	ICS – Sample significance	ICS – Audit system	Strength Scoring
Belgium Flanders	2	2	2	2	1	1	83%
Belgium Wallonia	2	2	2	2	2	2	100%
Belgium Brussels	2	2	2	2	1	1	83%
Bulgaria	2	2	0	2	2	2	83%
Croatia	2	0	2	2	1	0	58%
Cyprus	1	2	2	2	2	2	92%
Czech Republic	2	0	2	2	2	2	83%
Denmark	1	2	2	2	2	2	92%
Estonia	2	0	0	2	1	0	42%
Finland	2	0	2	2	1	1	67%
France	2	2	2	2	2	1	92%
Germany	0	2	2	2	1	2	75%
Greece	0	0	2	2	2	1	58%
Hungary	2	0	2	2	2	2	83%
Ireland	2	2	2	2	1	1	83%
Italy	1	2	2	2	2	2	92%
Latvia	1	0	0	0	0	0	8%
Lithuania	2	2	2	2	2	2	100%
Luxembourg	0	2	2	2	1	1	67%
Malta	0	0	2	2	1	1	50%
Netherlands	2	2	2	2	1	0	75%
Poland	0	0	0	0	0	0	0%
Portugal	1	0	2	2	2	2	75%
Romania	2	0	2	2	1	0	58%
Spain	0	0	0	1	0	0	8%
Slovakia	1	0	0	2	1	1	42%
Slovenia	2	2	2	2	1	1	83%
Sweden	2	0	2	2	1	0	58%
UK	1	2	2	2	2	2	92%

Annex 5 MEP confidence scoring methodology

A5.1 Introduction

As presented under section 3.4, the Member States have different monitoring, control and quality assurance systems in place to assess the compliance rates with the MEP requirements. The way these systems are organised have great influence on the confidence that could be attributed to the compliance rates reported by Member State representatives under this study. A confidence assessment framework has been developed in order to address this issue.

This assessment involved both a qualitative and a quantitative approach. Under the qualitative approach, the study team has qualitatively analysed the information flows and mechanisms for assessing, documenting and centralising compliance information, as described in Figure A5.1. Based on such analysis, a scoring system was established in order to translate it into a quantitative assessment. As is described in Annex 6, this scoring system was applied to adjust the compliance rates reported by Member States, which were fed into the missed energy saving analysis, presented in section 6.

Figure A5.1 Components of confidence assessment framework

Quality Assurance (QA) System	The quality assurance (QA) system refers to any procedure aimed at checking the accuracy of the data input in the energy performance database (EP database). In the absence of a database, the QA system refers to any procedure aimed at checking a sample of buildings for compliance with the MEP requirements. Where an EPC is required to demonstrate compliance with the MEP requirements, the Independent Control System (ICS) may be considered a QA system.
Energy Performance (EP) Database	The energy performance (EP) database refers to any centralised platform which periodically or systematically gathers information on the energy performance of all new (as a minimum). It may be an online platform or simply a spreadsheet kept by a central body. Databases kept by subnational (e.g. regional) governments are not encompassed by this definition
Building Control System	The building control system refers to the system by which the buildings' energy performance is first checked. It will normally refer to the checks performed by subnational building control authorities when a building requires a permit to build or use/occupy. These checks can take place at different points in time (design, construction and completion stages) and be based on different approaches (desk based or on-site).

Source: ICF

Although all Member States have a building control system in place, not all have implemented an energy performance database or have performed any quality assurance study so far. Furthermore, even though a Member State may have a database in place, there are some cases under which this database does not get to be applied to report a compliance rate.

Given the above, seven compliance rate information scenarios have been structured to reflect the different configurations Member States have applied to report compliance rates under this study. Ultimately, such scenarios describe how Member States have combined the monitoring, control and quality assurance components described above to report a MEP compliance rate, as shown under Figure A5.2.

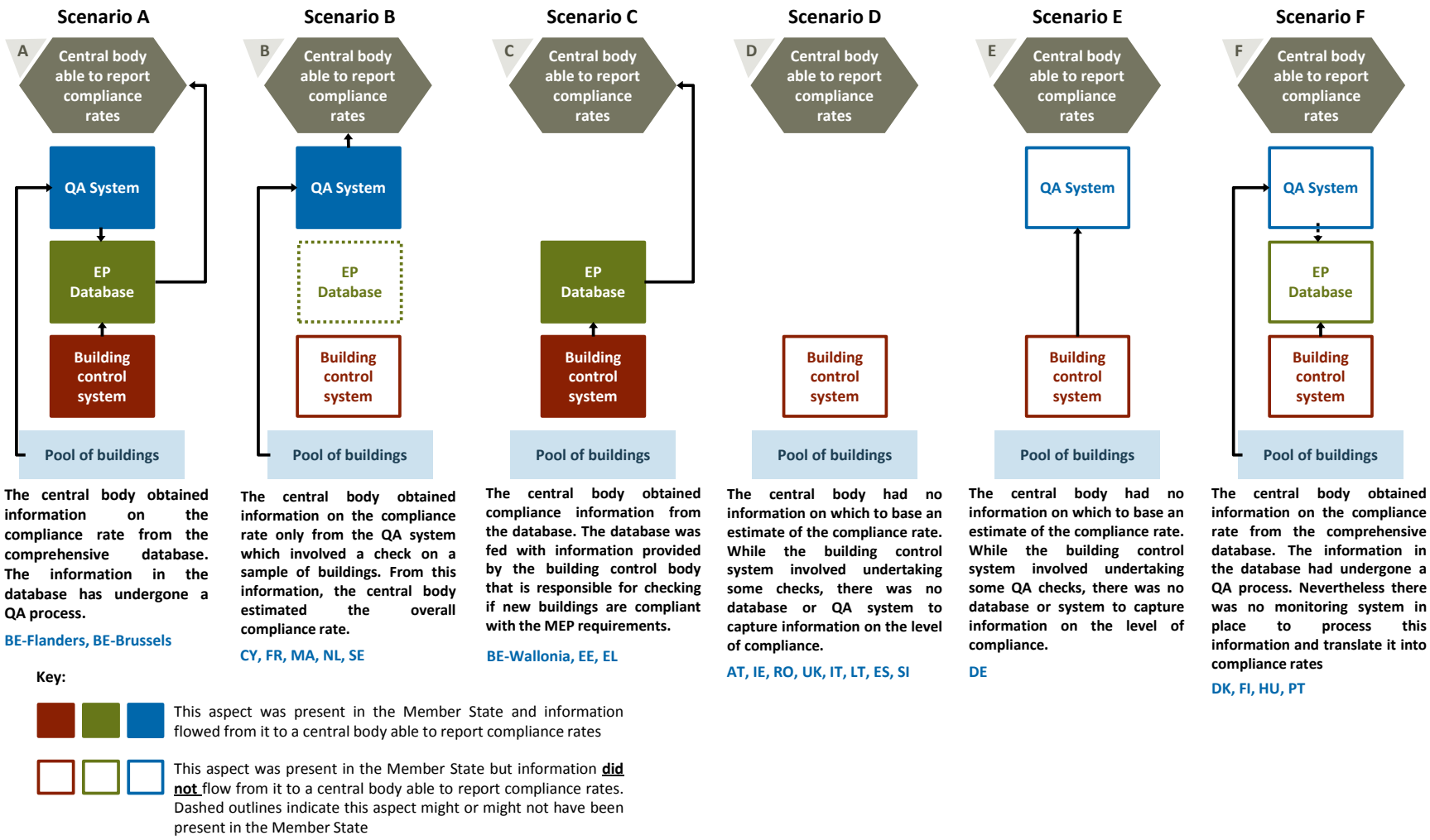


Figure A5.2 Monitoring, control and quality assurance scenarios

Under scenarios A, B and C, there is an information flow from at least one of the components to a central body able to report MEP compliance rates. In contrast, scenarios D, E and F describe systems where there may be compliance monitoring systems in place (i.e., databases or quality assurance studies), but the central body does not have enough information or institutional structure to monitor compliance rates. These include, for instance, Member States which have a regionalised governance structure, under which some regional governments perform quality assurance studies, or have comprehensive energy performance databases in place. Nevertheless, those regional governments are not required to report back on their monitoring to the central government.

Following the grouping of Member States under each scenario, the next stage was to characterise the components that make up each monitoring, control and quality assurance scenario in each one of the Member States. This was necessary because there are different approaches to establishing a buildings control system, an energy performance database and a quality assurance system. As a first step under the quantitative approach of the confidence assessment framework, the different approaches adopted under each component were attributed a rate, as described in Table A5.1, Table A5.2 and Table A5.3.

Table A5.1 Building control systems – characterization of approaches and scoring methodology

Level of confidence	Rating	Building control systems (BSC) The BCS will be rated "x" if…
Higher confidence	1	…there are desk based checks at either design or construction phases (or both) and all buildings undergo an on-site check at completion stage
↓	0.512	...there are desk based checks at either design or construction phases (or both) and at completion stage. Only some buildings undergo an on-site check at the completion stage OR …there are desk based checks at either design or construction phases (or both) and at completion stage. All buildings are checked at construction phase
	0.216	…there are desk based checks at either design or construction phases (or both) and at completion stage. No buildings undergo on-site checks at any stage.
	0.064	…no checks are performed at the completion stage. There is a desk based check at design stage and all buildings undergo on-site check at the construction stage. OR …no checks are performed at the completion stage. There are desk based checks at design and construction phases. Some buildings undergo on-site checks at the construction stage. OR …buildings are only checked through a desk review and at completion stage.
Lower confidence	0.008	...no checks are performed at the completion stage. There is a desk based check at design and/or construction stages.

Under Table A5.1, it can be noticed that the rating range applied to the approaches have an exponential structure. This aims to reflect the fact that any approach which does not include an on-site visit at the building completion (either by a governmental body or an accredited professional) is likely to bear a low confidence.

Table A5.2 Energy performance (EP) data control – characterization of approaches and scoring methodology

Criteria	High Confidence (Rating = 2)	Medium Confidence (Rating = 1)	Low Confidence (Rating = 0)
	The approach is considered to provide high confidence if…	The approach is considered to provide medium confidence if…	The approach is considered to provide low confidence if…
EP Data control practices for buildings covered by MEP requirements	…a comprehensive energy performance database is available, including all buildings required to comply with the MEP requirements	-	… an energy performance database is available or under preparation but is not comprehensive; or no data is captured on energy performance
Geographical scope of EP data control	…data on buildings energy performance (EP) centrally gathered and input under a centralised database	…data on buildings energy performance (EP) is gathered by subnational bodies and input under a centralised database	…there is no central control of buildings energy performance (EP) data; or there is no MEP compliance data management

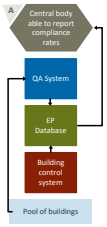
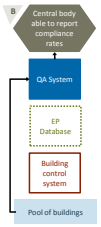
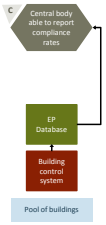
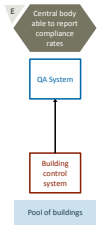
Table A5.3 Quality assurance systems – characterization of approaches and scoring methodology

Criteria	High Confidence (Rating = 2)	Medium Confidence (Rating = 1)	Low Confidence (Rating = 0)
	The approach is considered to provide high confidence if…	The approach is considered to provide medium confidence if…	The approach is considered to provide low confidence if…
Geographical scope of quality assurance	...quality assurance activities are run by a central body, which is also responsible for bringing non-compliant cases to compliance	...quality assurance activities are run by a central body, but subnational bodies are responsible for bringing non-compliant cases to compliance	...quality assurance activities are run by a regional body, which is also responsible for bringing non-compliant cases to compliance
QA approach	…the QA is performed via on site verification on a statistically significant random sample; or if all buildings are subject to QA visits.	…the QA is performed via on site verification on either a targeted or a not statistically significant random sample; or the QA is performed via desk review of all or a statistically significant random sample	…the QA is performed via desk review of either a targeted or a not statistically significant random sample
Currency of QA	…2014 is the base year for the QA	…2013 is the base year for the QA	…the QA base year if before 2013

Each of these components were attributed the same weight when making up the total confidence score per Member State. Therefore, under the final score, the ratings relating to the data control and QA components were divided by two in order to have the same weigh as the building control system component.

As aforementioned, not all Member States have all components in place under their monitoring, control and quality assurance systems. Therefore, when rating each Member State's system, the components that make up their monitoring, control and quality assurance systems had to be taken into account. Table A5.4 describes which components were taken into account under the scoring of each Member State, according to the Member State scenario.

Table A5.4 Quality assurance systems – characterization of approaches and scoring methodology

Scenario		Member States covered	Scoring methodology
Illustration	Code		
	Scenario A	Belgium (Flanders) and Belgium (Brussels)	Criteria relating to all components are accounted for.
	Scenario B	Cyprus, France, Malta, Netherlands, Sweden	Only criteria relating to the QA system is accounted for.
	Scenario C	Belgium (Wallonia), Estonia, Greece	Criteria relating to both the BCS and the Database are accounted for.
	Scenario D	Austria, Ireland, Italy, Latvia, Romania, Spain, Slovenia, UK	Only criteria relating to the BCS is accounted for and overall rating is discounted by 30% due to the lack of information flow.
	Scenario E	Germany	Criteria relating to both the BCS and the QA system are accounted for and overall rating is discounted by 30% due to the lack of information flow.
	Scenario F	Denmark, Finland, Hungary, Portugal	Criteria relating to all components are accounted for and overall rating is discounted by 30% due to the lack of information flow.

The equations below represent the methodology applied to each of the scenarios.

Scenario A *Equation 7-1*

$$CS_{MS} = \left(BCS_{MS} + \frac{Data\_1_{MS} + Data\_2_{MS}}{2 * 2} + \frac{QA\_1_{MS} + QA\_2_{MS} + QA\_3_{MS}}{2 * 3}\right) \div 3$$

Scenario B *Equation 7-2*

$$CS_{MS} = \frac{QA\_1_{MS} + QA\_2_{MS} + QA\_3_{MS}}{2 * 3}$$

Scenario C *Equation 7-3*

$$CS_{MS} = \left(BCS_{MS} + \frac{Data\_1_{MS} + Data\_2_{MS}}{2 * 2}\right) \div 2$$

Scenario D *Equation 7-4*

$$CS_{MS} = BCS_{MS} \times 70\%$$

Scenario E *Equation 7-5*

$$CS_{MS} = \left(BCS_{MS} + \frac{QA\_1_{MS}+QA\_2_{MS}+QA\_3_{MS}}{2*3}\right) \div 2 \times 70\%$$

Scenario F *Equation 7-6*

$$CS_{MS} = \left(BCS_{MS} + \frac{Data1_{MS} + Data2_{MS}}{2 * 2} + \frac{QA1_{MS} + QA2_{MS} + QA3_{MS}}{2 * 3}\right) \div 3 \times 70\%$$

Where:

CS_{MS} *Represents the confidence scoring of the Member State MS*

BCS_{MS} *Represents the scoring attributed to Member State MS under the building control system criteria*

$Data_{i_{MS}}$ *Represents the scoring attributed to Member State MS under the criteria i of the data management criteria*

QA_i_{MS} *Represents the scoring attributed to Member State MS under the criteria i of the quality assurance criteria*

Table A5.5 below presents the final confidence attributed to the compliance rates provided by each Member State.

Table A5.5 Confidence Scoring for Member States

Member State	Building control approach	EP data control practices	Geographical scope of EP data control	Geographical scope of QA	QA approach	Currency of QA	Confidence Scoring
Austria	0.51	0	0	0	0	0	**36%**
Belgium (Flanders)	1.00	2	2	2	2	1	**94%**
Belgium (Wallonia)	0.06	2	2	2	1	2	**53%**
Belgium (Brussels)	1.00	0	2	2	1	2	**78%**
Cyprus	1.00	0	0	0	2	1	**50%**
Denmark	1.00	2	2	2	2	2	**70%**
Estonia	0.22	0	2	2	0	0	**36%**
Finland	1.00	2	2	2	1	2	**66%**

Member State	Building control approach	EP data control practices	Geographical scope of EP data control	Geographical scope of QA	QA approach	Currency of QA	Confidence Scoring
France	0.22	0	0	1	2	1	**67%**
Germany	0.51	0	0	0	1	2	**35%**
Greece	1.00	0	0	0	2	0	**50%**
Hungary	1.00	2	2	0	2	2	**62%**
Italy	0.51	0	0	0	0	0	**36%**
Lithuania	1.00	0	0	0	0	0	**70%**
Malta	0.01	0	0	2	1	2	**83%**
Netherlands	1.00	2	2	2	1	0	**50%**
Spain	0.51	0	0	0	0	0	**36%**
Slovakia	1.00	0	0	0	0	0	**70%**
Slovenia	0.51	0	0	0	0	0	**36%**
Sweden	0.22	0	0	2	0	1	**50%**

Source: ICF consultation with Member State representatives and literature review

Note: Ten Member States were not included in this table – Bulgaria, Croatia, Czech Republic, Ireland, Latvia, Luxemburg, Poland, Portugal, Romania, UK – due to lack of data on compliance rates with the MEP requirements.

Annex 6 MEP compliance rate adjustment methodology

As stated under section 3.4, Member States have applied a broad range of approaches to report the compliance rates with the MEP requirements. In order to inform the analysis for this study as a whole and, particularly, the missed energy savings analysis, these rates have been adjusted to values deemed to be more realistic than those originally reported. The reported compliances rate ("raw" compliance rates) have all been adjusted taking into account the confidence attributed to the reporting methodology adopted by each Member State, as described under Annex 5.

In order to adjust the compliance rate, the study team sought to determine a range in which the compliance rate was thought to be. Assuming that the compliance rates provided by Member State representatives reflected the upper bound of the range, it was necessary to estimate a lower bound. This was done by applying Equation 7-7.

Equation 7-7

$$CR^{MS}_{LB_{j,i}} = CR^{MS}_{UB_i} - \left[\beta_{j,i} \times \left(1 - CS^{MS}\right)\right]$$

Where

$CR^{MS}_{LB_{j,i}}$ $Refers\ to\ the\ lower\ bound\ compliance\ rate\ i\ (i = A1, A2, A3\ requirements)\ estimated\ for\ a\ given\ Member\ State, given\ a\ discount\ rate\ of\ \beta_{j,i}$

$CR^{MS}_{UB_i}$ $Refers\ to\ the\ compliance\ rate\ i\ reported\ by\ a\ given\ Member\ State\ (also\ called\ raw\ compliance\ rate\ or\ upper\ bound\ compliance\ rate)$

$\beta_{j,i}$ $Refers\ to\ a\ discount\ factor\ between\ 0\ and\ 1\ which\ is\ applied\ to\ the\ confidence\ rate, for\ the\ compliance\ rate\ referring\ to\ requirement\ i$

CS^{MS} $Refers\ to\ the\ confidence\ score\ (a\ value\ between\ 1\ and\ 0)\ attributed\ to\ the\ approach\ adopted\ by\ a\ given\ Member\ State\ to\ report\ the\ compliance\ rate$

Source: ICF

Several levels of β were tested in order to assess the most suitable level, given the other sources of information available for the compliance rates[61]. Different levels of β have been chosen for each MEP requirement, according to Equation 7-8. The selected levels were 30%, 70% and 100% for requirements A1, A2 and A3, respectively.

Equation 7-8

$$\beta_{j,i}\ is\ such\ that\ MIN\left\{CR^{MS1}_{LB_{j,i}}, CR^{MS2}_{LB_{j,i}}, \ldots, CR^{MSx}_{LB_{j,i}}\right\} \leq CR^{Min}_{SS_i}$$

Where

$CR^{Min}_{SS_i}$ $Refers\ to\ the\ minimum\ compliance\ rate\ reported\ by\ secondary\ sources, across\ all\ Member\ States, for\ requirement\ i$

Source: ICF

Under the second step of the adjustment of reported MEP compliance rates, a central case compliance rate has been estimated applying to Equation 7-9. According to this equation, the estimated mid-point level will be closer to the upper bound for Member States whose reporting approaches bared higher confidence levels.

[61] Please refer to section 2 for a list of sources of information for compliance rates in each Member State.

Equation 7-9

$$if\ CR^{MS}_{UB_{j,i}} > 50\%:$$
$$CR^{MS}_{MP_{j,i}} = \left(CR^{MS}_{UB_i} \times 2 + CR^{MS}_{LB_{j,i}}\right) \div 3$$

$$if\ CR^{MS}_{UB_{j,i}} \leq 50\%:$$
$$CR^{MS}_{MP_{j,i}} = \left(CR^{MS}_{UB_i} + CR^{MS}_{LB_{j,i}} \times 2\right) \div 3$$

Where

$CR^{MS}_{MP_{j,i}}$ *Refers to the mid point level complaince rate for a given MS, regarding requirement i*

Annex 7 Summary of workshop on 3 September 2015

Interim Findings Workshop: On-the-Ground Fulfilment of the Requirements of the Energy Performance of Buildings Directive

Date: Thursday 3 September 2015

Time: 16.00 – 18.00

Location: BBRI offices, Boulevard Poincaré 79 Poincarélaan, 1000 Brussels

This interim findings workshop formed part of a research study into on-the-ground fulfilment of a number of the requirements set out in the Energy Performance of Buildings Directive (EPBD); minimum energy performance (MEP) requirements and the production and use of Energy Performance Certificates (EPCs).

The research study is being undertaken by ICF International on behalf of DG Energy of the European Commission. The research aims to inform the future development and implementation of regulation around the energy performance of buildings.

The workshop aimed to share early findings from the study with key stakeholders, including indicative fulfilment rates and different national perspectives. Feedback was sought on a number of themes that underpin the implementation of the EPBD. Workshop attendees were invited to participate in five 'discussion stations' in order to provide feedback and insights on a number of statements that were deliberately worded to prompt debate around current practice in different Member States. Note that these statements should not be interpreted as study findings.

The comments received from each of these 'stations' are set out below along with some brief conclusions

A: Fulfilment of Minimum Energy Performance (MEP) requirements for new buildings

- **Comments on interim findings presented:**
  - This session presented findings for the fulfilment of MEP requirements for new buildings as reported by Member State representatives. The interim findings, reported by 19 Member States, fell into two broad groups. Around two thirds of these Member States reported fulfilment rates of around 100%. In many cases this was based simply on an assumption of compliance given that the requirement is embedded within legislation, however there was no specific methodology for establishing compliance levels. Around a third of Member States reported fulfilment rates based on some kind of analysis of a sample of buildings. Typically the fulfilment rates reported by this group were lower.
  - The views of participants on the interim findings presented were mixed. Many participants disagreed with the very high levels of fulfilment reported, with instances of 100% fulfilment seen as "not realistic". Some participants felt that they had more confidence in the data presented when it was backed-up by actual checks of a sample of buildings. It was noted by one participant that 100% fulfilment was credible based on the assumption that as the requirement is mandatory, all parties fulfil their requirements.
- **Statement A1: There are not enough suitably skilled persons to undertake site inspections to check compliance with MEP requirements.**
  - Participants had mixed views on this statement. In general it was felt that there are sufficient numbers of suitably skilled experts to deliver the type of control systems currently in place. However, the cost of accessing such skills was seen as potentially problematic; the private sector is attracting many suitably skilled people and some public authorities therefore lack access to suitably skilled staff or the resources to procure it. It was noted that the number of experts required depends on the nature of the compliance checking system – for example, if systematic checks were required of all buildings, then capacity constraints could be seen.

- **Statement A2: We are confident of high levels of compliance with minimum energy performance requirements simply because you cannot get a building permit without proof of MEP compliance.**
  - There was near universal disagreement with this statement from participants; obtaining permission to build does not adequately ensure that the final building, once built, meets the MEP requirements. For example, in Cyprus it was reported that despite the requirement for building permits no checks are made of the building as-built and that there is no requirement for a post-construction EPC so establishing accurate compliance rates is challenging.

B: Fulfilment of MEP requirements for existing buildings

- **Comments on interim findings presented:**
  - Only nine responses for this element were presented. Of the nine, four responses were based on primary sample data, the remainder were assumed rates of compliance as a result of legislation requirements. The former displayed values ranging from 65 – 94%; those based upon assumptions reported a 100% compliance rate. The response for existing buildings was similar to that of new buildings, in that compliance rates of 100% were unrealistic and unjustifiable, particularly given that all 100% responses were not based upon sampled or audited data sets.

- **Statement B1: Following a major renovation, the only way to ensure the building is compliant is to require a post-renovation EPC.**
  - There was near unanimous agreement among workshop participants that a post-renovation EPC is an effective route for ensuring compliance with MEP requirements. However, this is dependent on the competence of the expert producing the EPC and the effectiveness of the methodology underpinning the production of the EPC.
- **Statement B2: Ensuring compliance with requirements for building elements is simply a case of setting maximum permissible U-values[62] / equipment efficiency ratings.**
  - This approach is seen as a good starting point for some participants (assuming elements satisfy minimum performance standards). However, assessing overall building energy performance is regarded as a more effective measure, and participants noted that actual compliance checks via inspections would still be needed.
- **Statement B3: Fulfilment of building elements requirements is being led by the industry, under the Ecodesign directive, and therefore, there is no need to take actions under the EPBD**
  - There was unanimous disagreement among workshop participants, with various reasons given, as to why industry should not be given sole responsibility for fulfilling building elements. For example, the eco-design process was considered to be too slow and complex.

C: Cost optimal statements

- **Comments on interim findings presented:**
  - There was no presentation on the findings of implementation of cost optimality. However, the interim findings show that 50% of Member States have already established standards that are cost optimal. A further 20% have carried out their studies and are in the course of implementing improvements. The remaining 30% are still yet to carry out studies, or are aware of the need to improve but have yet to define exactly what is required.
- **Statement C1: We have found changing to and implementing cost-optimal minimum energy performance requirements easily achievable.**
  - There was some discussion about this statement as it was felt that there were three key elements within the statement. The term “easily achievable” could therefore apply to (i)

[62] This language was hard to understand for some delegates. The reality is that for U values, the lower the value the more efficient the performance. So the “maximum” value is actually the minimum performance which a Member State would set. Building specifications could improve upon this value if the client so wished.

changing to (ii) implementing or (iii) actually achieving the new standards once set. A number of stakeholders noted that the cost-optimal study itself was a complex and challenging process, however once completed it provided a clear pathway to the levels of improvement (if any) required. It was reported that the cost-optimal level is not particularly challenging considering today's technologies (Sweden) and the level of stringency in comparison to existing requirements (France). In Romania, where energy supplies are subsidised, the situation was seen as more complicated in terms of actually agreeing on what is cost optimal.

- **Statement C2: The requirement for cost optimal methodology has enabled us to justify investment in increasing standards.**
  - There was a general level of consensus with this statement in terms of providing the evidence base for investment. However, it was pointed out that simply having an evidence base does not directly lead to increased levels of investment, particularly as there still has to be an up-front investment which is not easy to lever out of either commercial or domestic sectors. There is still considered a need to have more concrete proof of savings achieved, as opposed to those claimed from theoretical studies.

D: The value of EPCs in informing the sale/letting transaction

- **Comments on interim findings presented:**
  - For this exercise, stakeholders involved in the real estate market were consulted on their views of the fulfilment rates with the EPC production and use requirements. The interim findings showed that in most Member States, stakeholders representing both real estate agents and building owners reported higher perceive fulfilment rates than those reported by stakeholder representing by tenants. The interim findings also showed that, overall, stakeholders involved in the real estate market have reported lower fulfilment rates for EPC use than for EPC production. This might indicate that, in some instances, the EPCs are being produced but then not used in advertisements or during rental/sales transactions. This raises the question of what is the value attributed to the EPC by prospective tenants and buyers.
  - There were mixed views on the EPC fulfilment rates presented. While some participants stated that the figures reported by the real estate market stakeholders were in line with their views on their Member States, others questioned its accuracy.
  - Some participants highlighted that the difference observed between fulfilment rates reported by the different stakeholders might be due to the difference on fulfilment rates for new buildings when constructed and when sold.
  - One participant raised a concern regarding the methodology applied by the study, adding that it would not be possible to draw representative conclusions from the data gathered.
- **Statement D1: The property market is so buoyant that no-one is bothered about energy performance.**
  - Participants were nearly unanimous in stating that the interest on the energy performance will depend on the real estate market characteristics. In markets where demand is high, lower interest in energy performance can be expected. Another example cited was of a market dominated by older buildings, which tend to present a lower energy performance. In such circumstances energy performance information may well play a greater part in the decision making process of tenants and buyers.
- **Statement D2: Prospective and current owners and tenants do not see the value in EPCs or the associated recommendations.**
  - There was a general consensus that many market participants did not see much value in EPCs. In Austria, for instance, most buildings do not undergo on-site check at completion, only during construction. This leads to some lower quality EPCs that do not reflect the actual building energy consumption. As such, people may not perceive the EPC to be a valuable indicator of real energy performance. Nevertheless, some of the participants highlighted that this situation is changing and awareness of the value of higher EPC ratings is growing.

- One participant asserted that the perceived value of the EPC is a question of awareness raising. Two others stakeholders highlighted that in some countries, such as the UK, Italy, the Netherlands and Sweden, there is some evidence emerging that more market participants are realising the added value of opting for a building with enhanced energy performance.

E: Display of EPCs

- **Comments on interim findings presented:**
  - The findings found a wide range of scenarios in terms of compliance with the requirement to display EPCs. It was explained that there are different interpretations of the legislation with regards to this component, and that this could potentially skew the findings. However, generally there was a poor level of compliance within the sample group, irrespective of their interpretation. In total only 26% of buildings had an EPC clearly on display, or produced but on display in a room not visible to the public.
  - Note on main comments received if any
- **Statement E1: There is a lack of clarity around which buildings should display their EPCs.**
  - The general consensus was that it is constructive to allow flexibility in the definition of which buildings should be required to display EPCs. However, there still subsequently needs to much more clarity then around each Member State definition and how it is to be implemented.
- **Statement E2: No-one checks that large buildings frequently visited by the public display an EPC.**
  - The overwhelming majority of participants agreed that this was an issue and that these checks are important and so should be pushed for. One comment received suggested that there should also be promotion of the public's role in enforcement, and that they should be encouraged to always check and ask to see the building's EPC.
- **Statement E3: EPCs for large buildings frequently visited by the public are too expensive.**
  - In general this was not considered to be an accurate statement, as the costs are set at Member State level and are bound by market conditions. One comment also pointed out that relative to the overall construction cost, the EPC cost was tiny. However, there were a couple of participants who agreed that the cost, particularly for larger buildings, were excessive and prohibitive within their countries.
- **Statement E4: There are not enough suitably qualified/accredited persons to undertake commercial EPCs.**
  - The majority of participants felt that there were plenty of qualified experts/accredited persons, although there were concerns raised that they may not necessarily be up to date with their training and may not necessarily have skills to do specialist building types (such as historic buildings). There were however a few stakeholders who disagreed and stated that there was a definite lack of qualified resources.

Annex 8 Glossary

Term	Description
A1	EPBD requirements regarding the application of minimum energy performance standards for new buildings.
A2	EPBD requirements regarding the application of minimum energy performance standards for existing buildings.
A3	EPBD requirements regarding application of minimum energy performance standards for retrofitted building elements.
B1	EPBD requirements regarding the production of EPCs.
B2	EPBD requirements regarding the production of EPCs for public buildings.
B3	EPBD requirements regarding the sharing of EPCs.
B4	EPBD requirements regarding the handover of EPCs.
B5	EPBD requirements regarding the inclusion of EP indicator in advertising.
B6	EPBD requirements regarding the display of EPCs in large buildings frequently visited by the public.
Building control system	The building control system refers to the system by which the buildings' energy performance is first checked. It will normally refer to the checks performed by subnational building control authorities when a building requires a permit to build or use/occupy. These checks can take place at different time (design, construction and completion stages) and be based on different approaches (desk based or on-site).
Building element	As defined by the EPBD, this means a technical building system or an element of the building envelope.
Building envelope	As defined by the EPBD, this means the integrated elements of a building which separate its interior from the outdoor environment
Building permit	See 'permit to build'.
Compliance rate	Represents the proportion of fully compliant buildings from the total population of buildings that are required to comply with a particular MEP or EPC requirement as set out in the national legislation of the Member State in question. Specific definitions of compliance with the various requirements of the EPBD are detailed in **Table 2.1.**
Compliance checking system	Refers to the systems in place to ensure a given MEP or EPC requirement is complied with. For instance, in the case of the requirement to produce an EPC when a building is sold, often, the notaries responsible for registering the sales transaction are also required to check whether the sold building has an EPC.
Confidence	The term "confidence" is used to collectively describe the systems in place to monitor, register and assess the quality of data on compliance with the MEP requirements in each Member State. The confidence attributed to these systems is applied in this study to adjust the compliance rates with MEP requirements informed by Member States.
Cost-optimal level	'Cost-optimal level' means the energy performance level which leads to the lowest cost during the estimated economic lifecycle of a building [EPBD (recast) 2010/31/EC].
Energy Performance Certificate	An Energy Performance Certificate means a certificate recognised by a Member State or by a legal person designated by it, which indicates the energy performance of a building or building unit, calculated according to a methodology adopted in accordance with Article 3 of the EPBD (recast) 2010/31/EU.
Energy performance database	The EP database refers to any centralised platform which periodically or systematically gathers information on the energy performance of all new and renovated buildings (as a minimum). It may be an online platform or simply a spreadsheet kept by a central body. Databases kept by subnational (e.g. regional) governments are not encompassed by this definition
Hand-over of EPC	The EPBD (recast) 2010/31/EC requires that EPCs are handed over to the buyer or new tenant. In this report, the "hand-over" of EPCs has been interpreted as providing the

	buyer or new tenant with a full copy of the EPC when (either in digital or physical format) or shortly after the transaction is formalised.
Independent control system	The independent control system (ICS) refers to the system in place in a given Member State to control the quality of the EPCs produced. There are several approaches to the ICS, encompassing either desk review or on-site verifications and covering either only the EPC inputs or also the methodology and/or recommendations.
Major renovation	Major renovation' means the renovation of a building where: (a) the total cost of the renovation relating to the building envelope or the technical building systems is higher than 25% of the value of the building, excluding the value of the land upon which the building is situated; or (b) more than 25% of the surface of the building envelope undergoes renovation. [EPBD (recast) 2010/31/EC]
Missed energy savings	Refer to the difference between the estimated energy savings achieved in the current scenario of compliance and the energy savings that would have been achieved had a 100% compliance rate been observed.
National regulatory framework	The systems in place in a given Member State to implement the EPBD. These encompass the actual pieces of regulation enacted, the institutions responsible for the oversight of the MEP and EPC systems, the financial and technical systems in place to support the implementation, among others.
Nearly zero energy building	A building that has very high energy performance, as determined in accordance with Annex I of the EPBD recast. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby [EPBD recast, 2010/31/EC].
Passivhaus	A building design and construction standard based around the definition of a Passivhaus building: "for which thermal comfort can be achieved solely by post-heating or post-cooling of the fresh air mass, which is required to achieve sufficient indoor air quality conditions – without the need for additional recirculation of air."
Penalty framework	A penalty framework refer to any instruments in place to discourage non-conformity with the MEP and EPC requirements, and may encompass financial penalties (fines) as well as sanctions and warnings.
Permit to occupy/use	Refers to the permit granted by relevant authority to new or renovated buildings once the construction works are completed, and without which the building cannot be legally occupied/used.
Permit to build	Refers to the permit granted by relevant authority to new or renovated buildings before the start pf the construction works.
Quality Assurance System (relating to MEP requirements)	The QA system refers to any procedure aimed at checking the accuracy of the data input in the energy performance database (EP database). In the absence of a database, the QA system refers to any procedure aimed at checking a sample of buildings for compliance with the MEP requirements. Where an EPC is required to demonstrate compliance with the MEP requirements, the ICS may be considered a QA system.
Showing of EPC	The EPBD (recast) 2010/31/EC requires that EPCs are showed to the prospective buyer or new tenant. In this report, the "showing" of EPCs has been interpreted making the EPC available to the prospective buyer or new tenant before any formal transaction is established - i.e. while buyers and tenants are still going through the decision-making process. At this point EPCs as usually made available through advertisements in commercial media.
Strength	The term “strength” is used to collectively describe an analysis of seven criteria which include the scope of the MEP requirements and the extent to which the enforcement and the financial and technical support systems are able to support compliance.
Technical building systems	As defined by the EPBD, this means the technical equipment for the heating, cooling, ventilation, hot water, lighting or for a combination thereof, of a building or building unit;
U-Value	The U value is a measure of heat loss in a building element such as a wall, floor or roof. The lower the U-value, the better the insulation. It is indicated in units of Watts per metre squared per Degree Kelvin (W/m2K).

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