

Overall energy performance of buildings



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The CENSE project

The CENSE-project was initiated by the European Commission to improve acceptance and use of the CEN-standards, which were developed to analyse the energy performance of buildings according to the EPBD.

One of the project's major goals is to identify problems concerning the standards' content and their implementation via questionnaires and workshops and to formulate recommendations for improvement.

Per cluster of standards on a specific subject technical recommendations have been prepared by the CENSE teams who focused on a specific subset of the CEN-EPBD standards. These recommendations are based on a combination of questionnaires and specific workshop sessions.

In addition to the general recommendations, described in the articles above, the technical recommendations on the two main standards dealing with the overall energy performance are described in this article.

The holistic approach: think "Pyramids"

The assessment of the overall energy performance of a building, including the technical building systems, comprises a number of successive steps, which can be schematically visualized as a pyramid.

Sets of **common terms, definitions and symbols** are essential for all segments from top to bottom.



These cover terms such as energy needs, technical building systems, auxiliary energy use, recoverable system losses, primary energy and renewable energy.

The top segment of the pyramid is the main output: the energy performance and the energy performance certificate of the building.

The second segment provides the inputs for the top segment: one or more numerical indicators expressing the energy performance (such as over all energy use per square meter conditioned floor area, EP), a classification and ways to express the minimum energy performance requirements (EP_{max}).

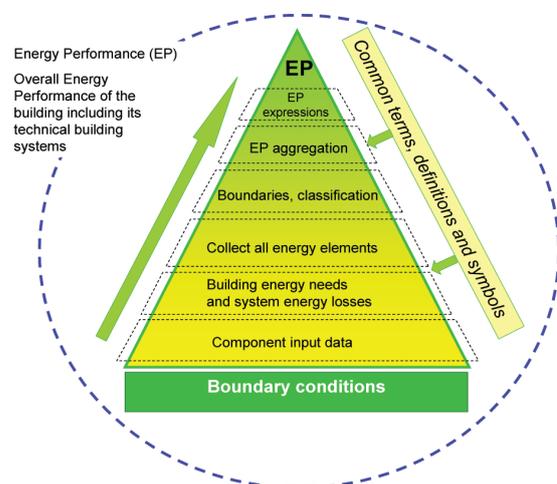


Figure 1. Overall building energy performance

The **third segment** describes the principles and procedures on the weighting of different energy carriers (such as electricity, gas, oil or wood) when they are aggregated to overall amount of delivered (and exported) energy. For instance, this may be expressed as total primary energy (EP) or carbon dioxide emission (E_{CO_2}).

The **fourth segment** specifies the categorization of building types (for example, office spaces, residential or retail) and specification of the boundaries of the building.

The **fifth segment** provides procedures on the breakdown of the building energy needs and system energy losses, aiming at gaining clear insights into where energy is used.

The **sixth segment** provides the building energy needs and energy use for each application (heating, cooling, etc.) and interactions between them.

The **seventh segment** provides the input data on components, such as thermal transmission properties, air infiltration, solar properties of windows, energy performance of system components and efficiency of lighting.

The standards on **boundary conditions** comprise external climatic conditions, indoor environment conditions (thermal and visual comfort, indoor air quality, etc.), standard operating assumptions (occupation) and national legal restrictions.

Information on the two main standards in this cluster
The CENSE project published a booklet with a



Figure 2. Harmonization of terms is essential

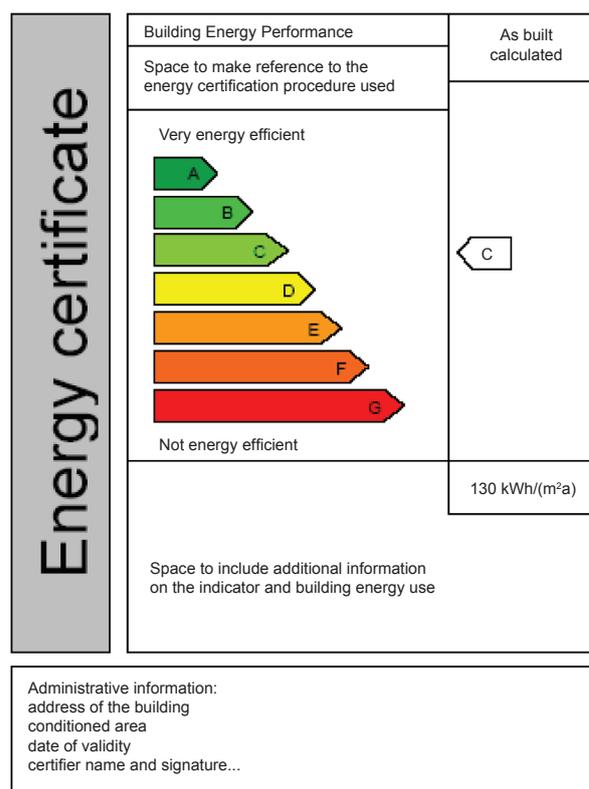


Figure 3. Example of energy performance certificate

compilation of the CENSE Information Papers on these standards.

EN 15603: Energy performance of buildings - Overall energy use and definition of ratings

The Energy Performance of Buildings Directive (EPBD) requires a general framework and a methodology for calculating the integrated energy performance of buildings. The energy performance of a building is the amount of energy consumed or estimated to fulfil different energy requirements. This amount shall be reflected in one or more numeric indicators that take into account insulation, technical installation characteristics, design and sizing in relation to climatic variables. In order to be able to compare different energy sources, an aggregate value must also be calculated.

European Standard EN 15603 covers this final step in the set of CEN standards that implement the EPBD. It defines a general framework for the assessment of overall energy use in a building, and the methods that should be used to calculate overall energy ratings.

European Standard EN 15603 defines the energy services whose energy performance ratings must be

articles

determined in planned and existing buildings by:

- ▶ the assessment of overall energy use of a building;
- ▶ the calculation of overall energy ratings (primary energy, CO₂ emissions, energy costs).

The standard collates results from other standards that specify calculation of energy consumption within a building. It accounts for energy generated in the building, some of which may be exported for use elsewhere. It presents a summary in tabular form of the overall energy use of the building and defines the uses of energy to be taken into account for setting energy performance ratings for new and existing buildings. It provides a method to:

- ▶ compute the **standard calculated rating**, a standard energy use that does not depend on occupant behaviour, actual weather and other actual (environment or input) conditions.
- ▶ assess the **measured energy rating**, based on delivered and exported energy.
- ▶ to improve confidence in the building calculation model by comparison with actual energy consumption.
- ▶ to assess the energy effectiveness of possible improvements.

EN 15217: "Energy performance of buildings — Methods for expressing energy performance and for energy certification of buildings"

This is the standard that clarifies the different possible approaches for certification.

This standard defines:

- ▶ Global indicators to express the energy performance of whole buildings, including heating, ventilation, air conditioning, domestic hot water and lighting systems. This includes the different possible

ISO/TC 163/WG 4 (Joint TC 163 – TC 205 WG)

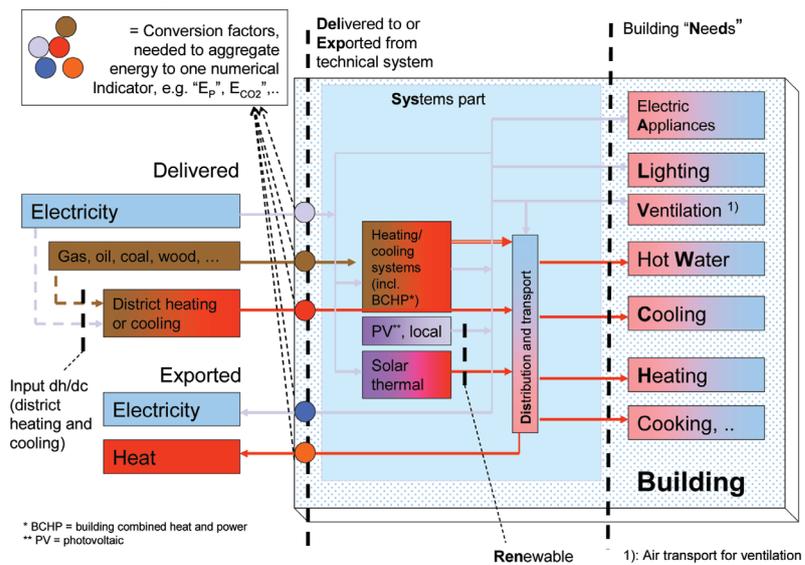


Figure 4. Boundaries and main building energy performance elements

Energy	Need (kWh)	Used (kWh)	
Heating	<p>Per energy carrier (oil, natural gas, electricity, wood, district heating, ...)</p> <p>Aggregation (weighting)</p> <p>Breakdown in delivered, renewable and exported energy</p>
Hot Water	
Cooling	
Ventilation	
Lighting	
Appliances	

Figure 5. Procedures for a consistent breakdown of energy elements

indicators as well as a method to normalize them.

- ▶ Ways to express energy requirements for the design of new buildings or renovation of existing buildings.
- ▶ Procedures to define reference values and benchmark.
- ▶ Ways to design energy certification schemes.

The choice of the relevant options must be made by each Member State.

Figure 6 shows the kaleidoscope of different ways to display the energy performance rating and classification in the Member States.

The main reason for the variety is that most Member States have not yet or little practical experience

with energy certification of buildings. The certificate has to fulfil various quality aspects, some of which are contradictory. It is expected that in the coming years feedback from early experience will lead to a basis for further harmonisation.

Recommendations for improvement of these two standards

Per cluster of standards on a specific subject technical recommendations have been prepared by the CENSE teams. These recommendations are based on a combination of questionnaires and specific workshop sessions.

In addition to the general recommendations, described in the articles above, the technical recommendations on the set of standards dealing with the overall energy performance are described in this article.

The questionnaire

The questionnaire is designed as a simplified questionnaire, distributed as email text, which contained a few questions and could be answered within a couple of minutes.

The questionnaire aimed at inquiring the status of implementation of the standards in the different member states of the European Union. The evaluation of the questionnaire should provide information on future efforts to make the standard better known and accepted and on necessary contents for revising the standard in order to allow a broad application in daily design practice.

The questionnaire was sent out to contact persons identified within the CENSE project from the 27 EU Member States as well as Switzerland. From representatives of 11 countries a completed short and/or detailed questionnaire was returned.

Main results of the questionnaire

In general, the respondents confirm the need for the

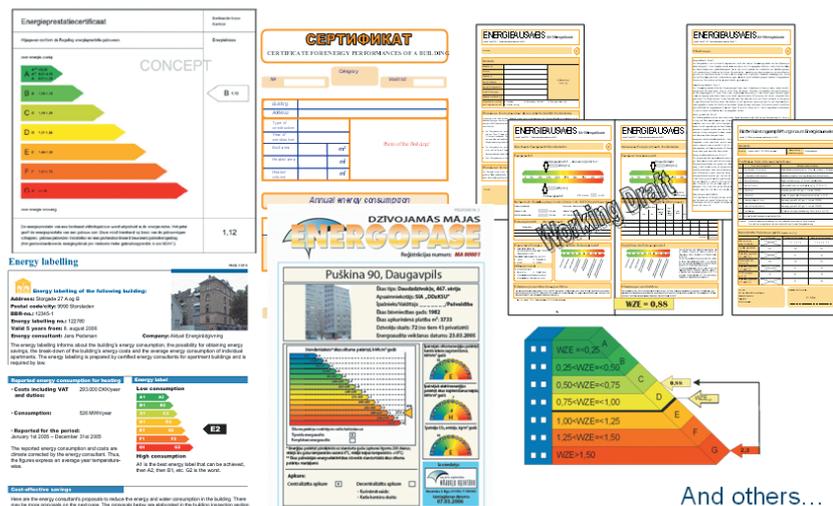


Figure 6. Illustration of the differences in energy performance certificates being implemented in the EU Member States, based on EN 15217

standards EN 15603 and EN 15217 for the buildings regulations in the Member States of the EU.

These standards cover all relevant issues; they are detailed and concrete enough.

The majority of respondents is also satisfied with the number of normative options given in these standards and do not want major changes or additional background information. And although the structure of the standards EN 15603 and EN 15217 is clear and understandable the majority of respondents expressed the need for a compact method at national level which had as consequence that only selected parts of the CEN standards were integrated in the national methods.

The main conclusions are the following:

We need a restructuring of the standards, leading to a clear separation between the obligatory common procedures in the standards and the options to be chosen at national level. Also, to remove informative annexes to separate Technical Report(s).

- ▶ This will make it easier to adopt at national/regional level the CEN standards as they are, translated in national/regional language if necessary.
- ▶ This will also make it easier for the writers of the methods for the national/regional building regulation to follow actively the preparation of the CEN standards, to exchange knowledge and experience with colleagues in other countries and to anticipate on the CEN standards when writing or

revising the procedures at national/regional level. The national procedures could then formally consist of the CEN standards plus short national annexes (containing national choices and input data). To accommodate the need for a compact national method, a (e.g. informative) national application document could be envisaged that integrates the contents of the CEN standards with the national choices and input data.

Workshops

In the course of the project several workshops were organised, focussing on discussions to additionally receive feedback and/or further results on the issue. Consequently the (preliminary) results of the questionnaire were intended to serve as base of an intense discussion. In particular it was tried to identify and discuss problems arising from the content of the standards and its implementation.

Additional feedback from workshops

In general, the workshops underline the conclusions from the questionnaire.

At some of the workshops presentations were given on the national or regional implementation of EN15603 and/or EN15217 and related standards which underline the recommendations, but provide very interesting details on the experience, national practice and proposed improvements. As part of the preparation of the development of a second generation of CEN standards on the energy performance of buildings, it is important to take these into consideration. The most relevant country presentations are mentioned in **Annex A** [of the CENSE report] taking into account that general conclusions and recommendations are already provided in the CENSE document providing general recommendations on the whole set of CEN-EPBD standards.

Specific additional conclusions:

The first priority seems to be to promote the common modular structure of EN 15603 to be used in all Member States and to work out in more detail the hierarchy in and links between the modular elements. In this respect, there is a strong need to develop a common position on the level of detail of the calculation procedures, such as the calculation time step (monthly, hourly, ..) and the complexity

of the calculation procedures. Typically, the choice depends on the application and specific boundary conditions.

A common understanding on the relation with the applications and the boundary conditions is necessary in order to be able to prepare a consistent set of standards that will fulfill the needs from the Member States and other interested parties.

In this respect it is also noted that the application range is wide: from a simple heated dwelling to very complex non-residential buildings; from an old building with very little information on the component and system properties to new highly energy efficient buildings.

- ▶ The development of a common position on these issues should be one of the highest priorities in the development of the second generation of CEN standards for the EPBD, which by its nature should precede the discussion of the revision of the individual standards.

Another concern is that the MS [Member States] don't want to be confronted with substantive changes in the calculation procedures which will jeopardize the continuity in the instrumentation implemented at national level.

- ▶ It is important to bring in from the start a maximum of clarity on the goals, the basic principles and the overall structure, and to involve the MS in the process.

More specific observations and recommendations related to the level of complexity of the methods and the link with software tools are presented in the relevant sections of this report.

References

1. *CENSE BOOKLET 1, Compilation of Information Papers introducing the CEN standards concerning Overall Energy Performance of Buildings, April 2010 (www.iee-cense.eu)*
2. *CENSE WP2.3 N03, Report on the application of two key standards for the EPBD: EN 15603 (Overall energy use and definition of ratings) and EN 15217 (Methods for expressing energy performance and for energy certification of buildings), Kees Arkesteijn en Dick van Dijk, May 2010 (www.iee-cense.eu)*