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Clean Energy Cooperation with India (CECI): Legal and policy support to the development and implementation of energy efficiency legislation for the building sector in India (ACE: E^2)

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EU Building Energy Certification/ Labelling

– development, organisation, functionality, market presence and influence

EU EXPERIENCE ON EPBD - POSITION PAPER No 9

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FOREWORD

This position paper has been developed by the project "Clean Energy Cooperation with India (CECI): Legal and policy support to the development and implementation of energy efficiency legislation for the building sector in India ("ACE:E²"[1])".

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[1] ACE: E² – Adoption, Compliance, Enforcement – Energy Efficiency

ABBREVIATIONS

ACE: E2	Acronym of the project (Adoption, Compliance, Enforcement – Energy Efficiency)
CECI	Clean Energy Cooperation with India
CEN	European Standards Body
CPD	Continuing Professional Development
DEC	Display Energy Certificate
DSM	Dynamic Simulation Model
ECBC	Energy Conservation Building Code
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificate
EP	Energy Performance
EU	European Union
EUD	European Union to India
ICT	Information Communication Technology
M&R	Monitoring & Reporting
NZEB	Nearly Zero Energy Buildings
SBEM	Simplified Building Energy Model
QA	Quality Assurance

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SUMMARY

The two primary requirements to be implemented by Member States under the EU Energy Performance of Buildings Directive (EPBD) are (1) **mandatory review and strengthening of energy performance standards of the building code** and (2) **mandatory establishment of building energy labelling**, in the form of energy performance certification (EPC) as a visible presence in the construction and property marketplace. All EU Member States have implemented these requirements, including establishing extensive EPC systems for both new and existing residential and non-residential buildings. **This Position Paper highlights the features and good practice ingredients of the most successful EPC systems applied in the EU since their introduction in 2006, which would apply equally in India's circumstances**.

Based on the successful concept of energy labelling of energy using appliances, EPCs have the key feature of providing a visible indication of the comparative energy performance between different buildings being considered for purchase or rental. As such, it empowers consumers and all other players in the construction and property sector with awareness and objective information to help to inform their construction, purchase and rental decisions.

The most successful implementation of EPC has been founded on a philosophy that certification is a positive instrument of national energy policy aimed at driving and assisting market choice and market transformation. This meant putting in place strong legislative, technical, administrative and promotional systems to establish certification as an effective market stimulus to achieve energy savings. An EPC label is meaningful only if its content is clear and its timing of delivery can impact the choices made by owners and prospective purchasers/tenants; it needs to be available in advance of a decision to purchase or rent. The alternative option of a simplistic approach would have led to a weak certification process that was seen as an ineffective and bureaucratic "paper exercise" that was a cost burden in the construction and property marketplace without superior benefits.

The credibility, power and ultimate cost-effectiveness of EPCs depends on them being based on well co-ordinated systems using best practice information and communications technologies. This includes: robust assessment methods, being delivered using validated assessment procedures appropriate to the complexity of the building, by a strong cadre of trained competent professionals, being administered efficiently through a consistent, well integrated system with quality assurance procedures, and having widespread visibility and 'currency' in the marketplace. Under the EPBD, the EPC system applied to both new and existing buildings and is mandatory (although at least three EU countries had operational EPC systems prior to the EPBD). **EPC is often most effective when complemented with other initiatives that support energy efficiency**. Portugal, Ireland and Denmark are among the prominent examples of EU Member States with such systems.

EPC systems can help to achieve national energy targets and enhance environmental, social and economic sustainability in the building sector. Direct benefits associated with building certification schemes include: energy and CO_2 emissions reductions and broader environmental benefits; increased public awareness of energy and environmental issues;

lower costs for users; and improved data on buildings, which can be used for future policy development to further improve energy efficiency in the building stock.

Based on EU experiences, the following is a summary of the key stages and elements that lead to the development and implementation of a successful EPC system for buildings:

- **Plan**: define the terms of reference for the EPC scheme, and develop an appropriate policy framework and action plan; engage multiple actors, allocate sufficient resources and communicate often with all stakeholders.
- **Implement**: provide for training and support to ensure well-qualified building assessors; raise awareness of the EPC scheme in industry and among the public; ensure efficient operation of systems for central collection, review and dissemination of data.
- **Monitor and Evaluate**: establish quality control mechanisms to monitor performance of the EPC scheme and of EPC assessors (and provide support for assessors); communicate results openly to relevant stakeholders; analyse whether the scheme is achieving its goals and adjust as needed to increase impact; consider expanding the scheme to include environmental issues and assess its effectiveness in relation to supporting (and being supported by) other policy measures

Finally, a further consideration is the need to ensure that EPC schemes are 'future proofed' through being adaptable enough to evolve with potential developments in the future.

1 INTRODUCTION

Reflected in the EU Energy Performance of Buildings Directive (EPBD), **EPC labelling is a key policy instrument for improving the energy performance of new and existing buildings.** This Position Paper documents the elements and steps necessary to successfully implement such EPC schemes. Its focus is mainly on the EPC as a label in the marketplace rather than as a certification of compliance with the building energy code (although it may also be applied for that purpose).

While the focus, methodology, application, output and impact of EPC may differ for new and for existing buildings, both require robust, transparent procedures that are consistent, clear and cost-effective:

- For new buildings, EPCs can demonstrate compliance with national building energy codes and provide a motive for achieving a superior standard compared with buildings of the same type.
- For existing buildings, an EPC attests to the energy performance of the building compared with buildings of the same type and may be accompanied by advisory recommendations on cost effective investment and operational actions to improve energy performance.

Since the 1990s, mandatory energy labelling of energy using appliances had been recognised throughout Europe as an effective driver of improved product offerings by industry and of informing and empowering consumer choice. In similar manner, **some EU Member States such as Denmark and Austria had introduced mandatory EPC labelling for buildings while others had piloted voluntary systems**. In essence, EPCs address a traditional information deficit in the construction and property market by providing information that can increase demand for more efficient buildings, thereby helping to improve the energy efficiency of the building stock as a whole. Providing owners and occupiers with a comparative certificate of the building's energy efficiency performance is increasingly viewed as a means of transforming real estate markets. If prospective purchasers and tenants come to regard an energy certificate as important to their decision making, building owners will have greater incentive to improve the energy efficiency of buildings.

This Position Paper highlights the features and good practice ingredients of the most successful EPC systems applied in EU Member States, which would apply equally in India's circumstances. In particular, it outlines the key stages and elements of planning, implementation and continuous improvement actions that lead to the establishment and operation of an effective EPC system for buildings.

2 THE EPBD REQUIREMENTS FOR EPCS

The primary aims of the EPBD (originally published in 2002 and strengthened in 2010) were to drive the building sector towards more ambitious energy efficiency standards, to make energy use in buildings more transparent and widely understood, and to increase the use of renewable energy sources. The EPBD had three sets of key requirements, whereby each Member State must:

1. **Adopt an official energy performance calculation methodology** that accords with the common general framework methodology specified in an Annex to the Directive. The scope of the technical parameters to be covered is set out in this Annex. This is aimed at encouraging a broadly common 'currency' or 'language' based on an integrated and relatively holistic scope of thermal and electrical energy usage. But it still allows flexibility regarding the detail of the methodology in individual Member States.
2. **Set mandatory minimum requirements for the energy performance** of new buildings and major renovations, using the above technical methodology. This mandated a performance-based approach (rather than specifications of component requirements). Energy efficiency requirements must be formulated as an overall performance criterion, covering the main thermal and electrical energy uses, expressed in terms of - normally primary (fossil fuel) - energy consumption (and possibly CO2 emissions) per annum per m2 of gross floor area. As a dynamic process, these requirements (plus requirements for retrofitting of building elements) must be reviewed at least every five years, using a 'cost optimal' method based on a Life Cycle Analysis to inform the technical standards. They are compounded by a requirement for Member States to establish 'Nearly Zero Energy Buildings' (NZEB) as mandatory for all new buildings by the end of 2020 and for new buildings owned and occupied by public authorities by the beginning of 2019, and to publish national NZEB roadmaps including intermediate targets for 2015.
3. **Establish and implement a system of energy performance certification (EPC)** mandatory for all residential and tertiary sector (offices, shops, hotels, public buildings etc.) buildings[2] at the point of construction, offer for sale or rental, and also using the above methodology. It applies to both new and existing buildings. This is aimed at making energy performance a visible market factor influencing purchase and rental choices – including mandatory use of EPCs in property advertisements. This system involves publishing an energy label for each applicable building, typically on a scale from 'A' to 'G', based on relativities to reference values. EPCs were required to be carried out by independent qualified assessors (or 'experts'). It also includes a requirement for the EPC to be accompanied by an advisory report recommending options for cost effective investment and operational actions to improve the energy performance of the building. Placing a greater emphasis on enforcement, the 'recast' EPBD of 2010 required Member States to establish independent recording and quality

[2] Except special cases, such as heritage buildings, religious buildings and buildings with very low energy use.

control systems for EPCs, and to ensure that 'penalties provided for infringements against national provisions must be effective, proportionate and dissuasive'.

The EPBD applies to all buildings – residential, commercial and public. It also required many public and commercial buildings above a specified size and visited regularly by the public to display EPCs in a prominent location. The above three requirements are linked as both the EP and EPC requirements employ the same methodology, and the EPC scale from A to G is designed with regard to the reference values set by the EP requirements.

Member States were given three years (to 2006) to transpose these EPC requirements into national legislation, but were allowed three additional years (to 2009) if they demonstrated a lack of qualified experts. According to the directive, EPCs must be made available when buildings are constructed and/or when they are placed on the market (e.g. through advertisement) for sale or rent (i.e. when potential buyers or tenants need to make informed decisions). Member States are also required to set a term of validity for EPCs.

3 RATIONALE

As a basic principle, a well-functioning market requires well informed decision makers. In relation to energy in buildings this has not been the case in the past. EPCs are a powerful means of tackling that information deficit.

Energy performance certification provides a means of rating individual buildings – whether they be residential, commercial or public – on how efficient (or inefficient) they are in relation to the amount of energy needed to provide users with standardised levels of comfort and functionality. The energy consumption depends on many factors including: local climate; the design of the building; construction methods and materials; systems installed to provide heating, ventilation, air condition or hot sanitary water; fixed lighting systems; and the appliances and equipment needed to support the functions of the building and its users.

As already noted, EPCs provide an objective mechanism by which prospective buyers and tenants can compare the energy efficiency of different buildings or the energy rating across a range of similar buildings. EPCs can also be used for new buildings as a means of demonstrating compliance with building energy codes. This is important, as many cost-effective energy efficiency opportunities are available at the time of design and construction. Within the construction industry there has been a shift towards more energy efficient design, better construction practices, increased integration of energy efficient components, and renewable technologies. Certification of new buildings can support this process by raising awareness of the energy implications of building design and improving the marketability of new buildings.

In the case of existing buildings, certification is used to compare similar buildings and to assess the degree to which an older building falls short of codes that have been introduced since the time of its construction. As much of the existing building stock was built to inferior energy efficiency standards, such certification can also identify measures to improve energy performance.

Through making the public in general aware, EPCs help builders, landlords and building users to become more aware of the impact of building performance on running costs and comfort and motivate them to take improvement actions or to ensure compliance with building codes.

4 ENERGY PERFORMANCE CERTIFICATION PROCESS

4.1 Guiding principles in EPC scheme implementation

In approaching the planning of EPBD implementation in an EU Member State, the following is an example of best practice guiding principles that were adopted in one Member State. Ultimately, the practical implementation ought to achieve a pragmatic balance between these principles.

Practicality: The technical services should be deliverable through the channels of existing professional and trade expertise. They should require a moderate level of training and upskilling of service providers with prior foundational skills. They should be geographically accessible, entail quick turnaround services at acceptable cost, and not retard normal market activity. The information and advice produced by service providers should be sufficient to enable building owners and energy consumers to exercise informed choices and avoid excessive detail.

Clarity: From the building owner or consumer perspective, the delivered information, its purpose and value should be clear. From the technical service provider perspective, the procedures and tools should be easily understood and as simple as possible to apply. Information and Communication Technology (ICT) systems should be exploited to achieve user friendliness in the process and results, underpinned by appropriately powerful technical resources and reliable administrative support systems.

Consistency: The measures should be of credible quality and value. Relative or comparative accuracy of the information provided is the goal, sufficient to enable informed choices by building owners and consumers. Results should be repeatable to an acceptable tolerance. Details of the technical methodologies being applied should also be transparent to inspection by specialists and regulators. The procedures must be underpinned by robust training, validation of tools and skills, quality assurance, and ongoing data and other technical support. The administration systems, engaging best practice in ICT systems, should co-ordinate and maintain these functions.

Cost efficiency: Related to all the above, services should be provided at as competitive a cost as possible, while complying with the obligations of the EPBD. They should seek to minimise the burden of time or complexity on either the service user or provider.

4.2 Overview of development process for EPCs

The concept of mandatory EPCs at the point of construction, or offer for sale or rental, required an extensive set of actions to be implemented in order to establish an effective system. In the good practice cases, the process typically included the following, with differences in detailed analyses and EPC system design between residential and non-residential buildings:

- Development and finalisation of the EP calculation methodology and software.
- Carrying out a series of modelling and benchmarking studies.
- Development of the format and designing of the scale of the EPC label.
- Specification and organisation of training, with timelines to ensure adequate numbers of qualified design professionals and EPC assessors.
- Development of Codes of Practice or Codes of Conduct.
- Establishment of registers of EPC assessors.
- Design and establishment of EPC databases/ registers for on-line lodgement, recording nd management of EPCs.
- Development of a quality assurance regime with associated disciplinary and complaints procedures.
- Website development.
- A major communication and promotional campaign for the construction industry, politicians and the general public.
- Ongoing helpdesks for EPC assessors, building owners and the general public.

The minimum period required to deliver this full programme of tasks, from inception to final operation of a fully functioning EPC system, is around 2-3 years.

4.3 Delivery of EPC service

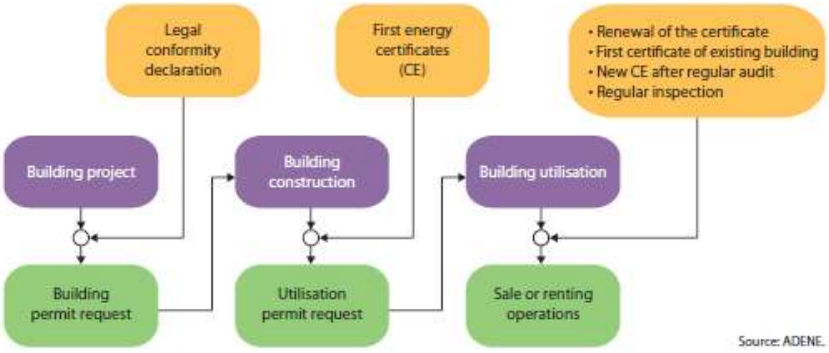
Production of an EPC is a complex procedure, requiring in-depth knowledge of building components. It also reflects increasing recognition of the need to think of buildings as "integrated systems", rather than simply the sum of their parts. The process involves three main steps:

- The assessment of the energy performance of a building by a competent assessor using a nominated methodology.
- The issuing of a certificate rating the building's energy performance which includes, in some cases, information on possible improvements aimed at yielding energy savings.
- The communication of this information to stakeholders through publication of the certificate.

These three steps will be described further below.

Below is a simplified illustration of the process for certification of new buildings in Portugal, linked to the building control and permitting process, from the point that the building is conceived up to first occupation, sale, or renting (Figure 4-1).

Figure 4-1 EPC administrative process for new buildings in Portugal



4.4 Basis and format of EPC

4.4.1 Asset versus operational rating

In general, two types of rating are used for building certification: **'asset rating', or calculated rating** based on data derived from building inspection or drawings and building specifications; and '**operational' rating** uses metered data of actual energy consumption.

In almost all EU Member States, for new buildings and buildings for sale or rental, the EPC was based on a calculated 'asset rating' rather than an 'operational' or measured energy use rating, to allow like-with-like comparison between competing properties. This is seen to be most appropriate for new buildings (as measured use does not exist for unoccupied buildings) and buildings which are being offered for sale or rent, as the rating is objective in the sense of being independent of user behaviour.

Operational rating would be influenced as much by user behaviour as by the intrinsic characteristics of the building. An operational rating is effective for buildings with infrequent user turnover, such as public services buildings, and forms a useful monitoring and tracking tool within the framework of public sector energy management programmes required under related EU directives which require public sector bodies to be exemplars of good energy efficiency and operational energy management practices. Most EU countries therefore have chosen operational rating for the regular rating of public buildings, and some have also used such ratings in relation to large and complex non-residential buildings, as this avoids an extensive data gathering process. However, asset rating is the prevailing norm in EU Member States across the overall building stock.

4.4.2 Calculation methodology

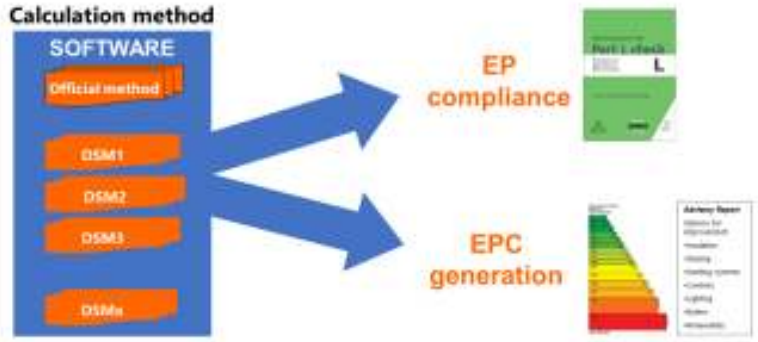
An energy performance calculation method is central to certification. Common standards have been developed to support harmonisation in Europe through the European Committee for Standardisation (CEN). **Assessment methodologies in Member States invariably use software tools to calculate energy performance and EPC ratings, which are expressed in terms of annual primary energy intensity per unit of floor area (kWh/m²/year).** On the basis of EU Commission and CEN guidance, primary energy rather than final energy is used, as it is

a better indicator of ultimate energy and environmental impact, and of running costs. The methodology often also calculates related CO_2 emissions, expressed in kilograms of CO2 per square metre ($kgCO2/m^2/year$). Most Member States have developed and approved software tools as part of a national scheme (e.g. as has been done in Ireland, Portugal, Denmark, Slovenia, UK etc.) or may validate and recognise commercially developed software tools, particularly for more complex buildings where dynamic simulation models have wide application.

In the case of display energy certificates (sometimes called DECs) for buildings frequently visited by the calculation method is essentially a spreadsheet system developed or adapted by the national energy authorities whereby the building is compared with benchmark energy performance data for buildings of similar or equivalent function, with due allowance for occupancy patterns, which still employs a rating scale from A to G.

Deriving from the terms of the Directive, the methodologies adopted in all Member States had a dual purpose, providing a common calculation engine for demonstrating compliance with the EP requirements and for producing EPCs, as shown in **Error! Reference source not found.**. The calculation method permits either the official national methodology, or alternatives in the form of validated dynamic simulation models (DSMs). This dual role provides consistency and efficiency benefits both to building professionals and to regulatory authorities.

Figure 4-2 Dual role of calculation in demonstrating EP compliance and generating EPCs



4.4.3 Software

Associated with the methodologies, officially recognised software tools were developed or adapted from existing tools. These also served as an important medium for training of designers, specifiers and EPC assessors in order to meet the relevant professional service delivery requirements to comply with the Directive. In most EU countries, for residential buildings and relatively simple non-residential buildings an official national method, typically based on monthly calculations, was adopted as freeware available to registered professionals (and in some cases to the general public). This covered most buildings, but most countries also provided the option of validated commercial dynamic simulation methods to cater better for more complex buildings.

Piloting and review: In Ireland, for both residential and non-residential buildings, once the draft national methodologies had been agreed and the associated software developed and validated to a sufficiently advanced stage, and an early cohort of EP assessors were trained, the calculation and survey methodologies were piloted by means of a commissioned study by the national energy agency in order to identify any issues and difficulties. This enabled corrective adjustments to be made and reduce the risks of errors or difficulties in the use of the methodologies, software and administration system.

A mix of software has been produced by either the central or regional authority, or private companies. The number of available software packages varies between countries. In 20 EU countries the uniform and reliable interpretation and implementation of the calculation procedure of the software is assured by an accreditation process. This also usually includes an automatic quality check of the input data or a digital data protocol. Accreditation 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.

4.4.4 Format and design of EPC

Generally, different methodologies were used for residential buildings (sometimes also between apartments and single homes) and for other buildings, but in a small number of countries a common universal methodology was used. All methodologies and the consequent EPCs used an overall energy performance indicator, covering the main thermal and electrical uses, and expressed as annual kWh of either final energy, primary energy or CO_2 emissions per m^2 of gross floor area. Energy scales based on primary energy have the advantage of being a more authentic basis for the evaluation of cost and CO_2 emissions.

Whether in assessing a building design or existing building, the concept of a 'reference' or notional building has been employed. The calculation is first performed on such a notional building with the same (or a standard) geometry and layout as the building being assessed, and with standard assumed occupancy and internal environmental conditions, but with 'reference' characteristics for its energy features based on good practice standards at a particular date (for example 2006). The same calculation is then carried out on the proposed or actual building and the key indicator from the assessment is the ratio of the performance of the actual building versus that of the reference building. This ratio determines where on the EPC scale the building is positioned.

While the fundamental concept of an EPC (based on other established energy labels) with a scale from A to G was commonly applied across the EU, individual Member States took different aesthetic and functional approaches to the design of the EPC. These may work well within the individual States but do not facilitate interpretation between different States.

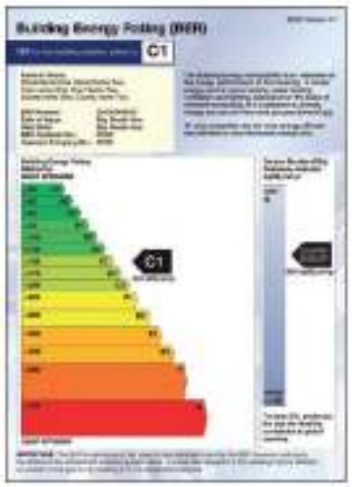
In general, EU Member States adopted an EPC scale running in bands from A (best) to G (worst), sometimes with subdivisions. This had similar appearance in different countries (see Figure 4-3), guided by an EN standard, but different levels of stringency were applied in different countries, for example in relation to the level of performance that would receive an

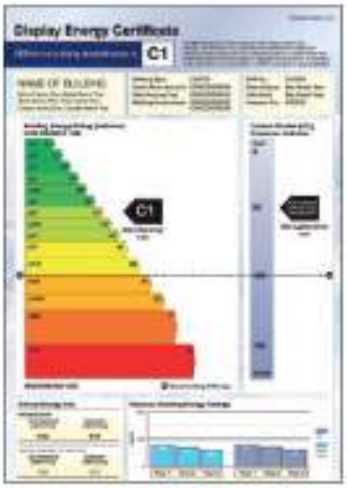
'A' rating. It is recommended that the scale allows sufficient 'headroom' for future regulatory upgrading on the pathway to 'nearly zero energy buildings' (NZEB) standards, and in good practice cases the existing regulatory standard for new buildings at the time of establishing the EPC (in 2006) was set at a 'C' rating or on the boundary between 'B' and 'C', as guided by the EN standard (i.e. with a ratio of 1.0 relative to the 'reference building'. NZEBs invariably are positioned within the A band. The EN standard recommended a linear scale, which was applied in the majority of cases. However, regarding the 'headroom' issue, it is regrettable that some Member States placed basic compliance with current regulations as having an 'A' rating (possibly under pressure from some construction industry interests), as this would then require A+ and A++ ratings in the future, and also weakening the market visibility and differentiation signal, and possibly the level of ambition for energy renovation of the existing building stock.

Figure 4-3 Examples of the variety of design formats for EPCs in Europe

In the case of display energy certificates (DECs) for buildings frequently visited by the public the format is similar to the above, where an adjusted benchmarking relative to a building of equivalent type and usage is produced and a ratio determined in like manner to a regular EPC comparing an actual building to a reference building. Figure 4-4 is an example of an EPC and corresponding DEC, with the main visual difference being the include of a running three year comparison of energy performance over a three year period.

Figure 4-4 Example of an EPC and corresponding DEC from one EU Member State





The typical information contained on an EPC would include:

- Address of building
- Photograph of building
- Functional type and size of building or relevant unit within the building
- Unique location identifier of building (e.g. electricity meter reference number)
- Address and official EPC number unique to the building
- Assessor registration number
- Assessor company registration number
- Date of issue and term of validity of certificate
- Software (including version reference) used to assess and rate the building
- The energy rating label or 'band' for the building (e.g. B1 and illustrated on a scale from most efficient A1 to least efficient G in kWh/m2/yr).
- A possible CO_2 rating label or band for the building (e.g. 24 $kgCO_2/m2/yr$ illustrated on a scale from best to worst)
- Numeric energy/CO_2 indicators expressed as kWh or kg per m2 per annum
- Possible description of building components and systems
- Possible data on indoor environmental quality
- Complementary advisory report identifying options for improvement with associated indicative costs, savings impacts and payback periods.

4.4.5 Advisory reports with recommendations

Directly associated with the generation of an EPC label is the EPBD requirement for advisory recommendations to be issued on energy efficiency improvements, with a view to motivating and assisting the building owners to take action in delivering energy savings measures. A pragmatic balance is required here: The specificity of the information provided is important in determining whether the building owners implement the advice. It is likely that the more specific the recommendation, the larger the impact but the costs of producing the advice are likely to be higher. Automatic generation of such recommendations by the assessment

software would reduce costs, but such recommendations would be less specific and accurate for the building (particularly for large or complex buildings), weakening the value and impact. More specific advice provided by a building professional is more likely to provide appropriate cost-optimal solutions and relevant details to motivate the building owner to undertake the upgrading measures but is more expensive.

It is not mandatory to implement any such recommended measures. Therefore, to increase the likelihood of building owners taking improvement actions, supporting initiatives or incentives may be necessary to prompt action on a significant scale.

In the case of display energy certificates (DECs) for buildings frequently visited by the public there is an option for these to be accompanied by an advisory report on improvement options which can contribute to a continuous improvement programme of energy management.

4.4.6 Building typologies

Differences in the detail of the EPC assessment apply between different building types. For example:

- New versus existing buildings: While all necessary data may be available from the design office for new buildings, a data collection survey will be heavily relied upon with existing buildings.
- Residential versus non-residential: For single houses the EPC can be expressed either directly as energy intensity (kWh/m2/year) or as a ratio between the actual building and a 'reference building'. For non-residential buildings, given that their typologies vary widely, the only feasible method is one which employs a ratio to a reference building.
- Multi-occupier buildings: For large buildings comprising multiple dwellings (apartment blocks) or multiple commercial occupants (probably tenants), there are options to assess the building as a whole and to assess individual units within the building to calculate energy consumption and payment of costs. Here the consumption and costs of individual units depend on a number of factors: (a) the positioning and orientation of the unit within the building – units in the centre of the building may have lower consumption than those adjacent to the roof, floor or gables (depending on the balance of climatic conditions determining the need between heating and cooling); (b) the building envelope design in respect of insulation, glazing, shading and shelter; (c) the energy supply system, in relation to individual or communal heating/ cooling; (d) the energy metering system; (e) the treatment of common/ shared areas; and (f) the cost-sharing system. On grounds of authenticity and fairness, it is recommended that asset based energy ratings to be calculated for each typology of unit within the overall building (20 units might mean, say, 6 typologies). These same principles apply to commercial buildings comprising multiple units. In the past with the case of a communal energy supply system, sometimes costs were shared equally by all occupants/ users regardless of the actual gains or losses of the individual unit. However, arising from the EU Energy Efficiency Directive, metering and associated tariffs to reflect properly allocated actual costs is generally obligatory in relation to day to day operation and management of such buildings. It does not invalidate

the concept of asset based EPCs in informing purchase or rental choices, but is closer to operational rating based EPCs in relation to ongoing usage and cost allocation. In multi-unit buildings, the scope for individual users to make decisions on upgrading energy performance may also be technically, economically, logistically and legally restricted.

4.4.7 Term of validity

As buildings and users change over time, the EPBD specifies a maximum of ten years validity for an EPC if no significant changes to the building occur within that period. Some countries have opted for shorter periods, typically between five and ten years, for their asset ratings. However, an update to an asset rating is only required in circumstances where the building is being again placed on the market. In the case of operational ratings of public service buildings, different Member States have set differing terms of validity, in some cases requiring annual renewal where this sits within the framework of an energy management programme.

4.5 Energy performance assessment

The energy performance assessment of the building's characteristics and systems is carried out by a qualified assessor who collects information on the building's characteristics and components, as well as its energy systems and energy consumption. For new buildings, this information is usually obtained from drawings and specifications, and verified at the completion stage – and indeed can inform specification choices at the design stage. For existing buildings, where drawings and specifications are not available, resort must be to data obtained from surveying the building.

4.5.1 Input data

An assessment generally requires an analysis of:

- The form, area, orientation and other details of the building.
- The thermal, solar, daylighting and air permeability properties of the building envelope.
- Space heating and/or cooling systems and hot water supply, including their efficiency, responsiveness and controls.
- Ventilation, air-conditioning systems and controls
- Fixed lighting systems – lamps, luminaires, controls.
- Fuel and renewable energy sources and systems.

Other elements, such as installed equipment and appliances may also be included in the assessment.

4.5.2 Calculation methodology and software

The above information is input into an authorised calculation model (as outlined in Sections 4.3.2 and 4.3.3) that assesses the building's energy consumption under local climatic

conditions. An energy performance calculation method, embedded in validated software, is central to a consistent and efficient certification system.

Validated software ensures the quality of the certification as it facilitates standardised calculations, allows internal checking mechanisms to minimise input or registration errors, and reduces time inputting repetitive data (through the use of default values or by storing information on typical building components and systems). In the good practice systems, the EPC assessor submits the assessment and results to a centralised system, which completes an automatic quality check of the assessment outputs and generates the EPC (either electronically or in paper form). Where the quality check is favourable, the EPC is produced immediately but where the quality check raises a query this is relayed to the assessor before confirming the final EPC. A comprehensive software system can also help to inform, and even auto-generate recommendations for upgrading the building to improve efficiency.

With this integrated approach, the EPC is issued by a centralised administration system that can attest to the effectiveness of the certification scheme. This helps to build stakeholder confidence and enhances the reputation of the certificate.

4.6 Issuance of building certificates

The timing of issuing of an EPC is important because it can determine the effectiveness of the certification and its potential to have a positive impact on the building's energy performance level. Hence the requirement in the EPBD for the EPC to be advertised when a building is placed on the market, so that all prospective buyers or tenants have the opportunity to consider energy efficiency as a factor in their choice of building.

While worldwide there are many voluntary EPC systems in operation, all EU Member States are required to operate mandatory systems. Over time, where a good practice central database of EPCs is established, this provides a very comprehensive market coverage of the entire building stock. Conversely, with voluntary systems the only parties that would have been motivated to advertise their EPC would have been developers/ owners of new buildings meeting or exceeding building energy code standards, or of the minority of existing buildings that had received energy efficiency upgrades.

4.6.1 Certification of new buildings

Designing for energy efficiency at the earliest possible stage of the design process is the most cost-effective means of improving energy performance in buildings. Given that a common software applies for both building energy code and EPC purposes, the calculation of EPC at this early stage helps early detection and avoidance of non-compliance with building energy codes and encourages the achievement of higher standards while such changes are least expensive. Once construction is complete, EPC can be used to verify final compliance with building codes and standards. As new buildings tend to have superior energy performance to existing buildings, developers/ builders will be motivated to advertise their EPCs accordingly.

Despite the additional costs associated with a two-step process, the tools of certification should ideally be applied both at the design stage (to influence construction) and upon completion (to increase compliance and record actual performance). Some Member States (e.g. Denmark and Portugal) have implemented schemes that combine self-assessment by the owner/architects at the project phase with independent assessment(s) following construction. Other countries (such as Sweden) require re-assessments of actual consumption after two years.

4.6.2 Certification of existing buildings

Mandatory EPCs for existing buildings is a significant tool for improving the overall efficiency of the entire building stock. As buildings have long life spans, turnover is low and it will take a long time before new building codes, policies and certification schemes for new buildings have any significant impact on the building stock as a whole. For existing buildings, certification and particularly the advice on options to improve energy performance help to raise awareness of energy efficiency opportunities when renovating and/or refurbishing. This is, after design, the most cost-effective time to implement energy efficiency upgrades.

4.7 Communicating through EPC labels

EPCs display the calculated outputs of the energy assessment, thereby providing key information to all stakeholders for a given building. Certificates need a simple, straightforward layout to ensure clarity, ease of use and comparability for all users; indeed, they must be understood by experts and by non-technical building owners, buyers and tenants. The certification should nonetheless provide sufficient detail from the energy assessment and appropriate information upgrading for owners and building managers. As outlined earlier, many certificates provide a block of essential information that includes building size and energy consumption to facilitate quick comparison of certificates.

4.8 Cost of EPCs

EPC prices in most Member States are set on a market basis, with official regulation only applying in four Member States (Croatia, Denmark, Hungary and Slovenia). In the open market, prices vary considerably across Member States (as do economic circumstances), but the prevailing norm for single family dwellings is an EPC fee of between €100 and €300 per dwelling, and tending towards the lower level in most countries. For non-residential buildings prices understandably range very widely depending on the size and complexity of the building, but can be expected to be relatively marginal over and above the design fee for new buildings, given that the EPC is a relatively simple adjunct to the design process in such cases.

5 DELIVERING EFFECTIVE EPC SYSTEMS – A ROADMAP

The pathway to EPC of buildings involves three stages – **Plan, Implement and Monitor/ Evaluate/ Improve** and these will be elaborated in the next three Sections of this paper. The approach outlined below is based on country experiences, and draws on the decisions and actions that paved the way for successful and cost-effective implementation, for example in Portugal, Ireland and Denmark.

Ireland and Portugal (combined population 15 million) have fully implemented the EPC requirements of the EPBD, both in spirit and in law, and have **issued 2.5 million EPCs for new and existing buildings**. These are regarded as model examples of high-quality certification schemes that both provide an energy performance rating and contribute to increased awareness of low-energy building. These countries are using the certification scheme to transform the energy performance of their respective building stocks, including integrating the EPC concept into their national energy efficiency renovation strategies and associated financing initiatives.

6 STAGE 1: PLANNING

The following are the recommended steps in the planning stage:

1 Define the terms of reference	› Define objectives in relation to targets, local requirements, and existing codes and standards. › Determine the scope in terms of type of buildings, and number of new and existing buildings. › Determine the appropriate method of assessment depending upon scope, targets and approach. › Decide whether to include other environmental issues.
2 Establish policy framework and action plan	› Determine if scheme will be voluntary or mandatory. › Develop a comprehensive action plan and establish an implementation group. › Involve all stakeholders at an early stage. › Set a realistic time frame for implementation. › Adopt the action plan and stick to it.
3 Secure the necessary resources	› Develop a comprehensive administrative system with integrated data collection capabilities. › Assess institutional capacity. › Allocate financial and human resources. › Test systems and processes in advance of launch.

6.1 Define the terms of reference

6.1.1 Define the scope and objectives

The objective(s) of the certification scheme will determine the assessment methods needed. A core objective is to provide decision makers with an objective comparative indicator of building energy performance. As a by-product in the case of new buildings and major renovations it may also provide evidence of compliance with building codes and encourage energy efficient practices beyond the minimum standards. It can also be used to advise and persuade owners or users to undertake improvements or Ultimately, certification can help countries to achieve their energy and emission reduction goals.

Buildings differ greatly in design, construction and use. An EPC system must take into account the differences between new and existing buildings, between commercial, residential and public buildings, between small and large buildings, between single unit and multi-unit buildings, and possibly between owner occupied and rented buildings. Different judgements and tools apply in relation to decisions regarding whether and where to apply asset ratings or operational ratings.

6.1.2 Determine the method of assessment

Asset rating (also known as a calculated energy rating) is appropriate for new buildings, or for existing buildings being offered for sale or rental, insofar as it provides an objective comparison under standardised conditions, in like manner to fuel economy ratings for motor vehicles or electrical white goods. Almost all EU countries have applied asset ratings for small, individually owned buildings, for all new buildings and for buildings at the point of offer for sale or rental.

Conversely, most EU countries have chosen to use metered consumption in assessing large public and commercial buildings for the purposes of producing display energy certificates (DECs). An operational rating (also known as metered energy consumption) is appropriate for existing buildings that are large and complex, including both public and commercial buildings, in which change of users is infrequent and user behaviour is therefore quite stable. Operational rating can be relatively simple, particularly if energy consumption data is available from utilities, as is frequently the case in India. It still requires a resource of benchmarking data to enable an assessment and it depends significantly on the user behaviour of the occupants, potentially as much as the building specification, and thus may have limited value in informing purchase or rental choices. Metered consumption is only reliable following about 2-3 years of building occupation when the building fabric, systems and users have settled int o a stable pattern of use.

In very low-energy buildings, it also becomes more important to address the impact of appliances and other energy-using equipment, and to take a more holistic approach when looking at energy use.

6.1.3 Decide whether to include other environmental issues

The scope of some building certification schemes has begun to extend beyond energy performance to include assessment of a building's environmental values, measuring aspects such as indoor environmental quality, the use of sustainable materials and components, land use, water use and waste handling. Health and wellbeing within a building, and its implications for productivity of employees, is an increasingly relevant business factor. A key challenge in this regard is developing calculation and assessment methods that appropriately measure very different criteria, some of which are quantifiable (such as use of energy, land or water) and others that are more qualitative in nature, or more difficult to codify (the types of materials used for the building construction and the processes used to produce them) – although there is a growing impetus by the building materials industry towards adopting 'environmental product declarations' (EPDs) to assist this. Ideally, the calculation method would transform all aspects into metrics to derive a rating of the total performance of the building, which could then be compared against other buildings. Among the more prominent schemes in this regard are LEED (originating in the USA, https://new.usgbc.org/leed), BREEAM (originating in the UK, https://www.breeam.com/) and DGNB (originating in Germany, https://www.dgnb.de/en/index.php).

Environmental assessment offers the benefit of being more holistic, assessing the total impact of a building on the environment. However, it is more difficult and costly to carry out,

and often adds a degree of complexity to decision making. It is being widely applied internationally for larger and more complex buildings that have the potential to have a significant impact on the surrounding environment, but has also extended to housing.

If such environmental assessment schemes are being planned by national authorities, it is important that EPC schemes are planned accordingly, as in effect they constitute an important subset of the overall environmental assessment.

6.2 Establish the policy framework and action plan

Once the EPC scheme's terms of reference are defined, the next tasks are to establish an appropriate policy framework and action plan for delivery. The process of establishing an operational EPC scheme can require 2-3 years. The details of the action planning and legislative transposition processes have been given in Position Papers 2 and 3 respectively.

6.2.1 Establish a coordination group

From the outset, a core coordination group drawn from senior Ministry and government agency officials, and possibly other major stakeholders, should be established to develop an action plan, oversee the process and facilitate smooth collaboration during the entire implementation process. Such groups were convened in Ireland and Portugal, and were considered essential to the success of the scheme.

This group *(or* the core official segment of it) would typically be responsible for overseeing the preparation of an Action Plan (with tasks, responsibilities and timetable) for implementation of all the Directive requirements, the drafting and negotiation of the enacting legislation, and monitoring and reviewing progress. It would be responsible for overall EPBD communication and with the EU Commission and peer energy agencies in other Member States, including the EPBD 'Concerted Action' and the CEN technical standards development process. Commonly, it would pursue examples of solutions and tools in neighbouring countries which might be transferrable or adaptable to their own circumstances.

6.2.2 Decide if the scheme will be voluntary or mandatory

Mandatory EPC schemes can be set up to include all buildings while voluntary certification schemes tend to include only buildings with the better energy performance ratings. Unless required to do so, owners of poorly performing buildings would not wish to display a negative label that could adversely affect the sale or rental value. The EPBD requires mandatory establishment of EPC schemes in all EU Member States.

Mandatory schemes, established by legislation, allow potential buyers, renters and users to compare ratings on a larger number of similar buildings and has a strong potential to influence market prices. Such schemes can include advice on energy efficiency improvements, which adds value to the EPC. Mandatory schemes eliminate the possibility of "hiding" poor performing buildings and help to identify buildings with the greatest potential

for energy saving, and ultimately make a significant contribution to national energy and emission reduction goals.

Both mandatory and voluntary schemes require established standards and clear procedures, whereas a mandatory scheme is likely to also require new legislation. In either case, planning ahead is crucial as the credibility will be easily lost if the scheme lacks secure foundations.

6.2.3 Establish a comprehensive action plan

As an EPC scheme involves many tasks and entities, it is vital to set out the full set of such tasks, responsibilities and timetable, and to secure commitment to their delivery. A detailed action plan should be published at an early stage, and circulated for consultation with all stakeholders, including the construction industry and real estate sectors. Early buy-in is essential from all responsible parties to avoid any bottlenecks in delivery.

In Ireland, the action plan was central to the successful EPC scheme establishment and implementation. It set out key tasks and dealt with issues such as legal transposition, institutional arrangements, technical systems development, training and accreditation, tasks and time frames, consultation, and promotion and information campaigns. In Portugal, the EPC scheme leaders agreed on setting ambitious targets, in terms of the number of certificates issued or the projected impact on market prices and energy savings. In both countries, the aims and benefits of schemes were promoted in advance through the media, the internet, seminars and workshops to make industry and the public aware and positively disposed towards this new market instrument.

6.2.4 Test certificates to ensure reader comprehension

Several EU countries engaged in consultation with stakeholders in relation to the scope, design and format of the EPCs. Differing interest groups would have different preferences but in the best practice cases the fundamental format of an A-G rating scale with current building energy code compliance positioned on the B-C boundary was adopted in alignment with CEN guidance.

Some countries engaged in pilot field trials of the assessment and labelling process, including gaining an insight into likely costs of delivery. Germany undertook a large field test involving certification of many buildings and by different types of experts to assess the skills of assessors, the process of delivering a certificate and the certificate's design. The field test was made at an early stage of the development process and had a large influence on the setting of EPC requirements in Germany. This led to a certificate design that differs from most other EU countries, which follow more closely the existing labelling of appliances.

6.3 Secure the necessary resources

6.3.1 Developmental and operational administrative resources

Effective implementation of EPC schemes requires a range of technological, administrative, institutional, financial and human resources. It is crucial to plan and provide for all the resources needed up front, otherwise there can be significant delays in implementation. Some EU countries underestimated the time and resources needed to establish a national EPC scheme for buildings. This led to delays in implementing the EPBD, in some cases resulting in EU legal infringement procedures.

Technological and administrative capacity should be developed to match the many tasks associated with certification including the development of calculation methodologies, software tools, assessment procedures and a comprehensive administration system. It is vitally important and beneficial to develop, from the start, a comprehensive administrative system with integrated data collection capabilities rather than trying to correct or redesign a poorly integrated system at later stages. Effective methodologies and software are essential first steps, as many subsequent elements will depend on their development, such as training material and delivery, software guidance and quality assurance systems. As a starting point, it may be useful to undertake a study to assess the appropriateness of existing methodologies and software, or to consider adopting/adapting methodologies and systems that are already in place in other countries.

Existing public institutional arrangements and systems are often fragmented, and it is critical to assign programme responsibility within the public sector and allocate financial and human resources at an early stage of development. Apart from the core coordination group, the task can require the full time commitment of 3 to 5 people in order not only to manage systems development and stakeholder engagement but also to specify, procure, oversee and test the significant technical and administrative software and ICT systems development required. The latter can potentially cost in excess of €300,000, to cover residential buildings calculation system, non-residential buildings calculation system and the administrative software and databases, including training and examination development and quality assurance systems. When the EPC system is operational and becomes mature, the core management team can be reduced to as few as 3 persons, with routine support services to the public and to EPC assessors being maintained through a combination of website, outsourced administration and call centre.

Consultation with stakeholders is needed in making decisions regarding the assessment methodology, software, design of energy rating and need for training. Consultation should include, at minimum, the potential users of the system, training providers and industry. All elements of the system should be thoroughly tested to validate the assessment software, the mechanisms for uploading assessments to the system and the process of providing certificates. Although it takes time, such testing is crucial when first developing a certification scheme as avoiding difficulties will pay off in the long run. Conversely, if the scheme encounters administrative or institutional problems at an early stage, it is very difficult to regain credibility among stakeholders.

Financial resources for the EPC scheme should be established at the planning stage. As indicated above, significant financial resources are needed to develop and administer the scheme, train the assessors (this can be self-funding in some countries by means of trainee fees), establish support systems and ensure quality by testing all aspects of the scheme in advance of its launch. Ireland was able to establish an EPC scheme that is cost neutral for the government. All of the necessary revenue is raised through assessor registration fees and certificate charges. Whatever financial business model is to be adopted, the budget must be carefully estimated in advance and include provisions for raising revenues in a realistic manner from within the scheme.

6.3.2 EPC assessor resources

Planning and acquiring the necessary qualified human resources to carry out EPC assessments may take time and should be started early. The competence of EPC assessors is vital to achieve a robust and respected certification scheme, which requires assessors with relevant foundational technical training and market experience. An early step by the scheme coordinators was therefore to evaluate the likely volumes of assessors required to service the volume of EPC market activity for residential and non-residential buildings, both new and existing and allowing for the proportion of such activity that would be part time rather than full time.

All EU Member States recognised the prior shortage of assessors and the need to initiate further training. Even initially highly skilled persons required some degree of training and familiarisation with the calculation methodologies and software, as with the administrative systems being developed. It was necessary to review existing construction profession capacities and capabilities, undergraduate educational programmes and continuing professional development (CPD) programmes in order to understand what training is necessary and where it might be provided to supply the market need for properly qualified assessors.

The aim is to achieve a slight surplus of qualified assessors in each market segment, in order to encourage a healthy level of cost-efficient competition for their services. In some countries an excessive number of persons were trained and registered, but market forces generally resulted in a reasonable equilibrium being reached within about two years.

7 STAGE 2: IMPLEMENTING

The following are the recommended steps in the further development and implementation stage:

1 Provide for training	› Develop a training strategy at the earliest possible stage. › Assess capabilities of existing professionals, and of existing training accreditation systems and programmes. › Demand high pre-qualification standards for assessors and establish an appeal system. › Retain control of training modules and materials, and of examination and registration processes. › Ensure sufficient assessors are trained before launching the certification scheme.
2 Raise awareness	› Ensure all stakeholders have access to relevant information. › Develop ongoing information campaigns that target the general public.
3 Collect, review and disseminate data	› Collect data centrally in a comprehensive administrative system. › Use the data to monitor and review the certification process. › Review data and use to foster greater overall energy efficiency.

7.1 Provide for training and examination

Availability of expertise directly affects the standards of assessment and the quality of the building rating programme. The extent of training resources required may be determined by the number of assessors needed to deliver EPCs to the market – and by the availability of qualified experts and developed training material. Delivery of training will be differentiated according to the nature and complexity of the buildings concerned. The numbers required for larger or more complex non-residential buildings are considerably less than for residential buildings, but require a higher grade of prior qualifications and expertise in order to undergo such training.

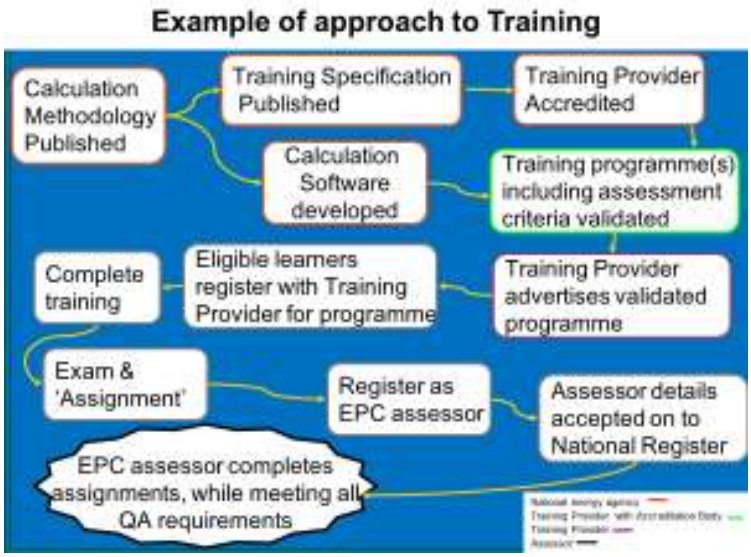
In either case, significant work is required to develop training materials, deliver the training, and establish an examination and appeals process, and requires prior work in relation to development of the calculation methodologies and software tools around which important elements of training are necessarily based. If training modules can be defined and delivered within existing training or undergraduate programmes early in the process, this may help to ensure the availability of highly skilled assessors by the time the scheme is scheduled to become operational. It also has the advantage of utilising existing training accreditation and professional trainers, and may allow for adaptation of existing training material.

To ensure the quality control of assessment and certification processes in Portugal and Denmark, only individuals with professional building qualifications can be trained and registered as EPC assessors. In Portugal, engineers or architects need a minimum of five years' experience.

Compulsory training courses have been organised in at least 15 EU Member States. Volume delivery of training by the training providers has been typically of short duration (perhaps 2 days plus follow up) and in several cases were delivered on-line. Costs of training have varied, but on-line training or a blend of on-line, classroom and project work was highly time-efficient for both trainers and trainees. Reported costs have ranged from €300 to €1800 between different Member States. Providers of training to building professionals (architects, engineers, surveyors, architectural technicians) varied between different Member States, but included a mix of academic institutions, professional bodies, software providers (for example of approved dynamic simulation models) and other commercial training providers. Training was frequently concluded with an examination in order to qualify for registration as a 'competent person'. In a number of cases, such examinations involved multiple choice questions. In a small number of countries, including Belgium (Flanders) and Ireland, a central State examination was established by the oversight authority.

Persons who pass the examination and who commit to complying with a Code of Practice/ Conduct are then eligible to be licensed to work as a certified EPC assessor. In up to 19 Member States, it has been necessary to maintain continuing professional development (CPD) and to pass the examination periodically (e.g. every two years) in order to retain their license and remain on the register of certified professionals.

Figure 7-1 Overview of steps in establishing and delivering EPC assessor training



An example of a series of steps involved in establishing a training and accreditation pathway to **registration as an EPC assessor** (or EP competent professional in relation to the building energy code) is shown in Figure 7-1. Different Member States have taken different approaches to registration, insofar as some register the individual professional whereas others register the company and its nominated professionals. Planning and design of this system and the levels of time and finance resources required on the part of trainees involves an appropriate balance between the criteria of volume, quality and quality assurance (V, Q and QA) cited in previous Position Papers. Training delivery was often preceded by a 'train the trainers' course given by the national energy agency, software developer, academic or other specialists to training providers. These providers were typically subject to national

training accreditation authorities. Prior to this, the national EPBD implementation authorities (typically the energy agency) would develop a training specification covering learning outcomes, minimum prior education/ industry experience requirements for trainees, credentials of individual trainers, curriculum content, tools and learning methods (e.g. including practical assignments). Curriculum content would cover the EP calculation software, accompanying manuals, understanding of regulations and procedures for lodgement of documents to the applicable databases. More than 16 Member States have prescribed requirements of this nature.

To summarise on training, qualification and accreditation:

- Development of assessment procedures and support mechanisms is a necessary precursor to development training curricula.
- Handbooks should be developed to provide guidance for undertaking assessments and surveying buildings, and should be made available in an easy-to-understand format for both assessors and the public.
- Initial training and continuing professional development should be available at reasonable cost to encourage assessors to keep skills at optimum level.
- Trainers, trainees and training programmes should be accredited by a central body that regularly carries out quality assurance procedures.
- Trainers need to be trained in the specifics of the software as accuracy of data input is essential for consistency.
- Training courses should allow individuals to train to a level that reflects their existing qualifications and skills.
- Trained assessors should complete an examination of their knowledge and skills, prior to registration; only the best should be registered.
- Assessments should only be carried out by trained, accredited and registered assessors; poor quality assessments should lead to sanctions or the termination of accreditation.
- Disciplinary processes and procedures for complaints and appeals should be developed and enacted in a transparent manner.
- A Code of Practice should be agreed with and signed by all assessors.

7.2 Databases of EPCs

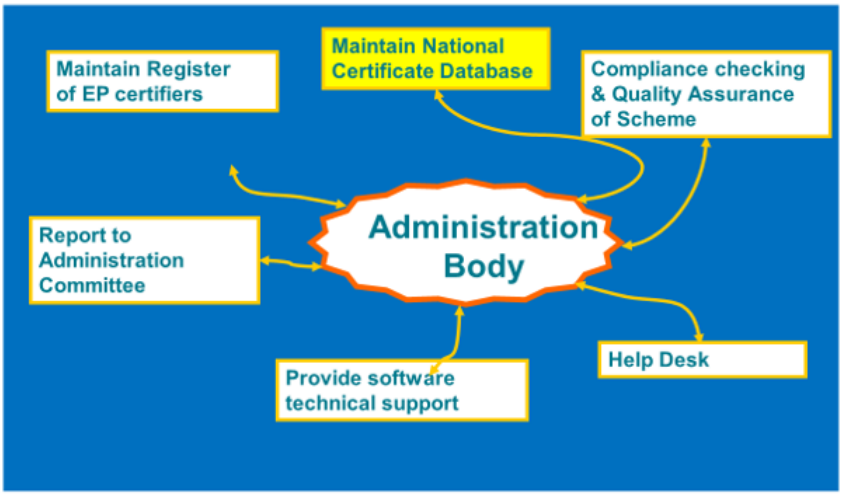
The output data (and desirably also input data) for EPCs are typically lodged to a separate EPC database operated by the EPC scheme administrator (for example an energy agency). The lodgement, assignment of unique identifier and any payment process can be enabled by the design of an on-line system of access to the database which is restricted to registered professionals. The importance of databases has already been detailed in Position Papers 5 and 8, and in a further paper on Monitoring and Reporting (M&R).

A large number of EU Member States (Portugal, Denmark, Ireland, Belgium-Flanders and others) have established mandatory registers/ databases of qualified EPC assessors and of EPCs, whereby EPC assessors were required to lodge their EPCs to a central database. These

are secure fully integrated systems which have entailed significant investment in robust ICT systems, but this has brought considerable strategic benefit and provided a monitoring resource and a basis for systematic quality assurance. Its automated features enable major operational efficiencies. Some further functionalities associated with such a database as part of the EPC administration system are shown in Figure 7-2 These can include registration of EPC assessors, link with calculation tools and on-line validation of EPCs. In relation to new buildings in particular, similar functionalities could apply to a building control database to serve as a compliance monitoring resource to the enforcement authorities in relation to the EP requirements (and indeed other building code requirements).

While a growing number of Member States have taken the step of establishing central databases for EPCs, not all have strong functionality, but the best examples allow access for enforcement authorities, researchers and policy makers, on an anonymised basis, to enable quality assurance strategies and inform national and regional plans for energy efficient renovation of the existing building stock. EU guidelines have been produced in relation to sampling of EPCs for quality assurance and associated enforcement purposes, and there appears to be a growing adoption of these guidelines, but significant progress still remains to be made in this regard.

Figure 7-2 Indicative functionalities of an EPC administration system

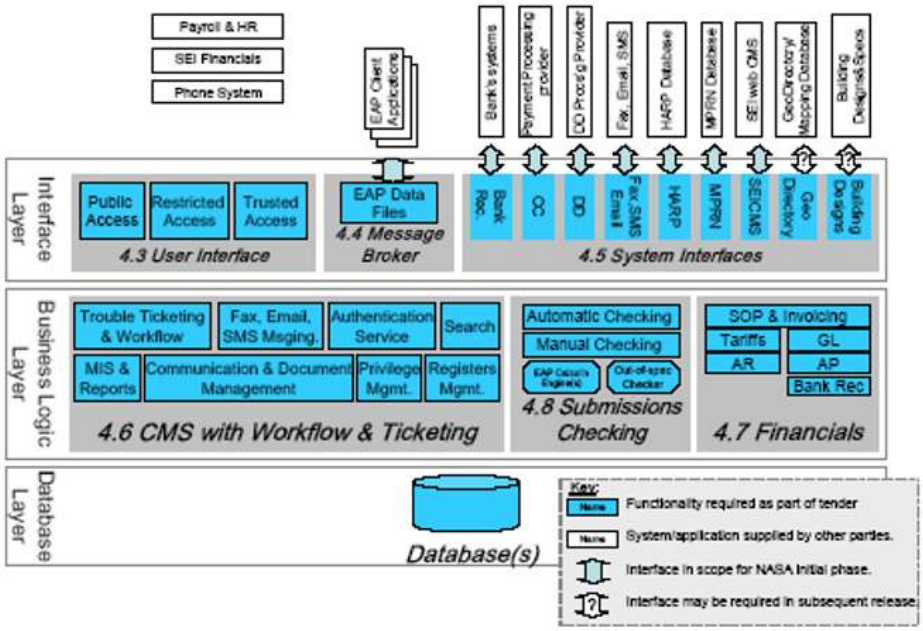


Some further functionalities associated with such a database as part of the EPC administration system are shown in Figure 7-3. These can include registration of EP/ EPC assessors/ certifiers, link with calculation tools and on-line validation of EPCs.

Management of central EPC registries/ databases is almost always maintained within the relevant Ministry or a delegated energy or administrative agency (such as a central data management agency for local/ municipal authorities) but day to day operation may be outsourced (subject to confidentiality and other contractual protocols). Usage can be restricted to registered professionals and enforcement authorities for security and confidentiality reasons. But the best examples allow controlled access for enforcement authorities, researchers and policy makers, with some data anonymised, to enable quality assurance strategies and inform future policies – such as national and regional plans for

energy efficient renovation of the existing building stock. Customer support can be resource intensive. Some countries offer support mainly by email rather than by phone. Self-financing registries, in which annual costs are covered by registration and document lodgement fees, have been reported from EU Member States in relation to certification/ labelling databases.

Figure 7-3 Example of detailed components of a central EP/EPC database and data management system



7.3 Raise awareness

Stakeholders associated with the building sector– including design, construction, real estate, legal, financial and property management professionals, as well as those involved in the sale and rental of new and existing buildings – should be targeted with tailored advice and technical information on how the EPC scheme will impact on their particular profession.

Wider promotion and information campaigns should be launched to introduce and highlight the benefits of building certification to the public. Building buyers and users in Portugal and Ireland, for example, became familiar with the campaign promoted on national television and in both the general and trade press. In Ireland a similar campaign was run repeatedly on an annual basis to raise the awareness regarding the benefits of EPCs among those viewing houses as potential buyers and tenants. Over a period of 5 years, direct seminar, conference and workshop presentations were made to over 12,000 stakeholders in the Irish construction industry. The compliance obligations on real estate agencies were emphasised. More general information on EPCs was disseminated through easily accessible sources such as citizens' advice, local authorities, real estate offices and websites. This is an ongoing process in which asy access to up-to-date information is an important aspect of keeping industry and the public informed.

A key group is that of real estate agents, as they have mandatory compliance obligations, acting on behalf of their building owner clients, to ensure compliance with the requirement of EPC ratings being included in property advertisements, whether outdoors, in real estate shop windows or on the web.

Another key target group can be conveyancing solicitors/ notaries who, with a mandatory EPC system, have an obligation to ensure that the EPC and advisory report is included in all relevant search documentation for the property in question.

7.4 Collect, review and disseminate data

Having a comprehensive administrative system with integrated data collection capabilities, as outlined in Section 7.2, is a key resource for the successful monitoring of the certification process and the achievement of an energy efficient building stock on a national basis. Information collected through EPC schemes can be used to help in re-design and improve both EPC systems and other initiatives for energy efficiency in buildings. Reliable information on national building stock performance can be used for developing evidence-based energy and construction policies, such as updated building regulations and codes, funding support mechanisms and public awareness programmes.

Disseminating information about innovative components and systems can assist in promoting such systems, overcoming market barriers such as lack of information and increasing the integration of renewable energy technologies into buildings. The dissemination should be targeted to different audiences, providing all stakeholders with relevant information.

It is wise to review the objectives set at the start of the certification development process to ascertain if the requested and stored data will achieve the aims of the scheme. This may impact on the process and tools developed, so it is essential to review regularly and holistically. Such data can be used to redefine the level of energy classes and scales, and to develop general information on energy improvement measures.

In Denmark, a form of energy certification has been in place since the 1980s. Since 1997, EPC was mandatory for smaller buildings and apartments at the time of sale, and at regular intervals for large buildings. All results and data from the EPC process are reported to a central register. This information has been used to research and assess the saving potentials and to develop policy actions for energy efficiency in the entire building stock.

8 STAGE 3: MONITORING, EVALUATION, IMPROVEMENT

The following are recommended steps in the monitoring, evaluation and improvement stage:

1 Assess quality and compliance	› Develop an overall quality assurance approach to include training and national examinations, validation of certificates and auditing processes. › Establish a comprehensive quality assurance system including complaint and appeal procedures. › Develop an initial auditing system within the centralised administration system. › rain specialists to undertake desk reviews and practice audits. › Provide support for assessors.
2 Communicate the results openly	› Communicate both positive and negative results to retain confidence in the certification scheme. › Translate energy savings into cost savings so that stakeholders can readily understand the benefits. › Communicate openly any weaknesses or errors uncovered through auditing.
3 Evaluate the scheme continuously	› Undertake continuous evaluation to ensure high quality and compliance with national buildings regulations. › Maximise the benefits through revisions of the scheme. › Adapt calculation methodologies to integrate stricter building standards.
4 Adapt the scheme as needed	› Link the certification scheme to other energy efficiency policies for buildings. › Consider implementing life-cycle assessments to determine the full impact on energy use or emissions (carbon footprint). › Assess the possibility to include other environmental effects on energy, water and land use, global warming and ozone depletion, toxic emissions (to air, land and water), and the impact on human health (environmental footprint). › Utilise whole energy performance or environmental building performance schemes to feed into larger policy goals.

8.1 Assess quality and compliance

Central to the reputation and effectiveness of the EPC scheme, assessors must provide a high-quality service, and certificates must be reliable and consistent to retain public confidence. The highest risks of error are likely to in the early period of the scheme, so it is vital to establish a strong monitoring and quality assurance (QA) system and related corrective and disciplinary procedures before building assessments begin.

The overall approach to QA will include many elements such as training and national examinations, validation of certificates and auditing processes. This reflects the three stage approach detailed in Position Paper 8, namely 'upstream', 'in line' and 'downstream' QA measures. That paper also highlighted a strategic approach based on risk considerations and applies to the mix of random and targeted auditing of EPCs lodged in the administration system. In relation to the upstream aspects, the extent of assessor compliance versus error (and need for disciplinary action) may be directly linked to the expertise of assessors, the quality of their training and the examination process. A centralised administration system can accommodate an auditing system to monitor operational compliance by assessors and ensure the accuracy of certificates. It can identify technical, procedural or system faults, so that identified errors can be rectified and avoided in the future. Countries that have developed centralised data management systems have found them to be invaluable in supporting and controlling these activities.

In addition to technical competence, appropriate professional conduct is also required to deliver EPCs in an independent manner. A serious breach of the Code of Practice, for example, may lead to immediate termination of registration. The development of a complaints and appeals process will also be necessary for assessors, subject to disciplinary action.

The need for an audit system is clear, but it is also true that good assessors need good support. In the case of Ireland, this was achieved through a help desk, regular bulletins and workshops. This not only provides support for the assessors, but also highlights necessary refinements of the assessment scheme for its developers.

In Ireland, the EPC auditing process for QA at the downstream stage has involved three types of control audits:

1. Weekly data review audits: High volume, desk-based audits on single EPC assessments highlighting inaccuracies or unusual patterns leads to a notification to the assessor or a more detailed review.
2. Desk review audits: Medium volume, desk-based audits undertaken by a specialist who carries out a forensic review of assessments may lead to an assessor notification or to a deeper documentation and practice audit.
3. Documentation and practice audit: Low volume, intensive audits carried out by an auditor appointed by the national energy authority administering the EPC scheme may include a practice or site assessment visit and could lead to disciplinary action in the form of penalty points, fines and eventual termination of registration as assessor from the system.

The budget for these activities can be derived from the revenue paid by assessors whenever a new assessment is logged into the administration system.

8.2 Communicate the results openly

Gaining and retaining public confidence is important to the ongoing success of certification. Communicating the results of the EPC scheme is important to raising awareness of the benefits of certification and to retain the confidence of the building industry and the public. Providing information in user-friendly language (avoiding acronyms, technical data and jargon) through the media and online will support informed communication among all stakeholders.

The mandatory EPC systems operating in EU Member States include advice on possible improvements to existing buildings, which is an important means of overcoming insufficient information barriers. Quantifying tangible improvements from recommended energy efficiency upgrading actions, in terms of energy and cost savings, encourages all stakeholders to continue improving the process of building certification. Providing owners and stakeholders with information on cost savings, required investments and feasibility establishes a better foundation for decision making, and can thus help to increase the impact of these measures.

But it is often necessary to use other means to support the realisation of such proposals. This might include economic incentives, but also more targeted information and advice on co-ordination of such works.

8.3 Evaluate the scheme continuously

Once an EPC scheme is successfully implemented, countries can focus on maximising its benefits and on improving the scheme. Regular evaluations should assess a number of issues, including: (a) public attitudes and confidence, and influence on their decision making; (b) levels of compliance, for example by real estate agents; (c) implementation of investments recommended in advisory reports; (d) continuous checking and evaluation of the quality of EPC assessment by assessors and their compliance with the demands in the process; and (e) evidence of impact on property price patterns.

Informed by such evaluations, scope for improvement can be considered. For example, if weaknesses in quality or other aspect of the scheme are identified, the scheme should be modified to improve performance.

To realise its full potential, a certification scheme must be able to adapt to changes in policy and legislation. Achieving NZEB standards and better will require significant changes in the way buildings are designed, regulated, constructed and evaluated. To meet such ambitious standards in a cost-optimal manner, there is a strong need for innovation in building construction, technologies and energy supply systems, including renewable energies. EPC schemes for buildings will need to adapt accordingly to accommodate such innovations in their calculation methodologies. More holistic energy performance may also be of increasing importance in future certification schemes, to include life-cycle environmental and cost analysis, indoor environmental quality and other environmental issues.

8.4 Adapt the scheme as needed

In addition to energy performance of buildings, many environmental issues could also be assessed such as land and water use, sustainable materials/ embodied energy, greenhouse gas emissions, waste handling, ecology, transport, local pollution, health and well-being, re-use of material, etc. Use of both life- cycle and broader environmental assessments of buildings has been growing steadily and, as mentioned in Section 6.1.3, various environmental assessment systems for buildings (including LEED, BREEAM and DGNB) are now in use worldwide. They were originally conceived as voluntary in their application, but increasingly, government bodies are using such systems as a basis for specifying minimum environmental performance for particular classes of buildings. They are also being promoted and in some cases administered through national Green Building Councils.

Including a life-cycle assessment of energy use and relevant costing in EPC methodologies could enhance the value of the certificate. Some such schemes also include calculations of energy use in construction (and eventual demolition) as a means of reflecting all energy use over a building's life cycle. This makes it possible to relate increased or decreased energy use in construction and demolition with changes in consumption during the building's operational phase. Traditionally the operational energy use far exceeded the level of energy capital or embodied energy in the building but with the advent of NZEB standards for operational energy use this is no longer the case.

9 ELEMENTS OF AN INTEGRATED EPC SYSTEM

The following is a summary of the system elements comprising an effective, technologically and administratively well integrated EPC system.

Development of calculation methodologies and software

- Calculation methodologies may be developed specifically to suit the national context, but existing international standards, methodologies and software in other countries may be more easily adapted (under licence) to suit national requirements.
- Methodologies and units applied must be appropriate to the type, age, use and context of certification, and must allow direct comparison of similar buildings on a national basis.
- Software tools are key to overcoming many calculation and quality issues, and should be addressed at any early stage to ensure development.
- In mandatory schemes, it may be that the government defines specifications for methodologies, but the private sector will develop software.
- Outputs should desirably reflect actual energy use, in both asset and operational ratings (while recognising the limitations of each).
- Methodologies and software should be validated and tested before dissemination to the market.
- Realistic time frames should be set for software development and testing.
- Software should be user friendly and simplify the calculation process for assessors.
- Software should automatically check for compliance with regulations, and for completeness of data entry and typical errors.
- Recommendations for upgrading should be appropriate and achievable and their cost effectiveness should be checked by the software tool.

Energy certificate design

- Certificate format and content require careful consideration; they should provide clear and comparative information for decision makers/ consumers.
- Rating scales should allow for quick comparison of performance levels between similar buildings, and should be based on realistic benchmarks (reflecting building standards and building stock).
- Rating scales should be detailed, yet flexible enough to make it possible to rate future buildings that perform better and demonstrate improvements in existing buildings.
- If possible, certificates for buildings can benefit from other labelling/certification schemes in the country; such "brand extension" can help consumers to understand key messages.

Delivery of an integrated administrative system

An integrated administrative system is essential for ongoing success and should:

- Provide access to an on-line 'one-stop-shop' for building industry, assessors and users on all matters related to energy performance certification of buildings – and ideally extending to sources of information to assist upgrading of energy efficiency.

- Provide a monitoring procedure for energy assessments and certification, as well as an auditing procedure for training providers, training assessment and assessors.
- Make certificates available on a user-friendly interface and include electronic communication with automated data entry wherever possible.
- Control the output of certificates and upgrading recommendations.
- Include a national database to store energy benchmarks and building information.
- Establish links with existing databases and facilitate the development of harmonised indicators and collection of information.
- Have the capacity to evaluate all aspects of the certification process to highlight potential improvements for the future.

10 DATABASES AND PROFILES OF EPCS

The benefits of central EPC administration systems becoming cumulatively greater over time as extensive records are acquired of EPC across the full spectrum of building types, sizes, functions, ages, ownership etc. This forms a powerful resource of real market data for the purpose of analysing potential policy options for improving energy performance of buildings and assessing their likely impact.

Figure 10-1 is an example of the profile of EPC ratings across a population of non-residential buildings in Ireland. Figure 10-2 is an example of the profile of ratings within the same population of buildings, differentiated into thirteen different functional types.

Figure 10-1 Example profile of EPC ratings across a population of non-residential buildings

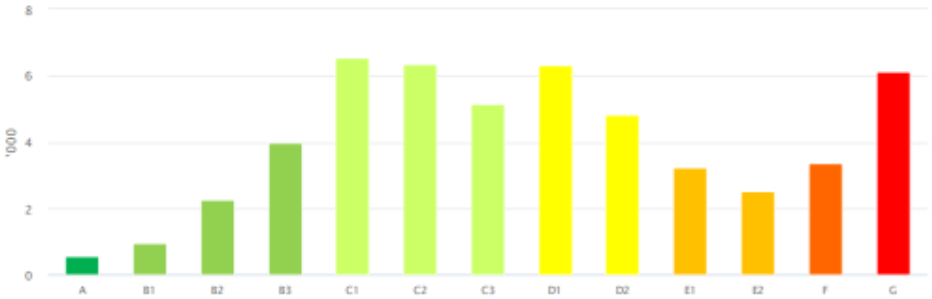


Figure 10-2 EPC ratings across 13 functional groups of non-residential buildings

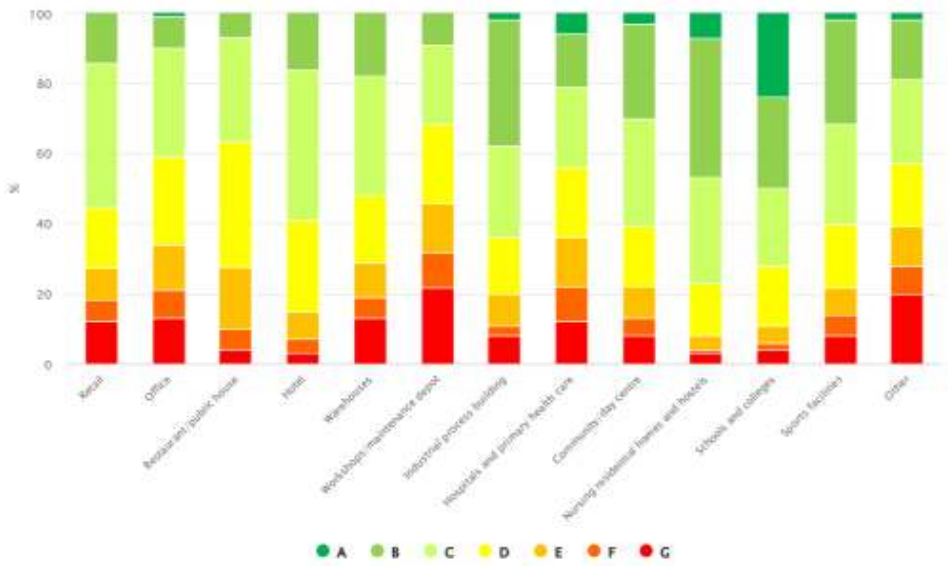
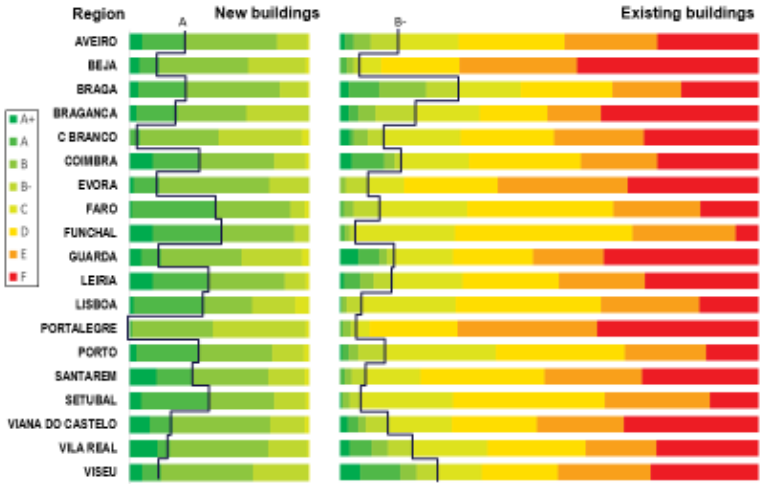


Figure 10-3 shows a similar analysis of the comparative EPC ratings for dwellings in Portugal, differentiated between new and existing buildings, and between 19 different regions.

Figure 10-3 EPC ratings for new versus existing homes across 19 regions of Portugal



11 MARKET PRESENCE AND IMPACT

11.1 Mandatory energy certification with market visibility

While the compliance and enforcement pattern around Europe is variable, in the best practice cases the introduction of EPCs for construction, sale or rental of a building is playing a prominent role in informing potential buyers and tenants about the energy performance of building units, such as an apartment or office space, or of entire buildings. They allow comparisons in terms of their energy efficiency which, with the obligations in relation to their inclusion in property advertisements, is making energy efficiency a visible market factor. In theory they should influence the demand for buildings with better energy performance and using a high proportion of energy from renewable sources. This is expected to increase their market value, on which there is already encouraging research evidence emerging, and to provide a market driver to stimulate building owners to renovate their buildings.

Figure 11-1 shows examples of such advertisements.

Figure 11-1 Examples of property advertisements containing an EPC rating

While the majority of Member States have taken the step of establishing central databases for EPCs, not all have strong functionality, but the best examples allow access for enforcement authorities, researchers and policy makers, on an anonymised basis, to enable quality assurance strategies and inform national and regional plans for energy efficient renovation of the existing building stock. EU guidelines have been produced in relation to sampling of EPCs for quality assurance and associated enforcement purposes, and there appears to be a growing adoption of these guidelines by Member States.

In the process of establishing the mandatory performance standards and EPCs, the EPBD has succeeded in creating a much stronger focus on the potential for improving the energy performance of buildings. In several countries this triggered interest among progressive investors in the construction and property sector in going beyond the minimum standards or seeking to undertake energy-saving refurbishment of the existing building stock including. This has been happening in both the commercial and apartment housing sectors.

11.2 New concepts, tools, skills and innovation

The EPBD has promoted new tools and concepts (e.g. a common methodology to calculate the energy performance of buildings, common CEN standards, EPCs, NZEBs, cost-optimality, and guidance documents) to drive forward improvements in the energy performance of the building stock. This is accompanied by the stimulation of new or improved professional, trade and industry skills in these fields.

It has also stimulated the creation of a new or improved set of skills dedicated to the provision of EPCs and the training, certification and management of EPC assessors. In the case of non-domestic buildings this was primarily an augmentation to the services of architects and building services engineers.

The EPC has been particularly helpful in giving clarity about the level of future energy requirements in regulatory building codes, notably in establishing a clear policy pathway for adopting NZEBs, which correspond to an EPC rating in the 'A' band. The improvement in standards and associated tools as a result of the mandatory requirements in the EPBD has been a strong driver in many Member States for innovation as well as the learning curve in the construction sector, which has traditionally been slow to evolve. Such innovation can help not only to improve the energy efficiency and quality of buildings but can also help to bring down costs.

11.3 Using complementary measures to increase impact

Analysis of existing schemes demonstrates the need for supporting measures to ensure that EPC achieves its intended impact. Simply providing information may not be enough to prompt energy efficiency improvement action and research shows that supporting incentives and other initiatives may be necessary.

The impact can be increased when the scheme is part of a set of complementary measures, including energy requirements in building codes and financial incentives. For example, coupling certification with building energy codes, and including calculations that show potential energy saving when codes are exceeded, can provide builders with the incentive to incorporate energy efficiency measures into the design of new buildings or retrofit proposals for existing buildings. This can lead to embedding energy efficiency in project planning and realise energy savings at the most cost-effective times in the building cycle. In some cases, additional financial incentives may be needed to encourage the desired action.

The majority of EU countries have already put in place such incentives, which include grants, tax reliefs, soft loans tailored to the degree of energy efficiency improvement, and other financial instruments. Ireland has a national grant scheme for energy retrofit and provides an additional EPC after the works are completed. Other countries have made EPC mandatory in order to obtain subsidies or tax exemption for energy saving measures.

12 CONCLUSION

Energy performance certification (EPC), based on the successful concept of energy labelling, is an important policy instrument that can assist the drive towards more energy efficient buildings. It provides decision makers in the building industry and the property marketplace with objective information on a given building, in relation to achieving a specified level of energy performance or in comparison to other similar buildings. It is closely linked with strengthened energy performance requirements in building energy codes.

Delivering a robust, accurate and low-cost certification scheme depends on many supporting mechanisms, from assessor training and validated evaluation procedures, tools and support, to quality assurance procedures and administration systems. This requires co-ordination and maintenance for successful and cost-effective implementation. Centralised computerised data management systems can be invaluable in supporting and controlling all these activities.

Based on EU experiences, the following is a summary of the key stages and elements that lead to the development and implementation of a successful EPC system for buildings:

- **Plan**: define the terms of reference for the EPC scheme, and develop an appropriate policy framework and action plan; engage multiple actors, allocate sufficient resources and communicate often with all stakeholders.
- **Implement**: provide for training and support to ensure well-qualified building assessors; raise awareness of the EPC scheme in industry and among the public; ensure efficient operation of systems for central collection, review and dissemination of data.
- **Monitor, Evaluate and Adapt**: establish quality control mechanisms to monitor performance of the EPC scheme and of EPC assessors (and provide support for assessors); communicate results openly to relevant stakeholders; analyse whether the scheme is achieving its goals and adjust as needed to increase impact; consider expanding the scheme to include environmental issues and assess its effectiveness in relation to supporting (and being supported by) other policy measures.

Finally, a further consideration is the need to ensure that EPC schemes are ‘future proofed’ through being adaptable enough to evolve with potential developments in the future.

13 REFERENCES

The following are sources of analysis consulted and referenced in the course of preparing this paper. In particular, the EU Commission study carried out by ICF provided significant information and insight into the levels of compliance and associated enforcement profiles across EU Member States.

Also listed is a selection of websites from which useful information can be obtained on EPBD implementation.

Website title and address	Description
Building Performance Institute Europe (BPIE) www.bpie.eu and particularly the publication 'Energy Performance Certificates across the EU at http://bpie.eu/publication/energy-performance-certificates-across-the-eu/	A European 'think tank' providing policy research and advice on energy in buildings, with publications and monitoring of progress with EPBD implementation, including EPCs
EPBD Concerted Action www.epbd-ca.eu and report on https://epbd-ca.eu/ca-outcomes/2011-2015	Public website for collaborative forum of Member States to assist EPBD implementation
Build Up www.buildup.eu	EU portal for energy efficiency in buildings. Extensive library of documents, webinars etc. relating to EPBD and related implementation
EU Commission – energy efficiency in buildings https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings	Covering EPBD and allied Directives, independent reports, national reports, events