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EPBD and Building Energy Codes - The role of capacity building (training, tools and resources)

EU EXPERIENCE ON EPBD - POSITION PAPER No 5

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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:E^2"[1])".

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[1] ACE: E^2 – Adoption, Compliance, Enforcement – Energy Efficiency

ABBREVIATIONS

ACE: E2	Acronym of the project (Adoption, Compliance, Enforcement – Energy Efficiency)
BIM	Building Information Modelling
BMS	Building Management Systems
CECI	Clean Energy Cooperation with India
CEN	European Standards Body
CPD	Continuing Professional Development
DSM	Dynamic Simulation Model
ECBC	Energy Conservation Building Code
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificate
EU	European Union
EUD	European Union to India
HVAC	Heating Ventilation and Air-Conditioning
NZEB	Nearly Zero Energy Buildings
SBEM	Simplified Building Energy Model

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1 SUMMARY

A key determinant of success with implementing building energy codes is the development and embedding of sufficient capacity both throughout the building industry supply chain (from planning/ design professionals to final commissioning and operation) and among the regulatory authorities. Capacity building is the 'bridge' between the formal technical performance requirements and targets set in the code and the practical delivery of those requirements and targets on the ground. It entails not only training and upskilling initiatives but calls for several other actions to assist in establishing the awareness, competence and confidence to deliver the necessary quality in the construction marketplace.

This position paper outlines the various capacity building actions taken by EU Member States in order to achieve compliance with the energy performance requirements arising from the Energy Performance of Buildings Directive (EPBD) (both the original and recast directive). The focus is specifically on practices and experiences pertaining to meeting minimum energy performance requirements and to some extent the associated energy performance certification or labelling) in non-domestic buildings, since these are most relevant to the process of implementing the building energy code (ECBC) in India.

While the quality of planning and coordination varied across Member States, and delays were experienced in some cases, ultimately the majority succeeded in putting the necessary human capacity, organisational and communication systems in place to ensure the awareness and preparedness of the construction and property sectors to achieve compliance with the new energy performance requirements. This is also relevant to ensuring readiness to meet the EPBD requirement for 'nearly zero energy buildings' (NZEB) by year 2020. **It is to be expected that elements of the capacity building frameworks applied in EU Member States could also be beneficially applied in the circumstances of India.**

The paper outlines the contextual positioning, status, functional role and features of the various capacity building actions, which include: (a) the development of technical tools to improve the efficiency and quality of the analysis and design processes, (b) the development and delivery of training for both building energy professionals and site tradespersons, (c) similarly with training for local building control/ regulatory professionals, (d) the development of efficient administrative/ organisational systems and processes, underpinned with good quality ICT systems, (e) the availability of building products and services to deliver code compliant buildings, and (f) the support for demonstration building projects which help to highlight the achievability of energy efficient buildings and thus provide evidence and confidence to the stakeholders. Allied to the latter, research and development projects aimed at tackling knowledge, skills gaps and developing new and improved building materials, equipment, design tools etc. can be seen as part of an ongoing capacity building process (these topics of RD&D and of industry capacity and role are addressed in next Position Papers).

In essence, it can be said that capacity building involves the engagement, skilling and mobilisation of the full orchestra of stakeholders responsible for ensuring that code compliant buildings are realised.

2 INTRODUCTION

The EPBD placed a series of mandatory requirements on Member States. It required that each Member State must adopt an official energy performance calculation methodology that accords with the common general framework specified in the Directive, must apply this methodology to the setting of minimum requirements for the energy performance of new buildings and major renovations, must review these requirements at least every 5 years, and must establish an energy performance certification/ labelling system mandatory for all new buildings and buildings offered for sale or rent. **The primary issue relevant to the ECBC situation in India has been to ensure that minimum requirements for energy performance were formally set and then achieved in practice.**

A key feature of good practice implementation of the EPBD was that the legal transposition process needed to be **accompanied, and in some matters preceded, by significant stakeholder consultation and communication, techno-economic studies, plus a range of capacity building activities - including the development of technical tools and systems, administrative systems, and training and skills development among building industry players and enforcement authorities**. All of these ingredients have been necessary in order to make the legislation operative and effective in the building industry sector. How to train and recognise/ register sufficient numbers of suitable qualified professionals to deliver buildings compliant with the new energy performance requirements and to deliver the associated certificates, plus the necessary awareness and upskilling by the construction trades workforce and the skilling of the enforcement authorities, were among the first challenges. These activities are also relevant to ensuring readiness to deliver buildings that meet the 'nearly zero energy buildings' (NZEB) standard by year 2020.

This Position Paper selects and highlights learnings from good practice approaches and experiences implemented in particular EU Member States in relation to building the necessary technical, human skills and organisational capacity to ensure that the provisions of the EPBD were successfully implemented. While the EPBD has multiple requirements, the **focus in this paper is on capacity building experiences from EU Member States pertaining to meeting minimum energy performance requirements** (and to some extent the associated energy performance certification or labelling), since these are most relevant to the process of implementing the building energy code (ECBC) in India. The details given in this paper are thus hybrid experiences drawn from implementing both the minimum energy performance requirements (the building energy code) and the energy performance certification/ labelling requirements.

These experiences relate, in approximate sequence, to 6 aspects:

(a) the development of technical tools to improve the efficiency and quality of the analysis and design processes

(b) the development and delivery of training for both building energy professionals and site tradespersons

(c) similarly with training for local building control/ regulatory professionals

(d) the development of efficient administrative/ organisational systems and processes, underpinned with good quality ICT systems

(e) the availability of building products and services to deliver code compliant buildings, and

(f) the support for demonstration building projects.

Particular elements of implementation in the EU show good resonance with elements of the ECBC implementation process to date in India.

3 BACKGROUND

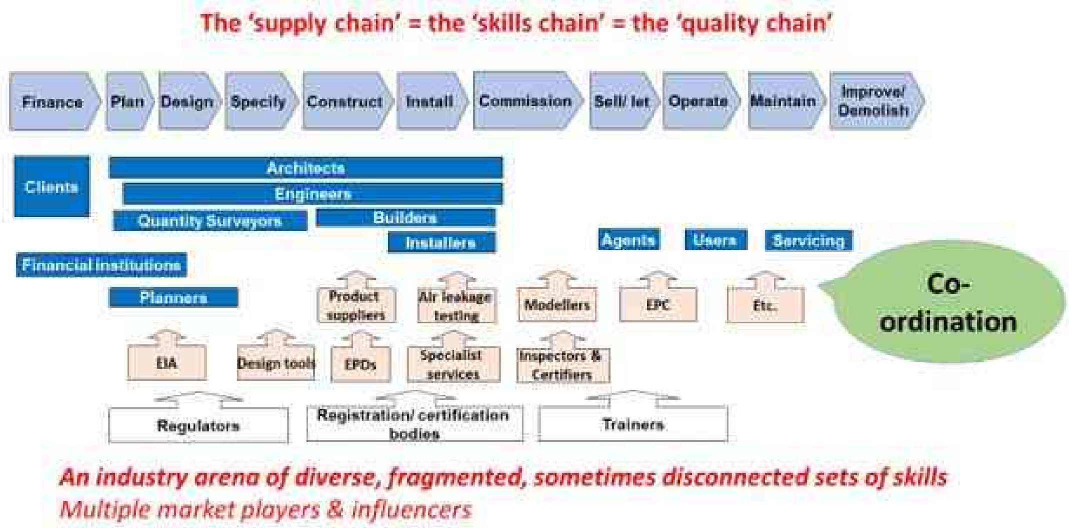
Position Papers 2 and 3 had outlined the overall range of activities – including governance, action planning, consultations, legal adoption, technical methodologies and systems development, standards, role of product and service providers, administrative systems development, certification, enforcement, promotion and incentivisation – applied in implementing the EPBD. Before presenting the key capacity building issues and elements addressed by EU Member States, this section recalls both the overall framework of activities and the relevant pre-existing systems for building code implementation.

3.1 The arena/ starting position – Context and positioning

Building energy codes can be embedded as an integral module within the overall building code or else they can be separate or stand-alone codes. Both prior to and following the EPBD, only in a small number of EU countries had the building energy code been a standalone code separate from the other aspects of the building code. In contrast, in the case of the ECBC in India, a standalone approach is being taken.

However, irrespective of which model applies, Figure 3-1 is a representation of the process of delivering code compliant energy efficient buildings, from planning through to operation and maintenance, showing the range of steps, diverse responsible parties and resources involved. These constitute a 'supply chain' of activities, which can also be seen as a 'skills chain' and 'quality chain', in which overall compliance requires that each entity has the necessary skills to make its necessary contribution to a quality outcome. This diagram can also be regarded as a 'stakeholder map'. In this context, capacity building includes the engagement, upskilling and co-ordinated mobilisation of the responsible construction professionals, product and service specialists and site trades to deliver code compliant buildings, and also the necessary engagement of enforcement authorities.

Figure 3-1 Schematic of roles of various entities in delivering energy efficient buildings

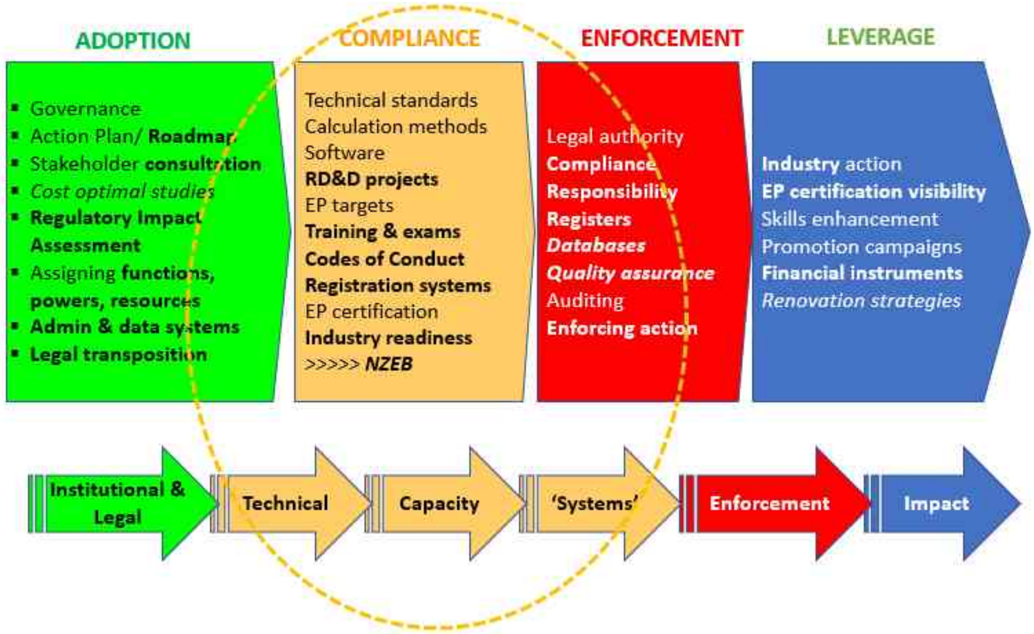


3.2 Positioning of the capacity building process

Figure 3-2, as introduced in Position Paper 2, is an overview of the overall process of EPBD implementation in relation to energy performance requirements and certification, as a good practice model showing a four-phase process of **Adoption > Compliance > Enforcement > Leverage**. These blocks of work constitute the platform for successful implementation.

The focus of the current Position Paper is primarily on the 'Compliance' block of actions. These actions are aimed at ensuring that the necessary technical and systems capacity is in place to ensure that, at the point of coming into effect ('Adoption'), the legislation has credibility by (a) having sufficient qualified persons in the construction industry market with (b) the necessary software and tools to deliver and certify compliant buildings and by (c) having sufficient trained resources and systems (e.g. databases) within the assigned enforcement authorities (or delegated on their behalf) to operate a visibly effective enforcement regime. Throughout the process, there is also a need for promotion and publicisation to the building industry professions, trades, suppliers, and building owners (the 'Leverage' actions).

Figure 3-2 Primary blocks of tasks necessary for implementation and effectiveness of building energy codes under the EPBD



3.3 Strategic approach to capacity building

Figure 3-3 is a schematic summary of three key groups of capacity building features required to achieve compliance with a new building energy code such as mandated by the EU EPBD or India's ECBC. These are:

- **Tools**: Technical tools with sufficient functionality, user friendliness, accuracy, consistency and completeness to enable qualified building industry practitioners to deliver on their obligations in a cost-efficient manner;
- **People**: Upskilling of sufficient numbers of building industry practitioners to sufficient levels of competence to fulfil their role in delivering code compliant buildings (this issue is elaborated further below in relation to the needs of volume, quality and quality assurance);
- **Systems**: Efficient (time and cost) administrative systems to enable submission of certification documents and evidence of code compliance and with the facility for utilisation by enforcement authorities to inform quality assurance strategies.

These three categories of capacity building actions will be addressed in turn further below.

Figure 3-3 Key factors in achieving successful building energy code implementation

As indicated in the Figure, good practice implementation involves looking beyond minimalist compliance and using 'Leverage' actions by authorities and industry players to promote wide awareness and incentivise superior performance, and hence maximise the impact of the building energy code. These elements will be addressed in other Position Papers. Market demonstration projects, discussed in the present Position Paper, can also be seen as a form of leverage action.

In relation to the design of the compliance and enforcement system, a process of development was pursued by the EU Member States. In the (small number of) best practice cases, this was an extensive process which typically included the following:

- Development of the methodologies, software and support resources for demonstrating compliance with the energy performance requirements and for generating the energy performance certificate/ label
- Specification and organisation of training, with timelines to ensure adequate numbers of qualified design professionals and certifiers
- Delivery of training to assigned enforcement authorities and their personnel
- Development of Codes of Practice or Codes of Conduct
- Establishment of registers of qualified persons
- Design and establishment of on-line databases/ registers for lodgement of evidence of compliance
- Training initiatives with construction industry trades engaged as the on-site workforce
- Development of a quality assurance regime with associated sanctioning procedures
- A major communication and promotional campaign for the construction industry, politicians and the general public
- Website development to assist that market awareness and hosting of tools and resources to assist efficient practical delivery by the industry
- Ongoing helpdesks for EPC assessors, building owners and the general public.

The core groups of actions in relation to tools, people and systems will be further elaborated in the sections that follow.

4 RULES AND TOOLS: METHODOLOGIES AND SOFTWARE

While the central element of capacity building is the upskilling of the personnel responsible for delivering code compliant buildings, it was important that preceding steps be taken to develop the necessary technical tools and resources on which to train the personnel and to assist them in the cost-efficient design, specification and construction of those buildings. These steps include the following, which are now outlined:

- The foundational role of European technical standards (EN)
- The official national energy performance calculation methodologies/ engines/ algorithms, aligned with the relevant EN standards
- The technical rules to be met in order to achieve code compliance, as set in the legislation
- Official and other accredited software for energy performance calculation
- Technical guidance documents to assist practitioners to achieve and demonstrate compliance with the legislated performance requirements (Position Paper 3)
- Support resources – documents, software, databases, best practice guides etc.

4.1 Role of EN standards

Details regarding the new series of European technical standards to support the EPBD were given in Position Paper 4. This process involved approximately 4 years of development and review work on the part of several European Standards Body (CEN) technical committees and feedback from individual national committees and industry interests. In a number of cases with particular standards, the experience of engaging with the process contributed in itself to strengthening the knowledge capacity of national authorities.

This work resulted in an integrated suite of procedures, criteria and options which provide a robust foundational support to national authorities and building industry practitioners. The standards were structured into a hierarchical and modular framework which allows Member State flexibilities in their detailed application. They have served as an important background resource to the 'tools' aspect of capacity building – for both national authorities and commercial product and service (e.g. software) providers.

They also encourage more harmonised regulatory and market practices across EU countries, while offering an appropriate level of flexibility for national adaptation to local/ regional conditions. For example, the core EP calculation standards are flexible in allowing annual, monthly or dynamic simulation model calculations, plus local climatic conditions. The suite also covers a wide range of issues in the fields of thermal insulation, windows/ glazing, heating, cooling, lighting, ventilation, domestic hot-water systems, building automation and control, and renewable energy sources.

4.2 Energy performance calculation methods

The officially recognised performance calculations and associated software (see further below) provide a vital foundation to the design and delivery of the necessary training to ensure adequate human capacity to deliver code compliant buildings according to the legally set deadlines.

In themselves, the EN standards did not provide a fully prescriptive energy performance calculation methodology. In general, each national methodology for calculating and demonstrating compliance with EP requirements was the outcome of a series of modelling studies and/or reviewing and adapting methods already in use in their own and other countries. It involved a calculation engine incorporating various algorithms, all of which are aligned to the relevant EN standards. Usually this development process was formally led by the national energy agency, but often with recourse to external expertise from universities, technical institutes etc.

The newly adopted methodologies varied in scope and complexity across Member States. Generally, different methodologies were used for residential buildings and for other buildings. Often the methodology incorporated the use of the 'reference building' (or 'notional building') concept versus 'actual proposed building'. All methodologies used an overall energy performance indicator, covering the main thermal and electrical uses, expressed as annual kWh of either final energy or primary energy per m^2 of gross floor area. In less than half of EU countries a similar way of expressing performance – and the associated regulatory requirement – was already in place prior to the EPBD, so that this particular new format required familiarisation on the part of both market and regulatory entities in most Member States.

A number of EU countries have adopted a methodology and software called SBEM (developed in the UK but also applied in adapted form in Cyprus, Malta, Ireland and some other States) to enable energy performance assessment of non-domestic buildings in their jurisdictions. This is an example of a degree of harmonisation or convergence between EU Member States (This would appear to be similar to the position regarding the ECBC across the different States or regions of India). In most EU countries, a broadly similar national methodology and associated software has likewise been developed by the relevant national energy agency (for example, by the national energy agency in Portugal, ADENE).

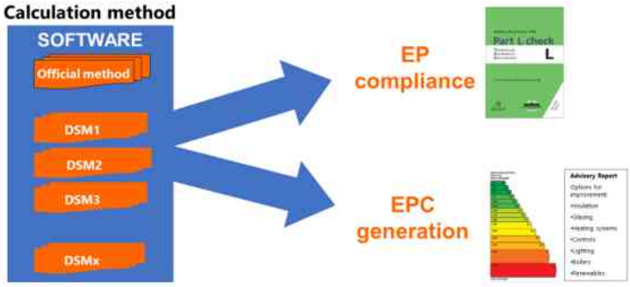
Such overall calculation methods still employ or reference a range of EN standards for individual sub-systems or components. Compatible with this framework, and assisting a holistic approach, implementation of the EU EcoDesign Directive also involves application of such individual mechanical and electrical component standards for boilers, air conditioning systems, lighting etc.

4.3 Setting of energy performance targets

The prescribing of energy performance targets in legislation constitutes the central set of rules in the building energy code. While it is not in itself a capacity building element, it is a pre-condition to the guidance document, other resources and training issues discussed further below, and is therefore outlined here to provide context.

Deriving from the terms of the EPBD, and aligned with the European technical standards, the energy performance calculation methodologies adopted in all Member States had a dual purpose, providing a common calculation engine for demonstrating compliance with the performance requirements and for producing energy performance certificates/ labels, as shown in Figure 4-1. This dual role provides consistency and efficiency benefits both to building professionals and to regulatory authorities.

Figure 4-1 Dual role of calculation methodology in demonstrating energy performance compliance and generating energy certificates/ labels



EU Member States were required to apply a ‘cost optimal methodology’ (essentially a life cycle analysis approach - addressed in Position Papers 2 and 3) in order to determine the appropriate level of ambition to be prescribed in their building energy codes. This involved use of the calculation methodology to model a range of representative building typologies to identify the optimum levels of performance. Similar modelling was applied in order to inform the design and scaling of the building energy performance certificate/ label.

As now outlined, the calculation method permits either the official national methodology, or alternatives in the form of validated Dynamic Simulation Models (DSMs).

4.4 Energy performance calculation software

Associated with the methodologies, software tools were developed or adapted from existing tools, with ‘official national software’ commissioned by the national energy agency and typically based on monthly calculations. Conceptually this is like a process of converting an Excel macro-based spreadsheet file and associated data libraries into a more user friendly interfacing experience. The process of specifying, developing, user acceptance testing/ pilot trialling and validating such software typically required up to one year and a cost often in excess of €100,000.

To enable a more streamlined compliance and administration system, it has been highly desirable that the tendering specification for such software development ensures that the data outputs – and ideally also the data inputs – to the software can be 'plugged in' to the database of information submitted as evidence of compliance. This would facilitate downstream interrogation of the administrative database (discussed further below as part of 'systems') to inform quality assurance prioritisation and targeting by the enforcement authorities. A further good practice ingredient in the software, aimed at assisting designers/ specifiers/ certifiers in using the software correctly and avoid typographical errors for example, is to have a validation check on the credibility of aspects of the input data, (e.g. U values, solar gain factors outside of normal ranges) and invite the user to double check the input before submitting it to the administrative system.

In most EU countries, this calculation software was available as freeware to registered professionals. This covered most buildings but most countries also provided the option of validated commercial Dynamic Simulation Modelling (DSM) software to cater better for more complex buildings. The latter software was normally developed by specialist technical software companies and service providers, sometimes linked to comprehensive 'Building Information Modelling' (BIM) systems, and was available for purchase in similar manner to most commercial software. While the software in some cases formed part of an architectural/ engineering design tool, in some instances it was confined to being a tool for assessing and demonstrating compliance with the building energy code.

The number of available software packages has varied between countries and regions. In 20 EU countries the uniform and reliable interpretation and validation of the calculation procedure in 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, and some systems included a preliminary module to assist the process of preparing the input data. 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 accreditation by a central authority is aimed at and ensuring consistency accuracy in the results and gaining customer confidence.

Accredited software packages were not only an important capacity resource themselves but also served as an important platform for the training of designers, specifiers and certifiers in order to deliver code compliant buildings.

Examples of commercially available DSM software, including some interface applications, available in the English language and in use in EU countries for building energy performance modelling and design are listed in Table 4-1. The first column labels are hyperlinked to sources of more information on these software packages. A source of more detailed technical information is the International Building Performance Simulation Association (http://www.ibpsa.org/).

Table 4-1 Examples of Dynamic Simulation Software used for energy performance calculations

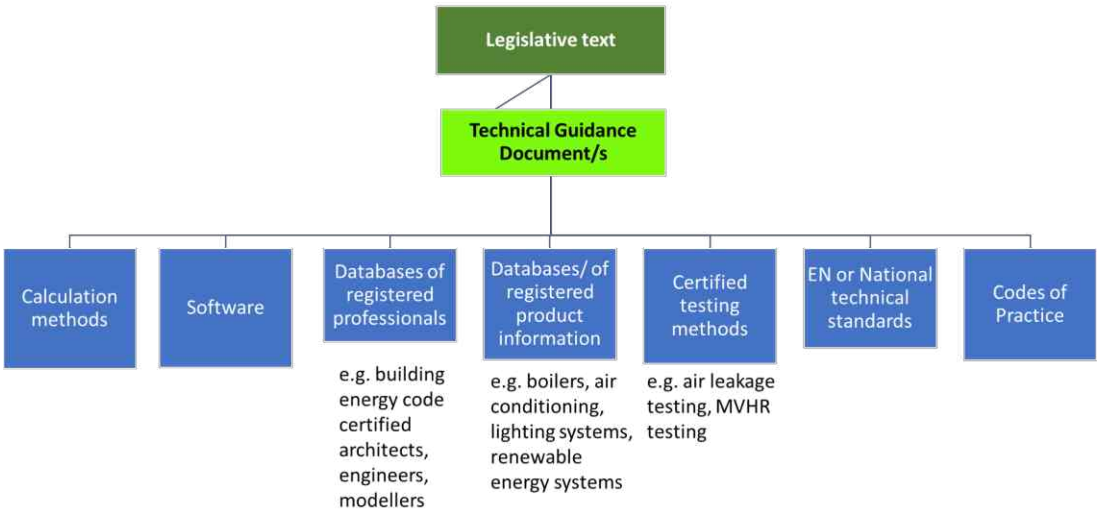
Software tool	Description	Used in
SBEM	Energy calculation tool for non-residential buildings (national calculation method)	UK, Ireland, Cyprus, Malta
IES Interface from IES to SBEM	Dynamic simulation software Interface between IES and SBEM	UK, Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Netherlands, Spain, Sweden – also in Australia, India, USA
EnergyPlus DesignBuilder	Dynamic simulation software Interface with EnergyPlus	UK, Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, USA, worldwide
IDA ICE	Dynamic simulation software	Sweden, Czech Republic, Denmark, Estonia, Finland, Germany, Italy, Norway, Spain, UK
Pleiades+Comfie	Dynamic simulation software with user interface (Pleiades) Interface between IES and SBEM	France
ESP-r	Dynamic simulation software Interface between IES and SBEM	UK, Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France,

Software tool	Description	Used in
		Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, worldwide (often more in a research context than in a design context)

4.5 Technical guidance documents

In transposing the energy performance requirements arising from the EPBD, a variety of different configurations and formulations of legislation for building energy codes have been applied in EU countries. However, a good practice example might consist of a hierarchy along the following lines of regulatory, guidance and support documentation, as illustrated in Figure 4-2.

Figure 4-2 Example of hierarchy of building energy code documents and resources to support compliance



These materials, along with the energy performance calculation software itself, form the immediate foundation to the training aspect of capacity building. Acquisition of the necessary training and experience is important in order to ensure that building industry practitioners involved in the design and construction of buildings subject to the building energy code are made aware and have a clear understanding of this full set of documents and resources.

The formal legal enactment has usually taken the form of a primary legislative document, specifying the basic functional objectives and requirements in a general manner, with limited technical content, and possibly specifying the mandatory overall performance requirements (in terms of energy or carbon intensity). But in some cases, the legislative document can include substantial detail, depending on legal tradition. This legislation will typically be prepared by the lead Ministry for inclusion in the Statute book.

However, to assist practical compliance, at the next level it is necessary to provide building industry practitioners with a technical guidance document or documents (in some countries this is termed 'secondary legislation' or 'rules'), explaining the detail of the energy performance requirements, and additional prescriptive requirements if applicable, possibly with effectively 'deemed to satisfy' solutions. Trade-offs between different features will normally be allowed (since the methodology is performance based), but may be subject to limits in the form of 'backstop' values, for example for minimum elemental insulation levels. While this document might not be mandatory, deviation from the guidance will require the designer or specifier to demonstrate equivalence of overall energy performance to the satisfaction of the building control inspector. This documentation may be prepared by the lead Ministry or on its behalf by a government agency or contractor.

Examples of such guidance documents from English speaking countries can be downloaded from the hyperlinks to the UK 'approved document' and Ireland 'technical guidance document' on energy performance provisions for non-domestic buildings.

4.6 Other detailed technical support resources

At a more detailed operational level, there will be further support documents and tools, providing assistance on individual aspects and options, also indicated in Figure 4-2. Ideally, all these resources will be accessible on-line and can possibly include:

- Lists of accredited computer software (which may be freeware or for purchase)
- Software manuals and guidance on calculation methods
- Databases/ registers of qualified design and certification professionals (individuals or companies)
- Databases/ registers of specialist service providers, e.g. thermal modellers
- Databases of registered product information (e.g. air conditioning, lighting systems, boilers, motors, renewable energy systems)
- Databases of eligible or certified energy efficiency products, e.g. products compliant with the EU EcoDesign Directive

- Detailed software tools for component calculations, e.g. for U-value calculations, sizing of HVAC systems, daylighting analysis, thermal bridging analysis, condensation risk analysis, solar overheating analysis, solar heating system performance
- Good practice guidance on indoor air quality issues
- Renewable energy methodological guidance, e.g. solar thermal, solar photovoltaics, air source heat pumps, ground source heat pumps, biomass systems
- Methodological guidance on district heating systems, cogeneration or polygeneration systems
- Certified testing methods (e.g. for air leakage testing) and registered service providers
- Reference to EN or national Standards
- Databases of accredited training bodies
- Recommended professional Codes of Practice and other good practice guides
- Good practice installation guidelines on building components and equipment.

Examples of ancillary software tools to assist energy performance analysis are among the tools listed on the (US hosted) international website https://www.buildingenergysoftwaretools.com/

The above resources may be prepared by government agencies, national standards authorities, professional institutions and possibly even by trade associations. At least some of the latter may not have a mandatory status but adherence to such guidelines may be grounds for a 'deemed to comply' decision by the building control authorities.

5 PEOPLE: UPSKILLING ACTIONS

A central focus of this second group of capacity building actions in EU countries was on the steps for ensuring the adequacy of the human and associated organisational resourcing that needed to be in place in each Member State. Under the EPBD, details of how to accredit and recognise qualified persons is left to Member States to decide. Training and education of professionals and site workforce personnel have been highly variable between Member States, influenced by the specifics of the local work markets, so the items that follow in relation to the 'People' issue are distillations of good practice experiences in EU countries.

The following sequence of steps will now be outlined:

- Planning the training and skilling process
- Questions for decision
- Responsibilities
- Pathways to registered professional competence
- Training specification
- Training and accreditation of trainers
- Training delivery to designers/ certifiers
- Examinations
- Code of Practice/ Conduct
- Registration with assigned registration body Registers/ databases of qualified persons
- Training of assigned code enforcers/ verifiers
- Training of building trades/ site workforce personnel

5.1 Planning the training process

By "adequacy" of human and organisational resourcing is meant satisfactory volume and satisfactory quality to ensure credible and smooth operation of the relevant building energy code and certification processes. In previous Position Papers, the capacity needs were summarised as three sets of conditions:

Volume (V): Adequate numbers of relevant competent professionals are required to be active in order to meet market demand and ensure healthy competition in the market, and thereby achieve acceptable prices and turnaround times.

Quality (Q): The relevant practitioners (professionals and tradespersons) need to be of adequate quality, in terms of both skills' competence and conduct.

Quality Assurance (QA): Effective underpinning quality assurance and administrative systems need to be in place to co-ordinate and oversee, on an ongoing basis, the reliable operation of these services.

These can be viewed as three preconditions for success in implementing a new building energy code.

In relation to the Volume (V) issue: Good action planning (Position Paper 3) involves projecting the levels of construction market activity in the near term in order to ensure that sufficient numbers of suitable persons (i.e. with the necessary prior foundational professional qualifications) undergo the necessary training. This requires sufficient initiation and clear scheduling of the training pathway (see further below) in order to have sufficient qualified persons in place to deliver code compliant buildings from the date the legislation comes into force. It involves taking into account of the pre-existing base of suitable architects, engineers, surveyors and others and their background level of building energy expertise. Uptake of training depends, *inter alia*, on government promotional activities and acceptable costs of training. Allowance also needs to be made for the possibility of not all persons trained choosing to register as, say, energy performance designers or certifiers; for example, some architectural or surveying personnel may participate in order to be familiar with the processes, key issues and the 'language' of the building energy code, without the intention of being day to day practitioners themselves. Ultimately, a small surplus of registered persons relative to market need is the ideal in enabling a competitive market with reasonable pricing. The main challenge is to have this in place in time, as subsequent to the initial phase it can be expected that the numbers reach the necessary equilibrium to meet market needs.

In relation to the Quality (Q) issue: This group of capacity building actions by Member States relates to the elements and processes involved in training of the necessary personnel in their various roles. This is required to ensure the technical authenticity and market reputation of the service in delivering code compliant buildings. These elements will be detailed within this 'People' section of the paper below.

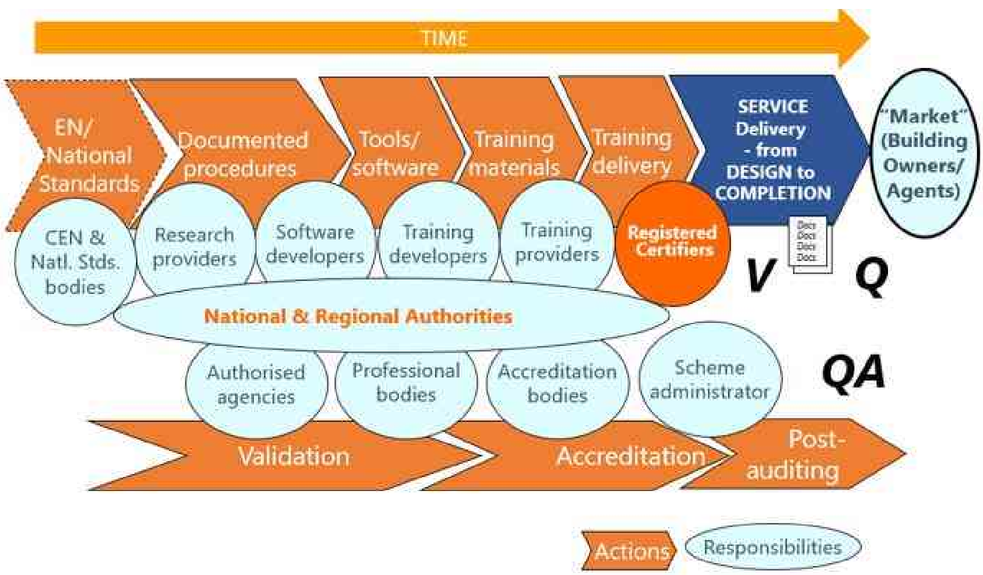
In relation to the Quality Assurance (QA) issue: These underpinning systems need to be in place to ensure ongoing good governance and closed loop control on the quality, efficiency and overall reliable and compliant operation (and hence the reputation) of the building energy code. This will be discussed further below as part of the 'Systems' section of this paper.

Using the V, Q, QA paradigm, the overall journey of this technical development and capacity building process, and the entities, responsibilities and interrelationships involved, is illustrated schematically in Figure 5-1. This highlights the importance of good oversight and co-ordination, in which regard the legislation transposing the EPBD will have assigned the relevant functions and powers, normally to the lead Ministry or national energy agency. As previously indicated in Figure 3-3, this good practice planning approach entails the following logical chains or streams of sequential actions:

- **Tools**: Standards > calculation methodology > software > guidance documents > support resources >code of practice
- **People**: Training specification > training and accreditation of trainers > pre-qualifications of trainees > training delivery > examination
- **Systems**: Validation of tools > accreditation of trainers > databases > registration > ongoing quality assurance (including post auditing).

These steps require completion of the prerequisite tasks related to setting of rules and technical tools development as outlined in a previous section, so any delay in any of the upstream steps has a downstream effect on all the other steps that follow. The tasks shown as block arrows constitute a chain of dependencies, with the delivery of any individual task being dependent on the preceding task in the chain being complete. For example, in relation to the upper (V, Q) supply line, the presence of adequate numbers of qualified EP assessors demands that training has been delivered; this in turn demands that a training syllabus has been put in place, which in turn depends on the development and validation of the software to enable the application of the core methodology. The parties associated with these sets of tasks are shown as ovals. A similar sequential interdependency applies to the lower (QA) supply line.

Figure 5-1 Sequence of tasks and responsible parties for delivering building energy code compliance and certification service to meet volume, quality and quality assurance requirements



For EU countries, the duration of this overall process was invariably in excess of 3 years. The scale and complexity of the work involved resulted in most Member States applying an incremental, phased approach to implementing the individual requirements of the EPBD over time, to the extent allowed by the Directive.

With regard to the 'systems' issues discussed further below, a similar chain of dependencies applies. Hence, substantial progress has also been required on the training and related tasks in order to allow integrated administration systems to be developed and tested, including on-line systems for lodging evidence documentation on compliance to a central database, and consequent data management and quality assurance procedures.

5.2 Questions for decision

Figure 5-2 is an indicative selection of key questions for consideration at an early stage by the central EPBD coordination group in each EU Member State in relation to ensuring the adequacy of the human skills available to implement the new building energy code and the robustness of the systems to be put in place to ensure quality:

Figure 5-2 A selection of key questions to be considered at the planning stage in relation to human and systems capacity

Who does what?

- Who designs and calculates the energy performance?
- Who certifies the energy performance?
- Who accredits the design and certification practitioners?
- Who maintains the register/s of qualified persons?
- Who carries out the quality assurance inspections and audits?
- Who will ensure enforcement of the energy performance standards?

What expertise is needed for each task?

- How many qualified persons are needed?
- Level of education?
- Fields of expertise (building, installations, energy management, ...)?
- Profession (architect, building engineer, building surveyor, energy company, ...)?

How is this expertise established?

- What are the plans and timing for training of the necessary qualified persons?
- What pre-qualifications to training are required?
- Who formulates the curriculum?
- Who develops training materials?
- Who trains and accredits the trainers?
- Who delivers the training?
- What qualifying examinations will be required?
- What are the plans and timing for training of enforcement personnel?

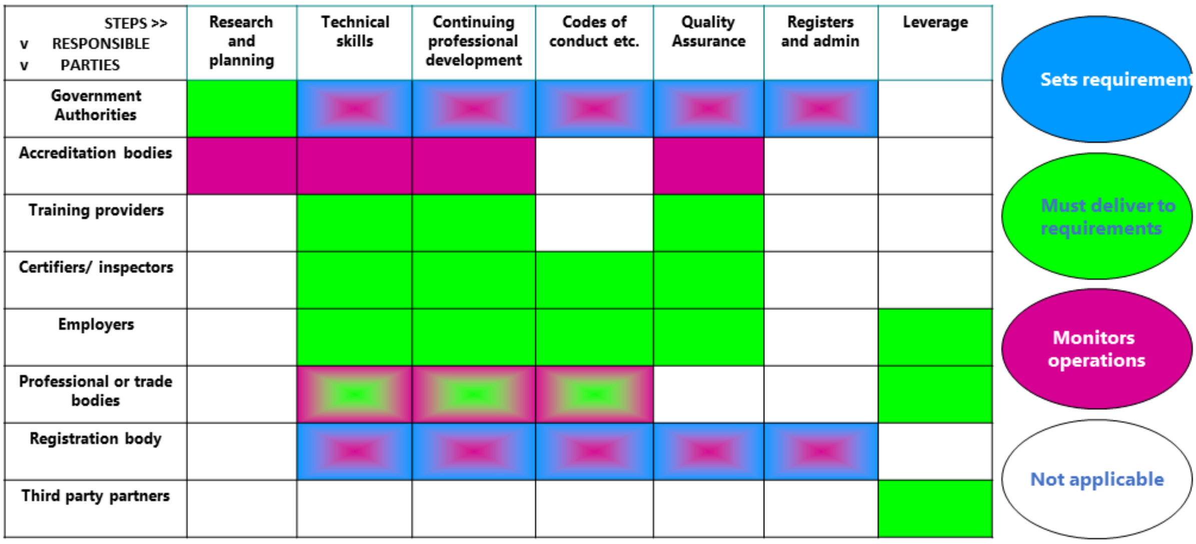
What QA-system is used for assuring this expertise?

- Government or market driven?
- Existing QA-systems?
- How will professional independence be assured?

5.3 Responsibilities

The details regarding assignment of responsibilities in relation to training needs varied considerably between Member States. However, Figure 5-3 shows the types of organisation that had a role in the majority of EU countries and can be regarded as a 'dashboard' on which the sequence of tasks could be communicated with all responsible parties and the state of progress reported.

Figure 5-3 Planning 'dashboard' of training development phases and responsible parties



processes.

- **Training providers**, responsible for developing their individual training curricula and other details, in accordance with the training specification. As indicated further below, these can be a mix of energy agencies, universities or other educational institutions, professional bodies (commonly architectural or engineering institutes or 'chambers'), building industry vocational training bodies, commercial training companies, specialist software companies or others.
- **Trainees as competent persons** in relation to the building energy code, responsible for designing and/or certifying the energy performance of buildings and maintaining that competence through 'continuing professional development' (CPD) following their being entered as registered professionals. These could be architects, engineers or architectural technicians. In countries where panels of 'validators' of building energy code compliance are established (i.e. similar to the division of functions applied with the ECBC in India), higher expertise thresholds (i.e. higher marks in examination) apply for such validators.
- **Employers**: As clients, responsible for ensuring that only registered professional service providers are employed in design and certification work. As employers in the case of architectural or engineering design practices, responsible for ensuring that their relevant personnel have the necessary foundational qualifications and specialist training, and use the officially recognised calculation software and other tools.
- **Professional and trade bodies**, responsible for alerting, informing and educating their members in relation to their obligations (and business opportunities) in relation to compliance with the building energy code. As indicated above, some professional bodies may also have an accreditation role in relation to both under-graduate and post-graduate training curricula.
- **Registration bodies**, responsible for holding relevant testamentary documentation and maintaining up to date records of registered persons, which in this context may

include professional bodies or may be national or regional energy agencies. They also have a role in relation ensuring adherence to the code of practice, quality assurance and potential disciplinary matters.

5.4 Early decisions

In most EU countries, good practice has involved the lead authorities making early decisions on the key issues and disseminating their proposals through the action plan for implementation of the building energy code and certification elements of the EPBD or as a separate document for stakeholder consultation. A core issue is the process (whether and how) of registering individuals as 'competent persons' to design to and sign off/ certify compliance with the building energy code. Issues and decisions have generally included the following:

- Decision is required on whether undergoing a new training course is mandatory as a precondition to registration as a competent person or whether any exemptions should apply on the basis of prior learning and experience. A number of Member States have permitted the latter.
- Accreditation of training and issuing of competency awards/ certificates. This is often under the aegis of pre-existing national and professional frameworks for qualifications, with their established regimes for quality assurance of education and training programmes.
- The extent of the role of government in relation to training and registration of competent persons – such as its regulation, financing and development of guidance materials. While this has varied in nature and extent across Member States, most jurisdictions played an active role in specifying the rules (defining the pathways) and providing resources (for example, Sweden provided financial subsidy to the process of training building energy certifiers).
- Similarly, as far as possible, the role of design and certification of energy performance can be seen as a 'top up' to the qualifications of existing professionals rather than creating a new profession – particularly for commercial and public buildings on which architects and building services engineers will already have foundational skills and established roles. Hence training is usually delivered through the channels of existing professional and trade expertise where feasible.
- In some Member States in which training is optional, passing the examination is still mandatory. This pragmatically facilitates persons with prior strong qualifications but retains a control 'gateway' on quality and avoids compromising the integrity of the system.
- Training services should be geographically/ regionally accessible as far as is practicable.
- Whether registration should be of individual qualified persons or of companies employing such persons. In most Member States it has been registration of individuals, but in some countries (e.g. Sweden) a company registration approach

has been taken where the company must demonstrate a minimum number of competent personnel and rigorous quality management procedures. Registered persons who have assistants on the work must sign off regarding the final design and declaring compliance.

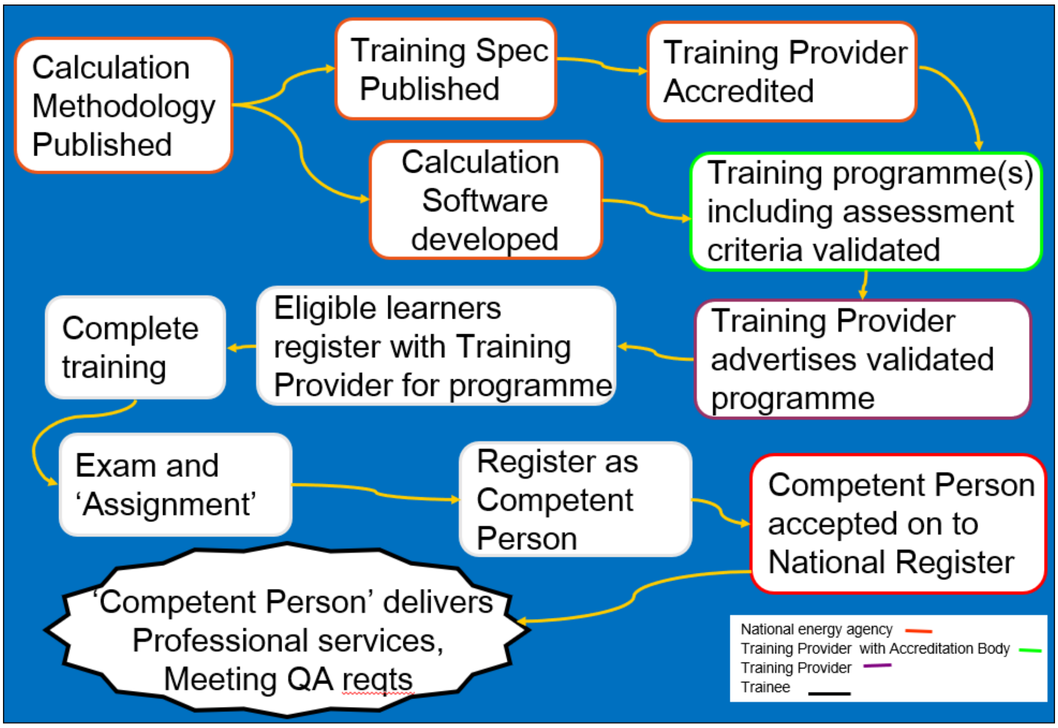
- Identification of potential training bodies - academic, professional, commercial or other bodies. In most Member States, this has been open to such a range of training bodies, but in a small number it has been restricted to academic or professional bodies.
- Specifications of fundamental and specific learning outcomes to be demonstrated by persons seeking to be registered as competent persons. These normally involve testing the applicant's understanding of the legal, technical and administrative systems and processes, and practical application particularly of the calculation software.
- Development of the core training curriculum, materials and examination. These will usually be covered in the training specification prepared by Member State authorities, but in some Member States it has been delegated to the training bodies and subject to evaluation as part of the accreditation of such bodies.
- Specifications of inputs to be demonstrated by training providers by way of (where applicable) entry requirements, tutor qualifications, duration/ mode of training, materials and facilities, examination content/ process and external validation.
- Approaches and mechanisms for registration of competent persons following training and examination, including re-registration requirements, maintenance and submission of records and monitoring of service delivery (as part of the quality assurance process).
- Approaches and mechanisms for quality assurance in the field, plus continuing professional development (CPD) to maintain or improve service quality.
- Approaches to codes of practice/ conduct governing matters such as service competence, diligence and ethical behaviour of certified qualified persons.

While the main focus was on the 'topping up' of skills of existing professional practitioners, universities and institutes teaching undergraduate courses in architecture and building engineering were also expected to incorporate the provisions and skills in relation to the new building energy code into those courses.

5.5 Training pathway

A typical overall step by step pathway leading to registration of building energy code certifiers is illustrated in Figure 5-4. The key steps will then be outlined.

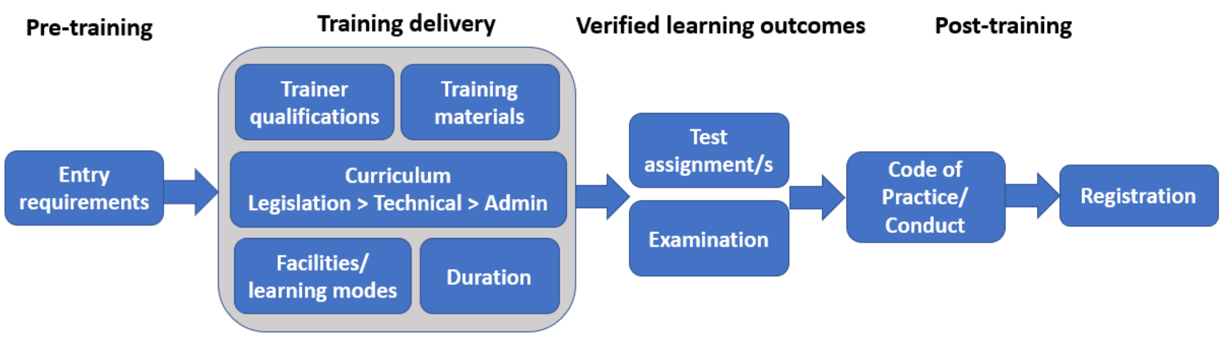
Figure 5-4 Overall training pathway leading to registration



5.6 Training specifications

Good practice approaches have usually involved the national EPBD implementation authorities (typically the energy agency) developing a training specification document. This may be done in consultation with the established accreditation bodies for professional technical education in the country and with prospective training organisations. The specification is effectively a set of rules issued to prospective training providers and with which they must adhere in delivering their training programmes and courses.

Figure 5-5 Elements of the training specification and delivery process



Key elements in the specification and its delivery are shown in Figure 5-5 and would cover the following:

- **Defined learning outcomes**. This involves documentation of both theoretical and practical competencies, notably through the understanding and practical application of energy performance principles and techniques, the technical rules in the building energy code, the calculation software and allied guidance. It will also be reflected at least partly through practical assignments/projects and examination.
- **Pre-entry requirements**. Minimum prior education/ industry experience requirements for trainees. For the case of commercial type buildings (offices, hotels etc.) such as those covered by an ECBC level of code, this would require a primary Degree in architecture or relevant branch of engineering, or a Diploma in the case of architectural technicians (for whom software applications in the context of CAD or BIM type systems is increasingly prevalent) and prescribed minimum work experience. Pre-qualification criteria may be met by including equivalence of combined qualification and experience.
- **Technical skills and teaching credentials of individual training organisation and their personnel who will be delivering the courses**. In the case of academic institutions, accreditation of such personnel and courses is relatively straightforward through existing frameworks.
- The curriculum content; this would cover:
  - The key aspects of the building energy code legislation
  - Key technical skills including use of the calculation software and revisiting the fundamentals of energy dynamics of buildings, and carrying out practical energy performance assessment assignments/ projects with design tradeoffs. Technical topics would include building science (refresher material), overall energy and CO_2 emissions performance calculations, calculation of heating or cooling demand, techno-economic evaluation, building energy certificates, thermal comfort, ventilation, indoor climate, energy efficient lighting issues, thermal bridging analysis, and glazing strategies.
  - Understanding of regulations and administrative procedures for lodgement of documents to the applicable databases, and the Code of Practice/ Conduct.
- **Learning methods and modes**. Most courses were initially classroom based, but an increasing proportion has been through on-line distance learning as part of a ‘blended learning’ approach. Practical assignments/ projects are an important part of the both the learning experience and of the concluding examination tests.
- **Learning facilities and training materials**. These would include reliable computing equipment, calculation software manuals, technical guidance documents and other support tools listed previously, and documents highlighting the most important lessons and issues.
- **Duration**: Depending on the nature of the cohort of trainees, the total duration of classroom and/or e-learning activity could range between 3 and 10 days. This may be intermittent rather than continuous learning, to minimise the intrusion on pre-existing day to day workloads of the trainees. Thus, the total elapsed time between course commencement and completion/ examination could range from as little as 3-5 days to as much as 2 months in some instances.

- **Verifying learning outcomes**: All courses must examine candidates to demonstrate that they have acquired all the necessary learning outcomes.

More than 16 EU Member States had prescribed requirements of this general nature. It should, however, be appreciated that typical specifications allow for a degree of flexibility in relation to some of the training delivery elements included in the composite grey shaded box in Figure 5-5.

5.7 Training and accreditation of trainers

Most Member States regulated the appointment of organisations offering training on the building energy code to building professionals (architects, engineers, surveyors, architectural technicians). Here the prospective training providers were typically required to submit the proposed curriculum and other details required by the training specification to the national or regional training accreditation authorities for approval before being permitted to offer their courses. In essence, they were required to demonstrate that their training will ensure that candidates have the knowledge base needed to become a ‘competent person’. The accreditation bodies may assess the submissions in liaison with the Ministry or energy agency officials responsible for the building energy code. The nature of organisations authorised to provide training varied between different Member States, but included a mix of universities/ academic institutions, professional bodies, building industry vocational training bodies, specialist software providers (particularly in relation to the application of dynamic simulation models where applicable) and commercial training providers.

In a small number of Member States no regulation of training for this specific purpose was applied, with the provision of the training service being ‘left to the market’ of training providers to respond with courses of sufficient quality (in some such cases, however, passing of a national examination was mandatory for trainees, which was a mechanism for determining satisfactory learning outcomes).

Good practice training delivery was normally preceded by a ‘train the trainers’ course given to the training personnel employed by prospective training providers. This course would usually be delivered by the national energy agency or an expert academic body or institute, e.g. a technical university, commissioned by the national authorities. It might also engage inputs from software developers or other specialists. The course would cover the elements and topics outlined above in relation to the training specification. It would often be supported by training materials in the form of a training manual of several hundred pages. Such courses would typically be between 2 and 4 days duration including a concluding examination similar or identical to that designed to apply to trainees in general. Some Member State authorities set a requirement that individuals proposing to deliver the training materials must have achieved a score of at least 85% or 90% in this examination.

5.8 Delivering the training to prospective building energy code practitioners

As indicated above, the courses may be delivered directly by organisations commissioned by national authorities or delivered by accredited academic institutions – universities, polytechnics, professional institutes – or by software providers, in accordance with the training specification.

Depending on procedures in the Member State for awarding accreditation to courses, the process of preparing all the necessary resources, obtaining authorisation and promoting to eligible trainees can entail a timescale in excess of a year.

All such courses involve a classroom element but increasingly distance e-learning is being employed, including practical examples for delivery of code compliant projects. In some instances, fieldwork site visits (e.g. to demonstration projects) may be included. Time spent on practical coursework would normally equal or exceed time spent on theoretical content.

The quantity of class time (which may combine physical classroom and e-learning) can range from 3 to 10 days. This will often not be continuous, to minimise disturbance to existing work schedules of trainees, and the overall time envelope can thus extend from one week up to two months.

Between 500 and 900 pages of course manuals, software guidance and other materials have been reported from some Member States.

It is difficult to give a reliable indication of course fees but from a sample of cases these appear to range from €800 to over €2000 per course in different countries.

5.9 Examinations

As indicated above, training of building energy code certification professionals was frequently concluded with an examination in order to qualify for registration as a ‘competent person’. The examination is aimed at testing the understanding of building energy issues and practical application of the calculation tools, software and guidance materials - verifying sufficient accomplishment of the prescribed learning outcomes (legislative, technical, administrative, conduct). For example, it can be a combination of multiple choice questions (which could be administered on-line under supervised conditions) and project work (with ‘open book’ access to relevant reference material). Reports indicate examination durations varying between 45 minutes and 4 hours with an additional practical/ case-study element.

Where examinations were designed and administered by the different training organisations, they needed to meet the requirements of the accreditation authority. In some cases, a national examination may be centrally designed and administered on behalf of the relevant Ministry or energy agency (in some instances the building energy code and certification authorities may also commission the development of a more rigorous national examination for trainers). In the designing of examinations, a number of variants in the content of the questions and project assignments would be recommended to ensure sufficient rigour from trainee group to trainee group. National authorities may also choose to engage an independent auditing/ external examiner specialist to verify the adequacy of the first training course delivered by each training provider.

A common examinations model sets a pass mark at 70% overall, but also with a minimum mark of 60% required for each module of the course. Where the examination is used as a criterion for testing proposed trainer personnel, a pass mark requirement of 85% or 90% has been reported from some Member States.

5.10 Code of Practice/ Conduct

Some Member States also published Codes of Practice/ Conduct to which technically qualified persons were required to commit before being registered by the relevant registration body (architectural, engineering or surveying institutions, or national authority for building energy code enforcement).

In essence, this commitment entails a declaration that the person concerned knows the rules regarding compliance with the building energy code and is competent to design and certify to the code. In particular that declaration will normally include submission to, and cooperation with, the quality assurance inspection and auditing regime and relevant complaints and disciplinary procedures. It also includes a commitment to ethical professional conduct.

The following is a typical list of contents found in such Code of Practice/ Conduct documents:

- Definitions
- Roles and duties
- Client service
- Technical competence
- Adherence to building energy code legislative requirements
- Certification of compliance
- Lodgement of drawings, data and documentation
- Inspection and verification
  - Commencement Stage
  - Intermediate construction stage inspections
  - Completion Stage
- Maintenance and archiving of records
- E-lodgements

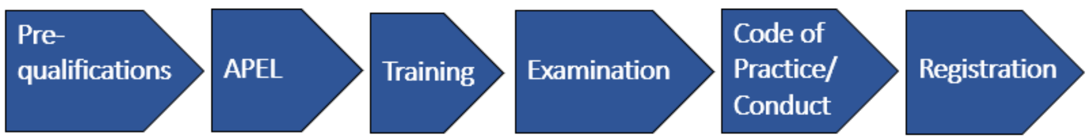
- Public registers
- Quality assurance
- Complaints procedure
- Disciplinary procedure
- Appeals procedure
- Continuing professional development (CPD)
- Standards and Procedures
  - Professional Ethics
  - Standards of Practice
  - Disclosure of Financial Interest
  - Advertising and sales promotion
  - Complaint resolution process
- Charges and levies
- Insurance
- Appendix: List of Requirements under building energy code

5.11 Registers/ databases of certified competent/ qualified persons

On the basis of the steps outlined above, persons who have shown themselves to be technically competent and committed to providing their services according to the relevant Code of Practice/ Conduct are then eligible to proceed to be entered on a register as licensed to practice as a certified professional in relation to the building energy code. This may involve payment of a registration fee. The register may be operated by a national energy agency. However, in some EU Member States, the system may choose to avail of existing registration infrastructure, whereby registration bodies for architects and engineers may list thus registered professionals in a specialist sub-category (such as 'energy efficiency professional' or similar) of their membership. Such registration can be open to persons, whether they are self-employed or employed by private companies or public bodies.

Figure 5-6 shows an example of a list of entry requirements and operational features of a register or database of 'competent persons'. The entry requirements correspond to the elements outlined above, and include the possibility of accommodating 'approved prior experience and learning' (APEL).

Figure 5-6 Indicative entry requirements in a registration system for building energy code professionals



Re-registration may be required on an annual basis. This would be automatic for registered persons except in cases where infringements of the code are detected by the quality assurance systems and lead to disciplinary action. It is normal for maintenance of registration of a professional to include an ongoing obligation to maintain appropriate professional indemnity insurance cover and for 'continuing professional development' (**CPD**), involving regular updating of knowledge and skills through attendance at a minimum number of educational events per year (these are increasingly being facilitated by means of webinar presentations). For example, such a CPD requirement might be for at least 12 hours of such educational attendance every 3 years.

Access to the register may be available on-line. Fuller details in relation to the functionalities of such registries as given in the 'Systems' section further below.

Mutual recognition of registered qualified persons between States in India may not be a difficulty, and commonly applies to the foundational academic qualifications between most EU Member State authorities, consistent with the provisions in the Services Directive (2006/123/EC) and the Recognitions Directive (2005/36/EC). However, in relation to recognition of 'competent persons' as building energy code certifiers, it is not always a straightforward issue in EU Member States owing to differences in legislation, methodologies, training levels, some details in codes of conduct and administrative procedures on building control and certification. In such cases, it is logical that, at a minimum, persons registered in one Member State will need to undergo top-up training in order to achieve registration in another Member State.

5.12 Assignment of enforcers

Building energy codes can be embedded as an integral module within the overall building code or else they can be separate or stand-alone codes. Traditionally, it was only in a small number of EU countries that the building energy code been a standalone code separate from the other aspects of the regulatory code for building standards, and this remained the case following the EPBD. In contrast, in the case of the ECBC in India, a standalone approach is being taken.

Pre-existing building code enforcement regimes have determined the most pragmatic approaches adopted by Member States in relation to enforcement of the new building energy code arising from the EPBD. The assignment of responsibilities for legal enforcement of compliance with the building energy codes did not usually change relative to the previously established systems for building codes in general – which were often local/ municipal authorities. The role of such authorities was sometimes confined to clerical type review of documentation plus sample inspections, and the training of their personnel did not always extend to the technical methodologies. In general, the building control officials in the local/ municipal authorities would have had limited levels of technical resources, tools, skills and experience in relation to the design, specification and modelling of buildings for superior energy performance. Hence the reliance on a form of specialist certification and verification by the registered professionals cited above. An example of a model chain of certification was outlined in Position Paper 3, and which will be covered in more detail in another Position Paper.

For most EU countries, capacity building in relation to the enforcement regime has accordingly required the training of not only the design and certifying professionals, but also the training of nominated building control officials already responsible for enforcing the building code in general.

5.13 Training of assigned enforcers

In a number of EU countries, complementary to the capacity building through training of design and certification professionals, the lead Ministry or energy agency has organised and/or directly delivered training to the proposed enforcement inspectors in public authorities on the above technical and administrative content, and on the discharging of their roles in enforcing the new legislation. Where applicable, such training has been carried out in collaboration with the representative and educational bodies for Building Control officials.

The content of the training provided to enforcement personnel would typically include:

- The legislation
- The compliance requirements at all stages
- Familiarisation with the energy performance calculation methodology and software
- Familiarisation with technical guidance documentation and support resources -
- Familiarisation with special issues – indoor climate, ventilation, glazing systems, air leakage, thermal bridging etc.
- Familiarisation with new energy efficiency and renewable energy technologies
- Enforcement functions and duties
- Recommended rates of inspection
- Enforcement procedures
- Compliance requirements
- Enforcement elements at all stages:
  - Documentation reviews
  - Detailed review
  - Site inspections
  - Final certification reviews
- Enforcement powers
- Penalties

5.14 Verifiers

As indicated above, officials within the building control/ enforcement authorities (typically local/ municipal authorities) responsible for checking compliance with other aspects of buildings may not always have the right level of experience and technical expertise to adequately assess compliance with energy-related requirements. In contrast, with a stand-alone form of building energy code such as the ECBC or its EU counterparts, a specialist cohort of assessors or verifiers can be established to engage with the complexities involved. However, this has not been the norm in EU countries.

The path to appointment of such a specialist panel of verifiers for this purpose would include a hybrid of the training elements that apply to building energy code designers and certifiers, and the elements described directly above in relation to enforcers. Logically, verifiers would require a similar standard of knowledge as personnel qualified to deliver training, and hence achievement of a minimum pass mark of 85% or 90% in the examination would apply.

5.15 Training of construction site tradespersons

Figure 3-1 showed a supply chain applying to the overall process of delivering energy efficient buildings, highlighting that this could be described as a 'skills chain' which determines the ultimate quality of the building. Weakness or failure in any part of the chain will compromise that quality. Hence it is clear that realisation of energy efficient buildings depends not only on architectural, engineering and specialist design expertise, but also depends heavily on the awareness, skills and commitment of the site tradespersons workforce, with good site coordination of the diverse trades-persons on site.

Generally in EU countries, responsibility for practical training of tradespersons tends to be led by vocational educational institutes, in relation to both foundational pre-qualification training and top-up (CPD type) training during the working career. Ongoing learning in this regard can apply to a variety of such trades – brick and block layers, glazing installers, plastering contractors, HVAC system installers and commissioners, electricians, specialist technician installers of electronic controls including building management systems (BMS) and specialist installers of renewable energy systems. This is important as the new building energy codes, including the introduction of NZEB standards, demand new practices in relation to such matters as new materials, installation techniques to avoid uncontrolled air leakage, thermal bridging control, insulation completeness, hybrid ventilation systems, intelligent heating and cooling controls, new lighting systems and renewable energy systems. Manufacturers and suppliers of building products and equipment often play an active role in this process, as they are motivated not only to promote immediate sales of their products but also to ensure that their products are installed properly for reputational reasons. Such training typically takes the form of a 2 to 3-hours technical evening highlighting good practices in installation by means of practical demonstrations.

Such continued support is required to build and maintain skills and capacity in the workforce, as well as general education and awareness within the building sector. This helps to strengthen compliance levels in general and indeed to drive ambition beyond basic compliance (which is helped by the new visibility in the property market arising from the energy performance certification/ labelling requirements in the EPBD). Such support is particularly important in Member States where the implementation of minimum energy performance regulations had been relatively immature prior to the EPBD.

Across EU Member States, and supported by the EU Commission, a number of initiatives in this regard have therefore been helping to raise standards and improve compliance. The 'BUILD UP Skills' initiative and subsequent developmental projects such as 'Qualibuild' have supported the provision of training to building craftsmen and other on-site construction workers and systems installers to ensure high energy performance quality construction works. This has also applied at individual country level. In the UK, the Zero Carbon Hub produced the 'Builders Book' which illustrates detailed technical and practical solutions to help overcome the construction challenges that impact significantly on building energy performance. In Finland, cooperation within the building sub-sectors and the active involvement of professionals in the field has ensured good acceptance and compliance with the legislation and building codes.

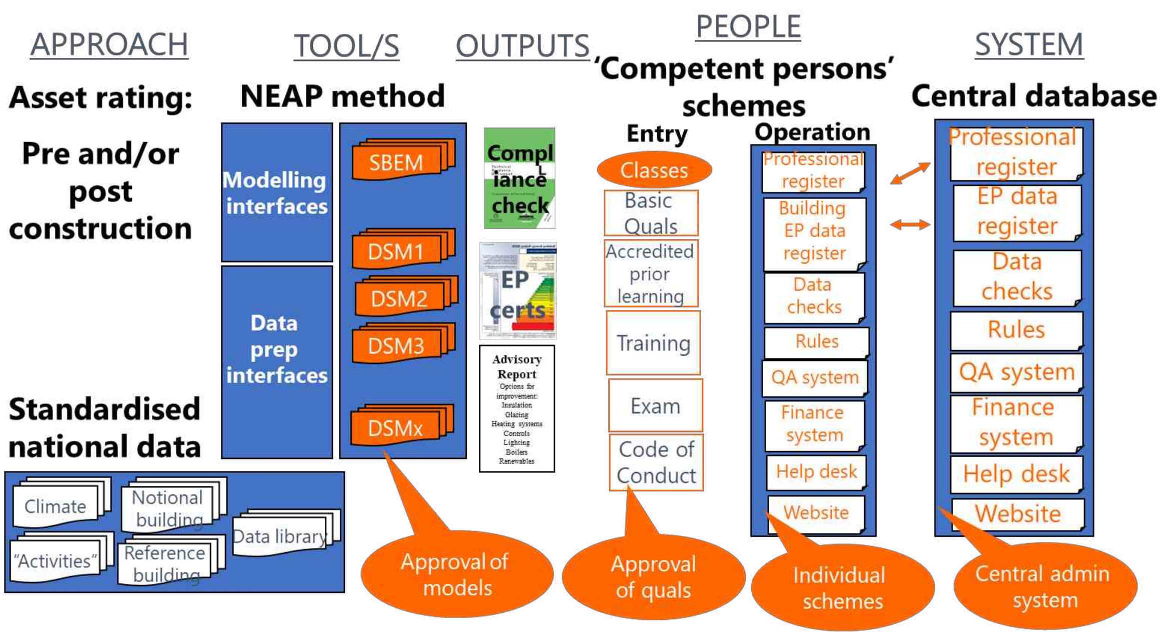
6 SYSTEMS DEVELOPMENT

The third main block of capacity building actions taken by EU Member States has involved the development of the necessary administrative systems to ensure robust implementation of the energy performance levels and certification required by the EPBD. While each Member State is permitted to develop its own monitoring and enforcement systems, common good practice elements include design and acquisition of the overall administrative and data management systems, the quality assurance system and the enforcement system. These principal elements are now outlined.

6.1 Overview of process flow from tools to people to systems

An example of a process flow overview applied in a small number of EU countries is shown in Figure 6-1. Moving from left to right, this consists of three main subsystems - energy performance calculation tools (including inputs and outputs), appointment of 'competent persons' to deliver code compliant buildings, and the administration systems and their functions. In this particular case the possibility was permitted for different market-based bodies (such as institutes of architecture or engineering) to establish their own 'competent persons' schemes for the purposes of designing and certifying compliance in relation to the building energy code. The column of features to the right of the diagram contains elements of the overall building control management system operated by the national or regional authorities.

Figure 6-1 Example of EP calculation and certification tool, 'competent persons' schemes & administration system for non-domestic buildings in some EU Member States



The national or regional authorities are invariably responsible for setting the rules for each part of the overall system. This includes approving the calculation tools, the qualification pathway to registration of 'competent persons' and the design and operation of the administrative system.

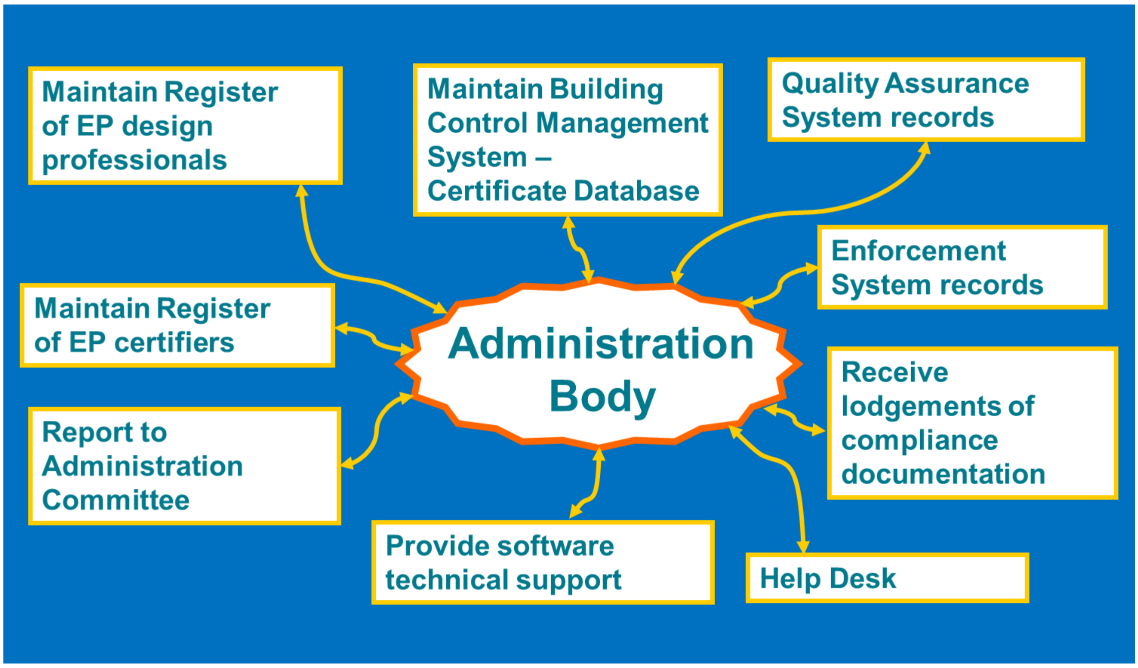
6.2 Establishment of administrative and data systems

Central databases are an essential platform for enabling user-friendly and efficient operation, systematic record keeping, monitoring, verification, quality assurance and reporting in relation to ensuring that building energy code requirements are met. They are necessary in relation to technical issues (e.g. registers of approved professionals, registers of product performance, registers of services such as air leakage testing) for use by both building industry practitioners and enforcement authorities. They are similarly necessary in facilitating administrative issues (lodging compliance declarations, certificates, other documents, quality assurance) for both building industry practitioners and enforcement authorities.

There is considerable design and financial overhead on the part of the authorities in the investment and set-up phase of such an on-line Building Control Management System or similar, intended for use by both compliance professionals and authorities. This procurement specification for a customised administrative software requires a clear and detailed specification/description of all business processes, data validation, user acceptance testing, user interfaces and ongoing operational and maintenance supports for the system. The full process of design specification, procurement, software coding and testing would commonly cost in the region of €200,000 (but considerably less for less comprehensive systems). As these need to be in place as soon as the building energy code and certification system become operational, planning of this development process needs to commence at an early point in Action Plan implementation. Some elements have a dependency on other systems development, e.g. the technical calculation software, and here the importance of adequate planning lead times.

The **ideal is a single central database** with oversight and day to day management by a national authority (e.g. energy agency, central service provider to local/ municipal authorities). There are several distinct operational areas – training, examination, registration, software, security protocols, quality assurance, finance, other administration, fee management and billing, credit control, user forum and help desks/ communications centre etc. – that could potentially be brought together in a single integrated administration system. An example of functionalities contained in one such system is shown in Figure 6-2. However, in many Member States the functionality of the registry and the extent of the information gathered has been rather limited. Very few operate a single integrated system with the full range of functionalities including direct interaction with the users.

Figure 6-2 Example of functions of a building energy code administrative system



For quality assurance purposes, there are advantages in including all inputs as well as energy performance output results in the database, as it can help to highlight risk areas and prioritise audit inspections. However, such data detail can be perceived as excessive micro-management and would require substantial data storage backup, as file sizes can be very large.

Management of central registries has been maintained within the relevant Ministry or energy agency but day to day operation if often outsourced. Usage is necessarily restricted to registered professionals and enforcement authorities for security and confidentiality reasons. 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, but it is not clear as to what extent the cost of Building Control Management Systems in relation to code compliance has been recovered from such fees.

While in the EU almost no countries have a formal link between actual energy use in the building and calculated energy use submitted for compliance purposes, the proposed regime for ECBC monitoring in India has this positive feature. This is facilitated by the fact that energy use in buildings covered by the ECBC is 100% electricity, whereas this is seldom the case in Europe.

6.3 Quality Assurance

All EU Member States are running live building energy code compliance and certification schemes at this point, and therefore establishment of a quality assurance (QA) system is an important operational capacity building and support element within the overall enforcement process.

Figure 6-3 Elements and phases in the Quality Assurance process

As indicated in Figure 6-3, a good practice QA strategy can have three phases:

- An **'upstream' control**, through verifying the quality of the calculation tools and associated tools, and through controlling the training accreditation pathway and verification gateway for professional practitioners. This could be reinforced, for example, by having an ongoing requirement that practitioners must sit and pass a refresher qualifying examination (which may be on-line) say every 2 years in order to maintain their registration.
- **'In-line' control**, through built-in data validation checks within the calculation software, through site inspections during the construction process, and through a requirement for ongoing continuing professional development (CPD).
- **'Downstream' control** through QA inspections and audits post construction. the Quality assurance data is particularly important for meaningful analysis and recording of findings. The intensity and visibility of such audits can contribute to a culture of compliance. Audit rates of between around 1% and 15% have been reported from different Member States. For resource reasons, it is common for the volume of desk reviews to be as much as ten times the volume of field inspections.

Both the upstream and in-line measures can be assisted by the QA systems commonly in place among professional architectural and engineering practices.

Continuing QA systems thus have a vital role in assisting successful delivery of building energy codes and certificates, ensuring the reputation and effectiveness of the enacted legislation. They should be introduced from the outset, be transparent and with clear rules. Strategically, good upstream control is most beneficial, as it allows through only people who show sufficient competence in the first instance, rather than afterwards striking people off a register upon serious failures found by audit. Conversely, there is also scope for downstream QA findings, for example patterns of common errors, to be fed back upstream in order to highlight areas for attention and improve the training process. QA can inform not only penalisation decisions on the part of enforcers but also educational and motivational ones, with the aim to constantly improve the scheme in general. Again, a constructive educational support approach to correcting and avoiding errors by experts is desirable.

6.4 Overall enforcement system

The main capacity building feature in relation to the enforcement system is the training of enforcement officials (which could include assistance by specialist verifiers, where applicable), as presented further above. Such training would include familiarisation not only with the technical energy factors and issues, but also with the legislative rules and the practical application of the administrative systems also outlined above. In relation to the latter, it would be recommended good practice on the part of the authors of the requirements specification to invite and obtain inputs from representatives of the building energy code enforcement community.

It would also be common practice for the enforcement officials to be briefed by the relevant Ministry or energy agency on rules and recommended procedures for document reviews, data reviews, field inspections, severity gradings of non-compliance findings, and strategy in relation to penalties. The latter would typically lead to the building in question receiving an occupancy permit only after material corrective action had been satisfactorily completed. In relation to the registered practitioner, this could lead to an escalation process ranging from correction on relatively minor infringements, probation in cases of multiple minor infringements, suspension in cases of serious infringements and temporary or permanent revocation of license in extreme cases.

The topic of Energy Performance Certification (EPC) or labelling systems – their development, organisation, functionality, market presence and influence – will be addressed in another Position Paper. Noting that demonstration of compliance with the building energy code and the generation of EPCs share a common calculation procedure, there is technical scope for the sharing of database information between these two functions in order to facilitate building standards enforcement authorities in fulfilling their functions efficiently. However, for this to be enabled to happen in practice it may be necessary, at least under the legal system in some Member States, to enact positive provision for this in further legislation.

7 OTHER CAPACITY BUILDING INITIATIVES

7.1 Research, Development & Demonstration (RD&D) projects

A further contribution to decisions on particular EPBD implementation options, and to capacity and confidence building in almost all EU countries, has been through the funding and delivery of R&D and demonstration projects.

Following EPBD publication, and sometimes prior to it, RD&D funding programmes at EU level and within a number of Member States had already established grant subsidy schemes for a range of project types. These included design studies, research studies, product/ technology development support, tools and skills development, market analysis and model demonstration projects aimed at identifying the practical and cost issues, and the feasibility, in achieving energy performance standards superior to current norms. Similarly, pilot training and field trials on the process of energy performance certification were used to identify and issues, difficulties and indicative costs. Overall, these activities contributed to an evidence base for more ambitious performance levels, helping to build capacity and confidence among both market professionals (mainly architects, building services engineers and modellers) and policy makers in regard to setting sufficiently (but not excessively) ambitious energy performance levels – while consistently bearing in mind the obligatory roadmap to NZEB standards.

The EU Commission has operated a competitive research, development and demonstration (RD&D) programme for many years, in which leading manufacturers of construction products and equipment have participated and collaborated for the purposes of developing more energy efficient products and service solutions. This contributes to the capacity of the market to innovate and respond actively to meet or surpass the requirements of the EPBD and other policies. The EU had also operated a support programme entitled 'Intelligent Energy for Europe' (IEE) to tackle barriers and assist market deployment of energy efficiency. These programmes supported projects in the fields of improving technologies, tools, skills development, market analysis, databases, market awareness initiatives and financial initiatives, and generated useful insights, findings and case examples. The RD&D and IEE programmes were merged in 2014 as part of the 'Horizon 2020' programme and continue to support work in all of these fields.

Most EU countries have commissioned their own studies to inform the judgements of the authorities regarding the form, content, tools, systems and performance targets appropriate to different types of buildings. Likewise, national and regional pilot trials have demonstrated the practical design, construction, installation and operation steps involved in delivering to the new energy performance standards (see Figure 7-1).

Figure 7-1 Energy efficiency demonstration buildings

This topic will be covered further in another Position Paper.

One significant initiative supported under these programmes has been the 'EPBD Concerted Action', described in Position Papers 1 and 2, which has been an important collaborative shared learning platform for Member State authorities in addressing many of the challenges in implementing the EPBD – including the technical methodologies, NZEB standards, training, quality assurance and incentives.

7.2 Dissemination and promotion

An important contribution to building awareness and capacity in the building construction market is the dissemination of information regarding the options and methods for delivering buildings compliant with the building energy codes mandated by the EPBD.

In 2005 the EU Commission invited and funded the development of a website called 'Build Up' (www.buildup.eu), illustrated in Figure 7-2, which serves as a comprehensive portal to all sources of legislative, technical and market information, policy studies, demonstration projects and numerous thematic topics. This information can be in the form of documentary reports at EU and national level, and often links to other websites and webinars. It is directed equally at public authorities, building industry practitioners and the more general public. Webinars have become an increasingly important ingredient in the awareness, education and dissemination process.

Figure 7-2 The EU ‘Build Up’ web portal

Many lead Ministries and energy agencies responsible for EPBD implementation in individual Member States published similar libraries of reference and support material on their websites, including using such a medium to assist their stakeholder consultations on various details of their proposed implementation of the Directive. This would be complemented by face to face meetings with stakeholders and other initiatives, such as study tours to individual buildings demonstrating superior energy performance standards. In recent years this has included case examples of buildings reaching ‘nearly zero energy building’ (NZEB) standards.

8 CONCLUSIONS

Three key groups of capacity building features are required to achieve compliance with a new building energy code such as mandated by the EU EPBD or India's ECBC. These are:

- **Tools**: Technical tools with sufficient functionality, user friendliness, accuracy, consistency and completeness to enable qualified building industry practitioners to deliver on their obligations in a cost-efficient manner;
- **People**: Training and upskilling of sufficient numbers of building industry practitioners to sufficient levels of competence to fulfil their role in delivering code compliant buildings (this issue is elaborated further below in relation to the needs of volume, quality and quality assurance), underpinned by robust quality assurance systems;
- **Systems**: Efficient (time and cost) administrative systems to enable submission of certification documents and evidence of code compliance and with the facility for utilisation by enforcement authorities to inform quality assurance strategies.

Allied to this, research and development projects aimed at tackling knowledge, skills gaps and developing new and improved building materials, equipment, design tools etc. can be seen as part of an ongoing capacity building process (These topics of RD&D and of industry capacity and role will be addressed in other Position Papers). Promotional and dissemination activities also help to inform and reinforce the effectiveness of these actions.

This paper has addressed the following range of capacity building actions:

- Provision of **technical tools** such as guidance documents, software, databases and other resources to assist the analysis, design and specification of buildings.
- Arrangements for **training and upskilling of the professionals** and site trades responsible for delivering code compliant energy efficient buildings (including training of trainers). Implementation of the new building energy code for non-domestic buildings was primarily an augmentation to the established services of architects and building services engineers.
- Likewise, arrangements for **training of the relevant enforcement authority personnel**.
- **Decisions on training pathways** to ensuring adequate numbers of competent persons. Generally, training has been through existing accreditation oversight systems, involving some combination of public bodies, academic institutions, architectural or engineering professional bodies, and sometimes commercial trainers.
- **Preparation of a Code of Practice** covering professional competence and conduct as a precondition or accompanying condition to registration of competent persons. This may be supplemented by codification of complaints, disciplinary and appeals procedures.

- Associated **development of databases** for publicly registering competent persons, for efficient quality assurance and administrative/ organisational systems and processes for verifying and recording compliance, underpinned with good quality ICT systems.
- The commissioning of **technical and strategic studies** to inform decisions on the energy performance calculation methodology, supporting software and other tools, and choices in relation to the administrative and quality assurance systems.
- The **availability of building products and services to deliver code compliant buildings** and the roles of commissioned studies and R&D projects in supporting product innovation and in informing detailed aspects of EPBD implementation.
- **Support for demonstration projects** which help to highlight the achievability of energy efficient buildings and thus provide evidence and confidence to the stakeholders.

Under EU law, each EU Member State may decide its own operational approach to implementing the EPBD, and this has led to a range of different technical methodologies, training and recognition systems. This has led to significant differences of detail in the approaches in various Member States in relation to registration and accreditation of assessors, training and professional development, examinations, audit inspection and quality assurance systems, and in the detail of their building control and certification administration systems. However, even with market-based models of training, the authorities normally still exercise a degree of control through setting rules and qualification criteria for those seeking recognition as registered professionals. This can extend to a government nominated agency commissioning or preparing generic training material, which could have the effect of improving quality and consistency of training while simultaneously decreasing the costs of training. However, it is more common for a government agency to issue a training specification rather than actually prepare a detailed curriculum.

Ultimately, this range of capacity building actions is aimed at achieving a consistent strengthening of the 'quality chain' of construction industry professionals and installation trades responsible for delivering code compliant buildings.

9 WEB RESOURCES

The following is a small selection of websites from which useful information can be obtained on EPBD implementation.

Website title and address	Description
Build Up www.buildup.eu	EU portal for energy efficiency in buildings. Extensive library of documents, webinars etc. relating to EPBD and related implementation
Building Performance Institute Europe (BPIE) www.bpie.eu	A European 'think tank' providing policy research and advice on energy in buildings, with publications and monitoring of progress with EPBD 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
EPBD Concerted Action www.epbd-ca.eu	Public website for collaborative forum of Member States to assist EPBD implementation
EU Build Up Skills initiative http://www.buildup.eu/en/skills	Strategic initiative to boost continuing or further education and training of craftsmen and other on-site construction workers and systems installers in the building sector