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EPBD and Building Energy Codes - The role of European and national technical standards

EU EXPERIENCE ON EPBD - POSITION PAPER No 4

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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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The contents of this paper are, however, the sole responsibility of the contractor and can in no way be taken to reflect the views of any particular individual or institution, including the European Union, the Delegation of the European Union to India, and the Bureau of Energy Efficiency (BEE) in India.

[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
BIS	Bureau of Indian Standards
CECI	Clean Energy Cooperation with India
CEN	European Standards Body
DSM	Dynamic Simulation Model
EP	Energy Performance
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificate
EU	European Union
EUD	European Union to India
HVAC	Heating Ventilation and Air-Conditioning
SBEM	Simplified Building Energy Model

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1 SUMMARY

This position paper **summarises the contextual positioning, status, functional role and features of European Standards (EN) relating to the energy performance of buildings** (EPB), and work leading to the establishment of a hierarchical suite of technical standards. Arising from collaboration between the standards bodies CEN and ISO, several of the key standards have been published under a new label as the ISO 52000 series. A driving force in the development of the overall suite of over 50 standards has been the need to provide a coherent consistent technical framework to support implementation of the EU Energy Performance of Buildings Directive (EPBD) (both the original and recast directive).

The standards have been published as a hierarchical and modular framework. This hierarchy spans from a holistic level to sub-system level to individual component level. Holistic standards relate to matters such as overall energy and CO_2 emissions performance calculations, calculation of heating or cooling demand, techno-economic evaluation and format of building energy certificates, and thermal comfort, whereas component items include U-value calculation methods, product testing methods, thermal bridging analysis, heating and cooling system efficiency, and various ventilation and lighting issues. The modular structure allows selective use of the standards and incorporation of alternative methods, subject to defined input/output protocols being applied.

It is important to appreciate that for EU Member States, these EN standards are not in themselves a calculation methodology. The **official national methodology for calculating and demonstrating compliance with energy performance requirements generally involves a calculation engine incorporating various calculation algorithms and is typically embedded in a user-friendly software**, all of which are aligned to the relevant EN standards. Thus, for example, several EU countries have used a methodology and software called **SBEM** - Simplified Building Energy Model (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 Portugal a national methodology and associated software has likewise been developed by the national energy agency in Portugal, ADENE. Such overall calculation methods will 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.

The ultimate role of the EN standards is to provide an integrated suite of procedures, criteria and options which provide a robust foundational support to Member State authorities and building industry practitioners in catering for ever more stringent energy performance requirements and encourage more harmonised regulatory and market practices across the EU, while offering an appropriate level of flexibility for national adaptation to local conditions.

It is to be expected that much of the philosophy and the content and features contained in this suite of EPB technical standards could also be beneficially applied in the circumstances of India. Such application would have the co-benefit of assisting the free movement of energy efficient goods between India, the EU and elsewhere.

2 BACKGROUND - REGULATORY SUPPORT NEED, CONTEXT AND PRE-EPBD STATUS OF TECHNICAL STANDARDS

2.1 The EU Energy Performance of Buildings Directive (EPBD): Key requirements on EU Member States

The principal obligations set for EU Member States by the EPBD are:

- Member States must **adopt a technical calculation methodology** that is relatively holistic in scope for determining the overall energy performance of buildings. The parameters to be covered within the methodology are set out in an Annex to the Directive. However, this provides Member States with considerable flexibility regarding the detail of the methodology.
- Using the above technical calculation methodology within the frame of a 'cost optimal' method consistent with EU Commission guidelines, Member States must **specify minimum requirements for energy performance** of new buildings and major renovations, and review these requirements at least every five years. Energy efficiency requirements must be formulated as an overall energy performance criterion, covering the main thermal and electrical energy uses, expressed in terms of - normally primary (fossil fuel) - energy consumption (and possibly CO_2) per annum per m^2 of gross floor area. In the case of non-domestic buildings (commercial and public), the performance criterion is typically expressed in relation to a 'reference' building which is a notional or virtual building with the same dimensions and functions as the proposed building, and which has energy specification features set at a baseline level for insulation, glazing and glazed areas, HVAC, lighting systems, control systems etc. For example, performance standards introduced in year 2018, might be set so that the overall calculated energy consumption (and possibly associated CO_2 emissions) of the proposed building, using the approved methodology, is i.e. 30% to 50% below that of the reference building based on the requirements in year 2015. A further obligation in the Directive is for Member States to **publish roadmaps for the achievement of 'nearly zero energy buildings' within their building energy codes by 2019-2021.**
- Also using the above technical calculation methodology, Member States must establish and implement a **system for energy certification** (published energy labelling typically on a scale from 'A' to 'G') of buildings at the point of construction, or at the point of offer for sale or rental. This applied both to new and existing buildings.

There are also a number of other EPBD requirements for Member States, such as inspections of heating and air conditioning systems above a defined size and particular building energy efficiency renovation upgrade obligations on public bodies. In the present context however, **the most significant accompanying requirement is for Member States to develop and publish 'roadmaps' for achieving 'Nearly Zero Energy Buildings' (NZEB) performance standards by between 2019 and 2021.** This is an ambitious progression of the second requirement above.

2.2 Implementing the EPBD

The 'principle of subsidiarity' in implementing EU Directives is overarching, which allows a relatively high degree of local discretion in relation to the detailed provisions that Member States incorporate in their national legislation – and hence can lead to a diversity of legislative and technical detail across Member States.

The Directive, and indeed sometimes even the associated EN standards which were in place prior to the Directive, are not highly prescriptive in a number of their defined requirements, which also would tend to allow a high degree of diversity in the technical detail of legal transposition/ notification and practical implementation by Member State authorities.

Traditionally, for example, there have been variations between EU countries in the technical scope of coverage (of energy use for heating, cooling, lighting etc.) and the form or grade of energy used in the performance criterion (useful, delivered or primary). However, the recast EPBD of 2011 and associated development of EN Standards had led to the most comprehensive coverage, namely all major energy end uses and primary (fossil fuel) energy use, normally expressed in term of kWh per m2 and possibly also kg of CO_2 per m2.

The holistic performance approach mandated by the EPBD has important advantages in terms of maximising design flexibility, consequent scope for cost-efficient trade-offs between different features (and hence a more optimised design), and of similarly encouraging the development and deployment of innovative energy efficiency products and systems. Some Member States had been applying such an approach prior to the EPBD, but many had not.

Against this background, in support of the EPBD requirements, and in order to encourage a more harmonised or consistent approach across different Member States, the **EU Commission mandated CEN to develop a stream of EN standards**, as described further below.

2.3 Building energy code documents arising from legal transposition process

As detailed in Position Paper 3, there is a variety of different configurations and formulations of legislation for building energy codes in EU countries. Technical building regulations or codes for energy efficiency can be set either in one main legislative document, in a coordinated suite of documents or in separate legal documents.

However, whether formally or effectively, they commonly consist of three levels, comprising regulatory, guidance and support documentation:

1. **Obligations**: A primary legislative document, often labelled 'regulations', usually specifying the basic functional objectives and requirements in a general manner, and possibly specifying the mandatory overall performance requirements (in terms of energy or carbon intensity). But in some jurisdictions, depending on legal traditions, the legislative document can include substantial detail. This may cover dwellings only, other buildings only, or both. This document will typically be prepared by the lead Ministry for inclusion in the Statute book.
2. **Guidance**: A guidance document or documents, 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, but may be subject to limits in the form of 'backstop' values, for example for minimum elemental insulation levels. This document will normally not be mandatory, but 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.
3. **Support**: Additional support documents and tools, providing detailed assistance on individual aspects and options. These can include calculation methods, databases of registered product information (e.g. boilers, air conditioning, lighting systems, renewable energy systems), certified testing methods (e.g. for air leakage testing), recognised computer software, reference to EN or national Standards, and recommended professional Codes of Practice (which may be voluntary). These resources may be prepared by government agencies, national standards authorities, professional institutions.

2.4 Purpose, positioning and prior status of European, international and national Standards

Rather than being a subset of category (3) above, ***technical standards*** can also be seen as an important foundational reference in the hierarchy. The standards authorities in all 28 EU Member States plus six other States are members of CEN (Figure 2-1).

Figure 2-1 The 34 member organisations (national standards authorities) of CEN

The **fundamental purpose of technical standards is the facilitation of free movement of goods and services**. Hence, where a European standard (EN) exists, they automatically become adopted and published as national standards by the national standards authorities in all those States with CEN membership. But it should be noted that in the context of building construction, EN standards can frequently provide scope for localised variation with data and details reflecting local conditions; this is usually facilitated by default or blank template annexes to the standard which have an optional status. Moreover, national legislation (category (1) above) may still choose to reference a (national or EN) standard as having either mandatory or optional (guidance) status. That is, an EN standard (which automatically becomes published as a national standard by the national standards authority) may not necessarily be referenced as mandatory in its guidance documentation (category (2) above) or by the relevant Ministry in its legislation.

From the late 1980s onwards, the scope of the energy efficiency provisions within building codes in many EU countries began to expand from basic insulation of the building envelope to include insulation of domestic hot water, pipework and other heating, ventilation and air conditioning (HVAC) plant. Subsequently, energy efficiency criteria began to be prescribed within the building energy codes in relation to thermal or electrical equipment such as boilers, air conditioners, pumps, fans, and electrical equipment such as lighting, often on the basis of common EU criteria determined by EU technical standards.

Unlike the case with such 'portable' tradeable goods and appliances, to which common EN standards were most naturally applicable, most EU Member States had their own independently developed methodologies to be used for determining compliance with various aspects of their building energy codes. The calculation procedures and compliance criteria were normally set nationally but could also have regional or local variants.

Members of CEN were also all members of the International Organisation for Standardization (ISO), with the same fundamental motive of facilitating free movement of goods, and today across all sectors 32% of CEN standards are identical to the corresponding ISO standards. ISO has a total of 120 member bodies, including the Bureau of Indian Standards (BIS). Such internationalisation (through membership of CEN and ISO) had begun to be introduced over the decades in EU Member States with the aim of developing, improving and harmonising test methods and models to calculate energy performance. However, in most cases it was following the issuing of the EPBD as a greater impetus for such harmonization emerged.

3 NEW OR IMPROVED TECHNICAL STANDARDS SUPPORTING EPBD: DEVELOPMENT, SCOPE, STRUCTURE AND FEATURES

3.1 The EU Commission mandates to CEN

To support Member States in implementing the original EPBD, the EU Commission mandated and funded the European Standards Body CEN to develop an integrated hierarchical suite of over 30 technical standards in order to encourage more harmonised technical and economic approaches across the EU, which would tend to encourage regulatory convergence. This process originally commenced in 2004 with the aim of having all relevant standards available, at least as drafts for consultation, in sufficient time to allow their adoption by Member State authorities, most of which had declared a receptiveness to using the new standards.

The process involved reviewing and updating a large number of existing standards or draft standards, plus creation of a number of new standards. The standards ranged from the holistic calculation of energy performance, to requirements for energy certification and inspection of technical systems, to the specification and performance of building elements, components and equipment. Five technical committees and various working groups were involved.

However, the development process took considerably longer than intended, and it did not prove possible to deliver final standards in time for Member States to meet their implementation deadlines on the original EPBD – although some of the standards were sufficiently advanced drafts to be useful. The cycle time for the full committee and Member State processes in drafting, feedback and approval of an EN standard can be as much as 3 years or more. Also, the nature of many of the standards was such that they were not in a practical form suitable for direct application by Member State authorities, software developers and building specifiers and required considerable national input before they could be used operationally. Therefore, Member States committed to meeting their deadlines from the original EPBD, were obliged to proceed with choosing or developing national methodologies for energy performance assessment in advance of publication of the new EN standards. This included reviewing and adapting methods already in use in their own and other countries.

Following the issuing of the recast EPBD and feedback from Member State representatives, a new mandate was issued to CEN by the EU Commission and ultimately, over the period 2012-2017 an extensive suite of standards was completed.

3.2 Effective principles

In approaching the process of reviewing and amending the standards or draft standards, a coordination committee was formed, seeking to ensure that the end product would be a suite of standards which, in their effect, are:

- **Comprehensive**: covering building energy performance from product level to holistic level
- **Structured**: in a modular hierarchical manner that reflects the range of levels from product to holistic level
- **Coherent**: ensuring interoperability of standards through internally consistent linkages, facilitated through input/output spreadsheet validation protocols
- **Transparent**: with the boundary conditions, algorithms, assumptions (e.g. national data such as primary energy factors) and base attributes such as indoor environmental quality, explicitly expressed
- **Unambiguous**: with clear consistent definitions of terms and intermodalities between modules, and avoiding an unnecessary excess of choices in application
- **Flexible**: in allowing appropriate localisation at national or regional level through the provision of suitable templates, and in facilitating selective use of the standards in conjunction with alternatives.

3.3 The suite of EPB standards including ISO standards – scope, structure and features

In relation to many of the EPB standards, the second phase review and redevelopment process included close collaboration between CEN and ISO. The outcome has been a 'second generation' suite of 52 published standards, 35 of which are published as European standards (EN) and 17 also as international standards in a new ISO 'family' labelled 52000 to 52150 in a reserved sequence, led by a key overarching standard EN ISO 52000-1. This overarching EPB standard is complemented by a set of standards comprising calculation methods for heating and cooling, performance of building elements, as well as aspects regarding energy performance indicators, ratings and certificates, for example.

The scope of coverage by the suite is indicated in Figure 3-1.

Figure 3-1 Scope of coverage by the holistic set of EPB standards

A key feature of the suite is its modular structure. This is conceptually illustrated in Figure 3-2, showing the approach to integrating the groupings of standards pertaining to the various components and sub-systems contributing to overall energy performance, and the necessary interactions between them – for example, between the heating, lighting and cooling modules. The hierarchy of EN/ISO Standards involves a series of levels:

- overall building energy performance
- performance of individual 'technical building systems', e.g. ventilation systems, lighting systems
- Product/component specifications
- certification format, test methods etc.

Overall, the suite is applicable to the processes of designing, specifying and evaluating the performance of both new buildings and building renovations, and their components.

Figure 3-2 Modular structure and interaction of European standards on energy performance of buildings

EN ISO 52000-1 is the overarching backbone of the ISO 52000 series of standards. The coherence of the overall suite of standards and its flexible nature in taking national and regional choices into account is also conceptually illustrated in Figure 3-3. Each calculation module is accompanied by two resources, namely an explanatory document, termed a ‘technical report’ (TR), to assist correct and coordinated use of the standard, and a datasheet in the form of an Excel spreadsheet in which the calculation algorithms and data input/ output can be tested and validated, and hence helping them to be ‘software proofed’. The first part of the diagram shows the relationship between the modules, the overarching standard and entry of localised data.

The second part of the diagram shows how the overall system can accommodate national or regional discretion to replace an EN or EN-ISO module or modules with a non-EN or EN-ISO standard – for example, an American standard. This optional step by step adoption facility within the overall modular framework allows Member States to ‘pick and mix’ other standards or methods (e.g. ASHRAE, ISHRAE), subject to adhering to the consistency spreadsheet protocols. The use of the datasheet is thus equally applicable to such an alternative module.

Figure 3-3 The ‘backbone’ role of the overarching standard (OAS) and the facility for module replacement

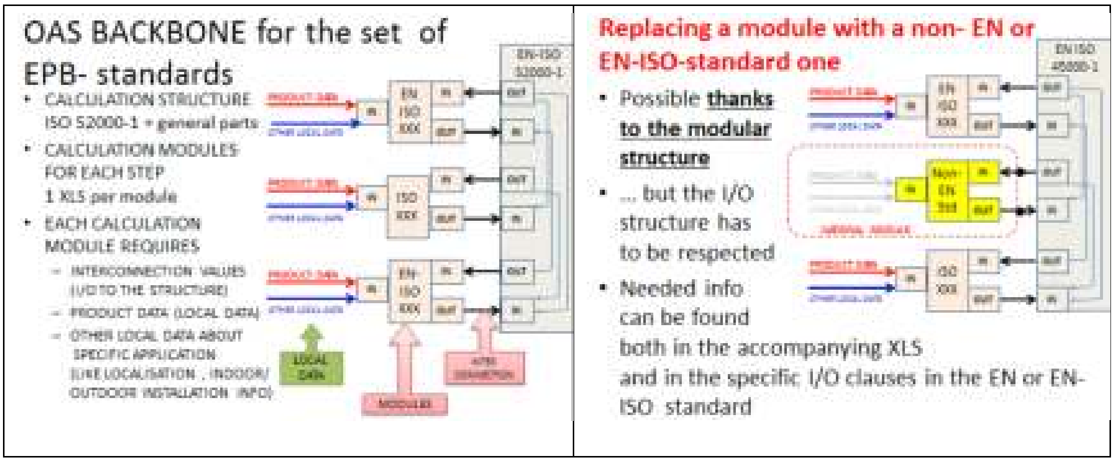
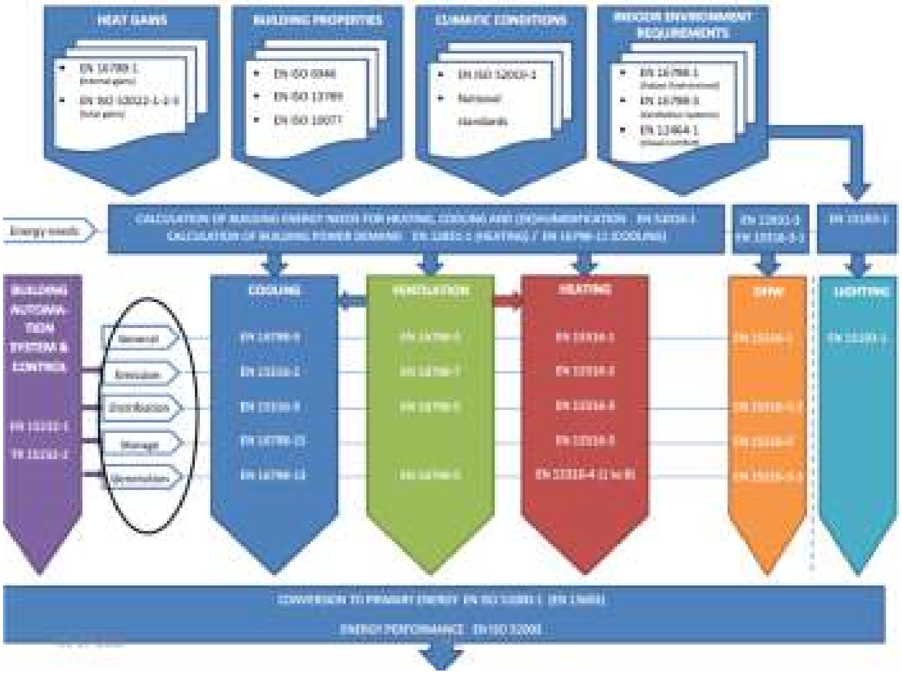


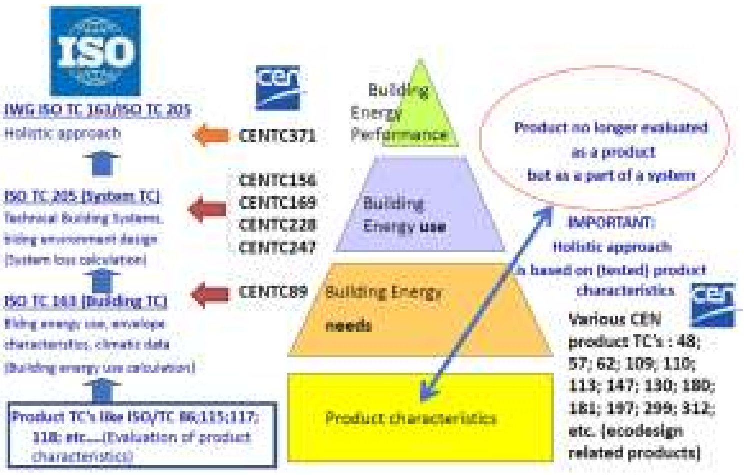
Figure 3-4 reflects the comprehensiveness of the suite of standards, covering all functional factors contributing to energy performance of buildings, and showing the coherence and inter-connected relationships between the different groupings within the suite.

Figure 3-4 Overview of the groupings of standards and their functional and interrelated contributions to building energy performance



These relationships are also presented in hierarchical form in Figure 3-5, spanning from individual product/ component level to overall energy performance of the building as a system.

Figure 3-5 Hierarchical range of scope of technical standards from product/ component level to overall system level



4 PRACTICAL ROLE AND APPLICATION OF THE STANDARDS

4.1 Holistic building energy performance calculation

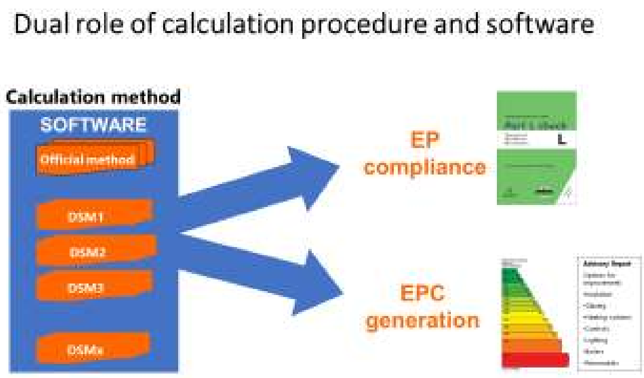
One of the core standards is EN ISO 52016-1, covering the calculation of annual heating and cooling needs for a building. While such EN standards are not in themselves a full EPB calculation methodology, they include clear guidance on the calculation frameworks and algorithms recommended for use in calculation procedures, with appropriate scope for localisation to relevant climatic conditions. Moreover, this core standard is flexible in allowing monthly or hourly dynamic simulation model calculations.

In general, across EU Member States, each national methodology for calculating and demonstrating compliance with EP requirements is the outcome of a series of modelling studies, and involves a calculation engine incorporating various algorithms, all of which are aligned to the relevant EN standards. It is typically embedded in a user-friendly software. The newly adopted methodologies varied in scope and complexity across Member States. Generally, different methodologies were used for residential buildings (sometimes also between apartments and single homes) and for other buildings, but in a small number of countries a common universal methodology was used. **All methodologies used an overall energy performance indicator**, covering the main thermal and electrical uses, and expressed as annual kWh of either final energy or primary energy per m2 of gross floor area.

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

Deriving from the terms of the Directive, the methodologies adopted in all Member States had a dual purpose, providing a common calculation engine for demonstrating compliance with the EP requirements and for producing energy performance certificates/ labels (EPCs), as shown in Figure 4-1. The calculation method permits either the official national methodology, or alternatives in the form of validated dynamic simulation models (DSMs). This dual role provides consistency and efficiency benefits both to building professionals and to regulatory authorities.

Figure 4-1 Dual role of calculation methodology/ software in demonstrating EP compliance and generating EPCs



Several EU countries have used a methodology and software called 'Simplified Building Energy Model' (SBEM), which was developed in the UK but also applied in adapted form (allowing for different climatic and other libraries of data) in Cyprus, Malta, Ireland and some other States, to enable EP assessment of non-residential buildings. This aligns with EN ISO 52016-1 which is an example of a degree of harmonisation or convergence between EU Member States. SBEM is subject to regular updating and is in the process of refinement to cater for the demands imposed by NZEB standards. In most EU countries, a broadly similar national methodology and associated software has likewise been developed by the relevant national energy agency.

4.2 Software

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

In 20 EU countries the uniform and reliable interpretation and implementation of the calculation procedure of the software is assured by an accreditation process. This also usually includes an automatic quality check of the input data or a digital data protocol. Accreditation can either be organized at government level (such as in Poland, Malta, UK or Italy) or by a voluntary commitment of the private software suppliers (such as in Germany). Official validation of the calculation methods used in the software packages by a central authority is designed to ensure consistency and accuracy in the results.

However, most of these developments took place in advance of the emergence of the new suite of EN and EN/ISO standards. While usually broadly aligned with these new standards, these can be expected to become more tightly aligned with those standards in the years ahead. A particularly significant feature of the new modular suite of standards and the datasheet is in the form of an Excel spreadsheet for the purpose of testing and validating the calculation algorithms and data input/ output, and hence helping them to be 'software proofed'.

4.3 Complementarity of EPBD with Ecodesign and Energy Labelling Directives

The EPB standards also provide a technical foundation and interact with relevant standards at product level in providing support to the co-ordinated implementation of the EU Ecodesign Directive of 2009 which applies to over 40 product groups including building equipment for ventilation, heating, cooling, lighting, refrigeration and control & automation, as well as a wide range of consumer electrical products. The scope of this Directive extends to environmental considerations other than energy, and to products such as windows, insulation materials and certain water-using products. Collectively these product groups are responsible for around 40% of all EU energy usage and associated greenhouse gas emissions. The EN standards similarly interact with the allied EU Directive on Energy Labelling.

These two Directives are complementary to the EPBD and relate to products and components in the base of the pyramid shown in Figure 3-5. In fact, most of the relevant energy using products applied in buildings are addressed under these Directives by means of product specific regulations which require each product to meet a certain minimum energy performance threshold, and to have a label (a **'product declaration'**) where compliance with these and other essential requirements must be reported. **National or regional authorities in each Member State operate product market surveillance regimes to monitor compliance**.

The relevant EN or EN/ISO standards specify the measurement and assessment procedures to be used to obtain the relevant product performance data, which must be published in a public database. These data are essential as input to the assessment procedures contained in the EPB system standards (at the higher hierarchical levels). This consistent framework of interaction accommodates the holistic building system approach to specifying and determining energy performance. Energy saving technologies, systems and products can thus be assessed and credited on a 'level playing field' basis.

5 CONCLUSIONS

Overall, the new suite of CEN technical standards for EPB, including the ISO 52000 series, contains a systematic, comprehensive, coherent body of authoritative reference guidance covering methods of assessing energy performance as the total primary energy used for heating, cooling, domestic hot water, ventilation and lighting of buildings. It has internally consistent protocols (Excel input/ output templates) in relation to linkages between the modules, avoiding both duplication and discrepancies. It is applicable to the processes of designing, specifying and evaluating the performance of both new buildings and building renovations, and their components.

The series is expected to help accelerate progress in building energy efficiency utilizing new materials, technology and approaches to building design, construction and management. This includes a capacity to address novel concepts in the fields of thermal insulation, windows/ glazing, heating, cooling, lighting, ventilation, domestic hot-water systems, building automation and control, and renewable energy sources. Such innovations likely to become more significant factors as the regulatory building energy codes in EU countries become ever more stringent, progressing to NZEB standards (by no later than 2021).

It can be expected to facilitate greater regulatory convergence across EU Member States in relation to building energy codes (and their sub-systems), as well a gradual adaptation of existing national methodologies as further refinements may be required in the short term to meet the needs generated following the adoption of NZEB performance standards. This adaptation can be greatly assisted by the optional step by step adoption facility within the overall modular framework, whereby Member States may 'pick and mix' other standards or methods (e.g. ASHRAE, ISHRAE), subject to adhering to the consistency spreadsheet protocols.

It is thus expected to be able to cater much better for future needs than had previously been the case. Similarly, with the modular structure, the internal consistency, the facility for localisation, the shared standards with ISO and the role of related standards (and policies) in relation to Ecodesign, **it is considered that individual standards from the overall suite have the potential to be adopted or adapted for application in India**, for example. This can most readily be the case with standards relating to building components or subsystems. In the case of overall or holistic energy performance of a building, the standards will require conversion into working methodologies in the form of tightly defined calculation methods and facilitating software. In relation to this requirement, their role can thus be seen as one of providing a robust foundational support to Member State authorities and building industry practitioners in catering for ever more stringent energy performance requirements. **The overall suite encourages more harmonised regulatory and market practices across the EU, while offering an appropriate level of flexibility for national adaptation**.

Overall, **the EN and EN-ISO suite of standards thus have a key role in serving the needs of EU Member States in advancing their EPB agenda**, whether in relation to improving holistic energy performance standards, energy certification or labelling of buildings or standards for constituent building systems and components. While taking time to be finalised, they are now expected to play a growing beneficial support role in relation to consistent and efficient implementation of the EPBD, and on allied Directives on Ecodesign and on Energy Labelling of energy using products. For timing reasons, their role had sometimes inevitably been an indirect one, and some national variations are inevitable for traditional reasons, but the application of the EPB suite of standards is expected to become deeper and more direct over the coming years.

Finally, it is to be expected that much of the philosophy and the content and features contained in this suite of EPB technical standards could also be beneficially applied in the circumstances of India. Such application would have the co-benefit of assisting the free movement of energy efficient goods between India, the EU and elsewhere.

6 WEB RESOURCES

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

A complete overview of all EPB standards and their accompanying technical reports is available on the EPB Center website www.epb.center, with information about how the documents can be obtained. For each document a link is provided to the page in the ISO catalogue or CEN database where a summary and other information about the document can be found. The EPB Center is an initiative of REHVA (Federation of European Heating Ventilation and Air Conditioning Associations) and ISSO (the Knowledge Centre for the building and building services sector in The Netherlands).

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
CEN website www.cen.eu and www.epb.center	Searching for 'EPBD' will lead to the work of the technical committees on energy standards for buildings. Epb.center gives more detailed information
ISO website www.iso.org	Searching for 'EPB' will list the 52000 series of standards and accompanying explanatory reports and documents

Acknowledgement

The diagrams and elements of content in this paper are drawn from reports and presentations by Jaap Hogeling, Chair of CEN Technical Committee 371 on Energy Performance of Buildings.

APPENDIX 1: *FIVE OVERARCHING EPB STANDARDS REFERENCED IN THE NEW EPBD (2018)*

The new EPBD cites five EPB standards as being 'overarching'. These standards ISO 52000-1, 52003-1, 52010-1, 52016-1 and 52018-1 have in common that each describes an important step in the assessment of the energy performance of building:

ISO 52000-1 is the overarching EPB standard, providing the **general framework** of the EPB assessment. It establishes a systematic, comprehensive and modular structure for assessing the energy performance of new and existing buildings (EPB) in a holistic way. It is applicable to the assessment of overall energy use of a building, by measurement or calculation, and the calculation of energy performance in terms of primary energy or other energy-related metrics. It takes into account the specific possibilities and limitations for the different applications, such as building design, new buildings 'as built', and existing buildings in the use phase as well as renovation. It also contains an overview of common terms and definitions and symbols for the whole set of EPB standards.

ISO 52003-1 provides general insight on how to make good use of the outputs of the set of EPB assessment standards for different purposes (**post-processing**) in the form of overall and partial EPB indicators. It describes the relation between the EPB indicators and the EPB requirements and EPB ratings. It also includes a couple of possible EPB labels and it lists the different steps to be taken when establishing an EPB certification scheme.

ISO 52010-1 contains procedures to assess the climatic data needed as **common input or boundary condition** for many elements in the energy calculations. For instance, as input for energy and daylighting calculations, for building elements (such as roofs, facades and windows) and for components of technical building systems (such as thermal solar collectors, PV panels). But also as boundary condition for the performance of specific heating, cooling and ventilation systems.

ISO 52016-1 provides the procedures to calculate the **internal temperatures** and **energy needs** for heating and cooling for the **building as such**. This is the core of the calculation of the energy use, because many aspects coincide in this calculation: thermal insulation, air tightness and ventilation, the building mass, solar heat load and passive solar energy and internal heat gains (e.g. from lighting). Many countries have introduced or consider to introduce specific EPB requirements at the level of 'the energy needs' of the building or the 'skin' or 'fabric' of the building, independent from the choice of technical building systems and renewable energy systems.

ISO 52018-1 provides an overview of options of indicators enabling (optional) specific EPB requirements (**post-processing**) at the level of the **building as such** (building energy needs or building fabric).

APPENDIX 2: *FULL REFERENCE LIST OF RELEVANT EUROPEAN EPB STANDARDS*

The following diagrams and detailed lists are taken from the EPB Center website and can be found at

https://www.rehva.eu/fileadmin/EU_regulations/Standards_and_standardization/EPBD_standards/EPB_standards_scheme.pdf

AREAS		Overarching	Building as such		Technical Building Systems (under EPBD)										Other systems or appliances (not under EPBD)	
SUB-MODULES	MODULES	M1		M2		M3	M4	M5	M6	M7	M8	M9	M10	M11		M12
						Heating	Cooling	Ventilation	Humidification	Dehumidification	Domestic Hot Water	Lighting	Building Autom. & Controls	Photovoltaic, Wind		–
1	1.General	EN ISO 52000-1	1.General		1.General	EN 15316-1	EN 16798-9	EN 16798-3	EN 16798-3	EN 16798-3	EN 15316-1	EN 15193-1	EN 15232-1		–	
2	2.Common terms and definitions, symbols, units and subscripts	EN ISO 52000-1	2.Building Energy Needs	EN ISO 52016-1 EN ISO 52017-1	2.Needs						EN 12831-3	EN 15193-1			–	
3	3.Applications	EN ISO 52000-1	3.(Free) Indoor Conditions without Systems	EN ISO 52016-1 EN ISO 52017-1	3.Maximum Load and Power	EN ISO 52016-1 EN ISO 52017-1 EN 12831-1	EN ISO 52016-1 EN ISO 52017-1 EN 16798-11		EN ISO 52016-1 EN ISO 52017-1	EN ISO 52016-1 EN ISO 52017-1	EN 12831-3					
4	4.Ways to Express Energy Performance	EN ISO 52003-1	4.Ways to Express Energy Performance	EN ISO 52018-1	4.Ways to Express Energy Performance	EN 15316-1	EN 16798-9	EN 16798-3	EN 16798-3	EN 16798-3	EN 15316-1	EN 15193-1	EN 15232-1		–	
5	5.Building Functions and Building Boundaries	EN ISO 52000-1	5.Heat Transfer by Transmission	EN ISO 10077-1 EN ISO 10077-2 EN ISO 10211 EN ISO 12631 EN ISO 13370 EN ISO 13789 EN ISO 14683 EN ISO 6946	5.Emission & Control	EN 15316-2 EN 15500-1 EN 12098-1 EN 12098-3 EN 12098-5	EN 15316-2 EN 15500-1	EN 16798-7 EN 15500-1	EN 16798-5-1 EN 16798-5-2	EN 16798-5-1 EN 16798-5-2			EN 15232-1		–	
6	6.Building Occupancy and Operating Conditions	EN 16798-1 ISO 17772-1	6.Heat Transfer by Infiltration and Ventilation	EN ISO 13789	6.Distribution & Control	EN 15316-3 EN 12098-1 EN 12098-3 EN 12098-5	EN 15316-3	EN 16798-5-1 EN 16798-5-2			EN 15316-3		EN 15232-1		–	
7	7.Aggregation of Energy Services and Energy Carriers	EN ISO 52000-1	7.Internal Heat Gains	EN 16798-1 ISO 17772-1	7.Storage & Control	EN 15316-5 EN 12098-1 EN 12098-3 EN 12098-5	EN 16798-15				EN 15316-5 EN 15316-4-3		EN 15232-1		–	
8	8.Building Zoning	EN ISO 52000-1	8.Solar Heat Gains	EN ISO 52022-1 EN ISO 52022-3	8.Generation & Control	EN 12098-1 EN 12098-3 EN 12098-5 EN 15316-4-1 EN 15316-4-2 EN 15316-4-3 EN 15316-4-4 EN 15316-4-8 EN 15316-4-5	EN 16798-13 EN 15316-4-2 EN 15316-4-8	EN 16798-5-1 EN 16798-5-2	EN 16798-5-1 EN 16798-5-2	EN 16798-5-1 EN 16798-5-2	EN 15316-4-1 EN 15316-4-2 EN 15316-4-3 EN 15316-4-4 EN 15316-4-5		EN 15232-1	EN 15316-4-3 EN 15316-4-4 EN 15316-4-5 EN 15316-4-10	–	
9	9.Calculated Energy Performance	EN ISO 52000-1	9.Building Dynamics (thermal mass)	EN ISO 13786	9.Load Dispatching & Operating Cond.	EN 15316-1	EN 16798-9						EN 15232-1		–	
10	10.Measured Energy Performance	EN ISO 52000-1	10.Measured Energy Performance		10.Measured Energy Performance	EN 15378-3					EN 15378-3	EN 15193-1	EN 15232-1 EN 15946-1		–	
11	11.Inspection		11.Inspection		11.Inspection	EN 15378-1	EN 16798-17	EN 16798-17	EN 16798-17	EN 16798-17	EN 15378-1	EN 15193-1	EN 16947-1		–	
12	12.Ways to Express Indoor Comfort	EN 16798-1 ISO 17772-1			12.BMS											
13	13.External Environment Conditions	EN ISO 52010-1													–	
14	14.Economic Calculation	EN 15459-1													–	

STANDARD		PUBLISHED	ACCOMPANYING TECHNICAL REPORT		PUBLISHED	Ref. Modules
EN ISO 10077-1	Thermal performance of windows, doors and shutters — Calculation of thermal transmittance — Part 1: General	2017-06				M2-5
EN ISO 10077-2	Thermal performance of windows, doors and shutters — Calculation of thermal transmittance — Part 2: Numerical method for frames	2017-06				M2-5
EN ISO 12631	Thermal performance of curtain walling — Calculation of thermal transmittance	2017-06				M2-5
EN ISO 10211	Thermal bridges in building construction — Heat flows and surface temperatures — Detailed calculations	2017-06	CEN ISO/TR 52019-2	Energy performance of buildings — Hygrothermal performance of building components and building elements — Part 2: Explanation and justification	2017-07	M2-5
EN ISO 13370	Thermal performance of buildings — Heat transfer via the ground — Calculation methods	2017-06				M2-5
EN ISO 13786	Thermal performance of building components — Dynamic thermal characteristics — Calculation methods	2017-06				M2-6
EN ISO 13789	Thermal performance of buildings — Transmission and ventilation heat transfer coefficients — Calculation method	2017-06				M2-5
EN ISO 14683	Thermal bridges in building construction — Linear thermal transmittance — Simplified methods and default values	2017-06				M2-5
EN ISO 6946	Building components and building elements — Thermal resistance and thermal transmittance — Calculation methods	2017-06				M2-5
EN ISO 52000-1	Energy performance of buildings — Overarching EPB assessment — Part 1: General framework and procedures [illegible]	2017-06	CEN ISO/TR 52000-2	Energy performance of buildings — Overarching EPB assessment — Part 2: Explanation and justification of ISO 52000-1	2017-06	[illegible]
EN ISO 52003-1	Energy performance of buildings — Indicators, requirements, ratings and certificates — Part 1: General aspects and application to the overall energy performance	2017-06	CEN ISO/TR 52003-2	Energy performance of buildings — Indicators, requirements, ratings and certificates — Part 2: Explanation and justification of ISO 52003-1	2017-06	M1-4
EN ISO 52010-1	Energy performance of buildings — External climatic conditions — Part 1: Conversion of climatic data for energy calculations	2017-06	CEN ISO/TR 52010-2	Energy performance of buildings — External climatic conditions — Part 2: Explanation and justification of ISO 52010-1	2017-06	M1-13
EN ISO 52016-1	Energy performance of buildings — Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads — Part 1: Calculation procedures	2017-06	CEN ISO/TR 52016-2	Energy performance of buildings — Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads — Part 2: Explanation and justification of ISO 52016-1 and ISO 52017-1	2017-06	[illegible]
EN ISO 52017-1	Energy performance of buildings — Sensible and latent heat loads and internal temperatures — Part 1: Generic calculation procedures	2017-06				[illegible]
EN ISO 52018-1	Energy performance of buildings — Indicators for partial EPB requirements related to thermal energy balance and fabric features — Part 1: Overview of options	2017-06	CEN ISO/TR 52018-2	Energy performance of buildings — Indicators for partial EPB requirements related to thermal energy balance and fabric features — Part 2: Explanation and justification of ISO 52018-1	2017-06	M2-6
EN ISO 52022-1	Energy performance of buildings — Thermal, solar and daylight properties of building components and elements — Part 1: Simplified calculation method of the solar and daylight characteristics for solar protection devices combined with glazing	2017-06	CEN ISO/TR 52022-2	Energy performance of buildings — Thermal, solar and daylight properties of building components and elements — Part 2: Explanation and justification	2017-06	M2-8
EN ISO 52022-3	Energy performance of buildings — Thermal, solar and daylight properties of building components and elements — Part 3: Detailed calculation method of the solar and daylight characteristics for solar protection devices combined with glazing	2017-06				M2-8
ISO 17772-1	Energy performance of buildings — Indoor environmental quality — Part 1: Indoor environmental input parameters for the design and assessment of energy performance of buildings	2017-06	ISO/TR 17772-2	Energy performance of buildings — Overall Energy performance assessment Procedures — Part 2: Guideline for using indoor environmental input parameters for the design and assessment of energy performance of buildings	ISO - Under development	[illegible]

STANDARD		PUBLISHED	ACCOMPANYING TECHNICAL REPORT		PUBLISHED	Ref. Modules
EN 12098-1	Energy performance of buildings — Controls for heating systems — Part 1: Control equipment for hot water heating systems	2017-05	CEN/TR 12098-6	Controls for heating systems — Part 6: Accompanying TR prEN 12098-1:2015	2016-08	[illegible]
EN 12098-3	Energy performance of buildings — Controls for heating systems — Part 3: Control equipment for electrical heating systems	2017-05	CEN/TR 12098-7	Controls for heating systems — Part 7: Accompanying TR prEN 12098-3:2015	2016-08	[illegible]
EN 12098-5	Energy performance of buildings — Controls for heating systems — Part 5: Start-stop schedulers for heating systems	2017-05	CEN/TR 12098-8	Controls for heating systems — Part 8: Accompanying TR prEN 12098-5:2015	2016-08	[illegible]
EN 12831-1	Energy performance of buildings — Method for calculation of the design heat load — Part 1: Space heating load	2017-07	CEN/TR 12831-2	Energy performance of buildings — Method for calculation of the design heat load — Part 2: Explanation and justification of EN 12831-1	2017-06	M3-3
EN 12831-3	Energy performance of buildings — Method for calculation of the design heat load — Part 3: Domestic hot water systems heat load and characterisation of needs	2017-07	CEN/TR 12831-4	Energy performance of buildings — Method for the calculation of the design heat load — Part 4: Explanation and justification of EN 12831-3	2017-06	[illegible]
EN 15193-1	Energy performance of buildings — Energy requirements for lighting — Part 1: Specifications	2017-04	CEN/TR 15193-2	Energy performance of buildings — Energy requirements for lighting. Explanation and justification of EN 15193-1	2017-04	M9
EN 15232-1	Energy performance of buildings — Energy performance of buildings — Part 1: Impact of Building Automation, Controls and Building Management	2017-05	CEN/TR 15232-2	Energy performance of buildings — Accompanying TR prEN 15232-1:2015	2016-09	[illegible]
EN 15316-1	Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 1: General and Energy performance expression	2017-04	CEN/TR 15316-6-1	Heating systems and water based cooling systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 6-1: Explanation and justification of EN 15316-1	2017-06	[illegible]
EN 15316-2	Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 2: Space emission systems (heating and cooling)	2017-05	CEN/TR 15316-6-2	Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 6-2: Explanation and justification of EN 15316-2	2017-06	[illegible]
EN 15316-3	Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 3: Space distribution systems (DHW, heating and cooling)	2017-04	CEN/TR 15316-6-3	Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 6-3: Explanation and justification of 15316-3	2017-04	[illegible]
EN 15316-4-1	Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-1: Space heating and DHW generation systems,	2017-05	CEN/TR 15316-6-4	Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 6-4: Explanation and justification of EN 15316-4-1	2017-06	[illegible]
EN 15316-4-2	Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-2: Space heating generation systems, heat pump systems	2017-04	CEN/TR 15316-6-5	Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 6-5: Explanation and justification of EN 15316-4-2	2017-04	[illegible]
EN 15316-4-3	Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-3: Heat generation systems, thermal solar and photovoltaic systems	2017-05	CEN/TR 15316-6-6	Energy performance of buildings — Method for calculation of system energy performance and system efficiencies — Part 6-6: Explanation and justification of EN 15316-4-3	2017-04	[illegible]
EN 15316-4-4	Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-4: Heat generation systems, building-integrated cogeneration systems	2017-04	CEN/TR 15316-6-7	Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 6-7: Explanation and justification of EN 15316-4-4	2017-04	[illegible]
EN 15316-4-5	Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-5: District heating and cooling	2017-05	CEN/TR 15316-6-8	Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 6-8: Explanation and justification of EN 15316-4-5	2017-04	[illegible]
EN 15316-4-8	Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-8: Space heating generation systems, air heating and overhead radiant heating systems, including stoves (local)	2017-04	CEN/TR 15316-6-9	Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 6-9: Explanation and justification of EN 15316-4-8	2017-05	[illegible]
EN 15316-4-10	Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-10: Wind power generation systems	2017-05				[illegible]
EN 15316-5	Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 5: Space heating and DHW storage systems (not cooling)	2017-05	CEN/TR 15316-6-10	Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 6-10: Explanation and justification of EN 15316-5	2017-04	[illegible]
EN 15378-1	Energy performance of buildings — Heating systems and DHW in buildings — Part 1: Inspection of boilers, heating systems and DHW	2017-05	CEN/TR 15378-2	Energy Performance of Buildings — Heating Systems and DHW in Buildings — Part 2: Explanation and justification of EN 15378-1	2017-04	[illegible]
EN 15378-3	Energy performance of buildings — Heating and DHW systems in buildings — Part 3: Measured energy performance	2017-04	CEN/TR 15378-4	Energy performance of buildings — Measured energy performance — Part 4: Explanation and justification of EN 15378-3	2017-05	[illegible]
EN 15459-1	Energy performance of buildings — Economic evaluation procedure for energy systems in buildings — Part 1: Calculation procedures	2017-06	CEN/TR 15459-2	Energy performance of buildings — Economic evaluation procedure for energy systems in buildings — Part 2: Explanation and justification of EN 15459-1	2017-07	[illegible]
EN 15500-1	Energy performance of buildings — Control for heating, ventilating and air conditioning applications — Part 1: Electronic individual zone control equipment	2017-05	CEN/TR 15500-2	Energy performance of buildings — Control for heating, ventilating and air-conditioning applications. Accompanying TR prEN 15500-1:2015	2016-08	[illegible]
(EN 16798-1)	Energy performance of buildings — Part 1: Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics	FV - Under approval	(CEN/TR 16798-2)	Energy performance of buildings — Ventilation for buildings — Part 2: Interpretation of the requirements in EN 16798-1	FV - Approval	[illegible]
EN 16798-3	Energy performance of buildings — Ventilation for buildings — Part 3: For non-residential buildings — Performance requirements for ventilation and room-conditioning systems	2017-07	CEN/TR 16798-4	Energy performance of buildings — Ventilation for buildings — Interpretation of the requirements in EN 16798-3	2017-07	[illegible]
EN 16798-5-1	Energy performance of buildings — Ventilation for buildings — Calculation methods for energy requirements of ventilation and air conditioning systems — Part 5-1: Distribution and generation (Method 1)	2017-05	CEN/TR 16798-6	Energy performance of buildings — Ventilation for buildings — Part 6: Interpretation of the requirements in EN 16798-5-1 and EN 16798-5-2	2017-07	[illegible]
EN 16798-5-2	Energy performance of buildings — Ventilation for buildings — Part 5-2: Calculation methods for energy requirements of ventilation systems — Method 2: Distribution and generation	2017-06				[illegible]
EN 16798-7	Energy performance of buildings — Ventilation for buildings — Part 7: Calculation methods for the determination of air flow rates in buildings including infiltration	2017-06	CEN/TR 16798-8	Energy performance of buildings — Ventilation for buildings — Interpretation of the requirements in EN 16798-7	2017-06	[illegible]
EN 16798-9	Energy performance of buildings — Ventilation for buildings — Part 9: Calculation methods for energy requirements of cooling systems	2017-06	CEN/TR 16798-10	Energy performance of buildings — Ventilation for buildings — Part 10: Interpretation of the requirements in EN 16798-9	2017-07	[illegible]
EN 16798-13	Energy performance of buildings — Ventilation for buildings — Part 13: Calculation of cooling systems	2017-06	CEN/TR 16798-14	Energy performance of buildings — Ventilation for buildings — Part 14: Interpretation of the requirements in EN 16798-13	2017-06	[illegible]
EN 16798-15	Energy performance of buildings — Ventilation for buildings — Part 15: Calculation of cooling systems	2017-06	CEN/TR 16798-16	Energy performance of buildings — Ventilation for buildings — Part 16: Interpretation of the requirements in EN 16798-15	2017-06	[illegible]
EN 16798-17	Energy performance of buildings — Ventilation for buildings — Part 17: Guidelines for inspection of ventilation and air conditioning systems	2017-06	CEN/TR 16798-18	Energy performance of buildings — Ventilation for buildings — Interpretation of the requirements in EN 16798-17	2017-06	[illegible]
EN 16946-1	Energy performance of buildings — Inspection of Automation, Controls and Technical Building Management — Part 1	2017-07	CEN/TR 16946-2	Inspection of Building Automation, Controls and Technical Building Management — Part 2: Accompanying prEN 16946-1:2015	2016-09	[illegible]
EN 16947-1	Energy performance of buildings — Building Management System — Part 1	2017-06	CEN/TR 16947-2	Building Management System — Part 2: Accompanying prEN 16947-1:2015	2016-09	[illegible]