[European projects]

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How to integrate the CEN-EPBD standards in national building regulations?

The use of EN 15603 to adopt the same structure as starting point for coordination of Member States regulations

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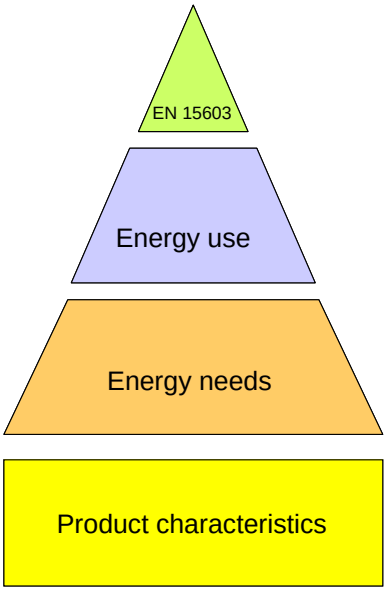

Figure 1: Structure of CEN standards (mandate 343)

The European Commission gave a mandate to CEN for the elaboration and adoption of a methodology calculating the integrated energy performance of buildings in accordance with the Energy Performance of Buildings Directive (EPBD).

Access to such a calculation methodology in the form of European Standards makes it possible to coordinate the various measures for improving the energy efficiency in buildings between the Member States.

It will increase the accessibility, transparency and objectivity of the energy performance assessment in the Member States.

This paper describes how these European standards (published in 2007 and 2008) could be progressively integrated in existing national building regulations in order to converge towards a common European calculation method of the integrated energy performance of buildings.

1 > Introduction

Background

The European Commission, DG TREN and DG Enterprise, gave the mandate 343 to CEN for the elaboration and adoption of a methodology calculating the integrated energy performance of buildings in accordance with the terms set forth in Directive 2002/91/EC (Energy Performance of Buildings Directive-EPBD).
Access to such a calculation methodology in the form of European Standards makes it possible to coordinate the various measures for improving the energy efficiency in buildings between the Member States. It will increase the accessibility, transparency and objectivity of the energy performance assessment in the Member States (as mentioned in recital (10) of the EPBD).

The CEN standards developed under mandate 343 were published in 2007 and 2008.

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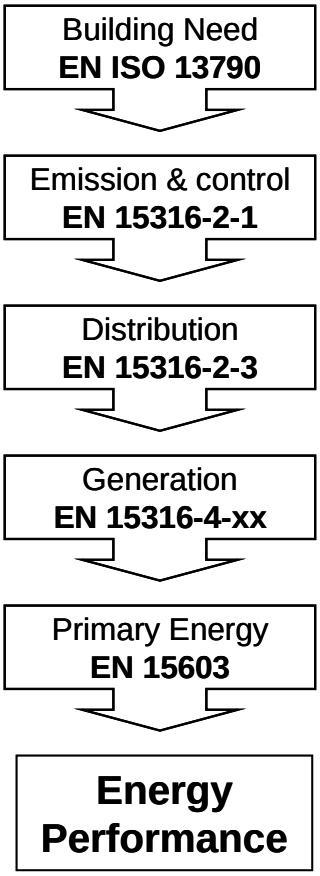

Figure 2: Calculation structure of CEN standards (mandate 343): from energy needs to energy source. Example for space heating

Starting point of convergence

The starting point of convergence is to adopt the same overall calculation structure and to start connecting the national method to this general structure. The structure could then gradually be filled in at national level with the appropriate CEN standards and the related national annexes.

The general structure is defined in the standard EN 15603 "Energy performance of buildings - Overall energy use and definition of energy ratings". The general structure defined in EN 15603 summarises the main parameters of the energy performance of buildings. The same parameters are required by the EPBD.

The results of the energy performance calculations can be obtained either by simplified methods or by more detailed methods. This has the advantage that the same structure can be used for different issues, e.g. for the assessment of single family houses and/or commercial buildings, for energy performance certificates and/or for checking compliance with minimum energy performance requirements, for new and/or existing buildings.

2 > Modular structure of CEN standards – from products to overall energy

The CEN standards are structured by modules starting from the product characteristics until and including the overall energy uses described in EN 15603 (see **figure 1**). This "going through" approach is very important in order to maintain the links between product testing and system evaluation, as the product is not longer evaluated as a product but as part of a system.

EN 15603 collects the different energy uses (heating, cooling, lighting, ventilation and domestic hot water) and converts it to one or more numeric indicators (primary energy, CO_2 emissions).

EN 15603 defines the boundaries of the calculation ("the system boundaries"), comprising the building energy needs and the energy use (and optionally: produced) by the technical building systems, including their interactions. It also defines the different types of energy flows entering and/or leaving the system boundaries.

EN 15603 defines the general structure and highlights the basic steps (connecting points for the calculation) of the building/systems energy balance as follows:

- Building energy needs
  (heating, cooling, lighting, ventilation and domestic hot water);
- Input to all distribution systems
  (these are the required outputs of generation systems);
- Generation systems energy input (energy use)
  sorted by energy carrier;
- Calculation of ratings (weighted energy ratings);
- Reporting.

The calculation direction in EN 15603 goes from the needs to the source, e.g. from the building energy needs to the primary energy (see example for space heating in **figure 2**). It follows the opposite direction of the physical energy flow in a building. Electrical services (such as lighting, ventilation, auxiliary) and thermal services (e.g. heating, cooling) are considered separately inside the building boundaries.

3 > Building energy needs

The calculation starts with the building energy needs. The values related to the building energy needs are collected in table 4 of EN 15603.

In national building regulations the values in table 4/EN 15603 can be determined by national methods or ideally by EN standards. The values in EN 15603 are annual values. They can be calculated by simplified methods (e.g. monthly calculation step) or detailed methods (e.g. hourly calculation step). Elements having a major effect on the building energy needs such as thermal insulation, glazing, form factor etc., should be taken into account.

The values put in the following table could be issued by those methods.

		C1	C2	C3	C3	C4
		Heating		**Cooling**		**Domestic hot water**
		sensible heat	latent heat	sensible heat	latent heat	
L1	Building heat gains and recoverable thermal losses [a)]		-		-	-
L2	Building thermal transfers		-		-	-
L3	Building thermal needs	14400		Not taken into account in this example		2100
a): if applicable						

Table 1: Building energy needs (example table 4/EN 15603, values in kWh/a)

The calculation then continues with the part related to the technical building systems.

4 > Technical building systems

In EN 15603 the technical building system losses are divided in two parts:

- Technical system thermal losses, electrical and auxiliary energy without building generation devices;
- Energy generation systems.

Technical system thermal losses, electrical and auxiliary energy without building generation devices

The values related to the technical system thermal losses, electrical and auxiliary energy, taking into account emission, control and distribution, without building generation devices, are collected in table 5/EN 15603. The values in table 5/EN 15603 can be calculated according to available national methods or issued by tables like the following.

EN 15316-1 defines that for each sub-system, simplified (e.g. tabulated values) and/or detailed methods may be applied according to the accuracy required.

Different levels of details may be used for the different sub-systems of the heating system. However, it is essential that the results correspond to the defined output values of the sub-system in order to ensure proper links to calculations for the following sub-systems and development of a common structure.

Type of domestic hot water distribution	System thermal losses (kWh/m² a)	Recoverable system thermal loss (kWh/m² a)	Electrical energy (kWh/m² a)
Collective with circulation	22,65	0,0	1,4
Alternatives, e.g.:			
Collect. without circulation	10,8	3,7	0
Individual	3,8	2,0	0

Table 2a: System thermal losses, recoverable system thermal loss and electrical energy for DHW distribution; simple example, energy per m² floor area.

Type of ventilation distribution	System thermal losses (kWh/m² a)	Electrical energy (kWh/m² a)
Mechanical ventilation system – not balanced	0,0	4,0
Alternatives, e.g.:		
Mechanical ventilation system – balanced (heat recovery eff. >60%)		
- inside thermal insulation	0,0	6.0
- outside thermal insulation	4,3	6.0

Table 2b: System thermal losses and electrical energy for ventilation distribution; simple example, energy per m² floor area.

Based on these examples and for a building with 100 m² floor area, with:

- a collective domestic hot water system with circulation;
- a non balanced mechanical ventilation system;
- a heating system with distribution losses amounting e.g. 2020 kWh table 5/EN 15603;

can be completed like follows.

		C1	C2	C3	C4	C5
		Heating	**Cool.**	**Domestic Hot water**	**Ventilation**	**Lighting**
L4	Electrical energy	190		140 (1,4x100)	400 (4,0x100)	Not taken into account in this example
L5	System thermal losses	2020		2265 (22,65x100)	0	Not taken into account in this example
L6	Recoverable system thermal losses					
L7	Thermal input distribution	16420 (14400+2020)		4365 (2100+2265)		

Table 3: System thermal losses and auxiliary energy without generation (example table 5/EN 15603, values in kWh/a)

Energy generation systems

Following the physical structure of heating systems, the heat input to the distribution system is dispatched, according to the system design, to the different energy generation systems and/or the energy supplied directly from outside the building (e.g. electricity, district heating). In EN 15603

the values related to the energy generation systems are collected in table 6/EN 15603.

As a first step, the required values in table 6 of EN 15603 could be determined according to national methods (efficiencies are convert to losses at each subsystem level).

		C1	C2	C3
	Type of generator	LT Gas boiler	Solar panel	Grid electr.
	Distribution systems supplied	Heating /DHW	DHW	
L8	Thermal output	19655 (16420+4365-1130)	1130	-
L9	Auxiliary energy (*)	80	80	-
L10	System (generator) thermal losses	3734		
L11	Recoverable system thermal losses			
L12	Energy input	23389	0	890
L13	Electricity production			
L14	Energy carrier	gas	solar	electricity

(*): for the generator

Table 4: Energy generation system (example table 6/EN 15603, values in kWh/a)

5 > Calculation of ratings (weighted energy ratings)

A building generally uses more than one energy carrier. Therefore, a common expression of all energy carriers shall be used to aggregate the used amounts.

According to EN 15603 the aggregation methods are based on:

- Primary energy;
- Production of carbon dioxide;
- A parameter defined by national energy policy.

Cost is a parameter that may be used in the energy policy aggregation method.

The values related to the weighted ratings are collected in table 8/EN 15603. Informative values for primary energy factors and CO_2 production coefficients are given in annex E table E1/EN 15603.

Informative values	Primary energy factors f_P		CO_2 production coefficient K
	Non-renewable	Total	[kg/MWh]
Fuel oil	1.35	1.35	330
Gas	1.36	1.36	277
Anthracite	1.19	1.19	394
Wood shavings	0.06	1.06	4
Electricity from hydraulic power plant	0.50	1.50	7
Electricity Mix	3.14	3.31	617

Table 5: Informative Primary energy factors and CO_2 coefficients in EN 15603 (extract)

For a building using:

- natural gas;
- solar panels;
- grid electricity;

the primary energy rating according table 8/EN 15603 can be completed like follows.

Row		C1	C2	C3
		Delivered energy		
		Gas	Solar	Electricity
L1	Energy delivered (unweighted)	23389	1130	890
L2	Weighting factor or coefficient	1,36	0	3,14
L3	Weighted delivered energy or CO2	31809	0	2794
		Exported energy		
		thermal	electrical	
L4	Energy exported (unweighted)			
L5	Weighting factor			
L6	Weighted exported energy or CO2			0
L7	Rating			34603 (31809+2794)

Table 6: Calculation of ratings (example table 8/EN 15603, values in kWh/a)

6 > Reporting

EN 15603 defines the content of the report on assessment of energy use of buildings. This report resumes the main parameters influencing the energy performance of a building. The report is also part of the general structure that should be respected by national building regulations.

With only a few values it is possible to get an overview of the weak and strong points in the energy balance of a building.

The values of this example are indicated in table 7.

Building thermal needs (without techn. build. systems)	Technical building system performance (thermal system losses-recovered losses)	Energy delivered (content of energy carriers)	Energy rating (Weighted Energy carriers)
Heating: **14400** Hot water: **2100** Cooling: -	Heat (H+W): **8019** (2020+2265+3734) Cooling: Electricity *): Heat auxiliary **490** (190+140+80+80) Cooling auxiliary Lighting Ventilation **400**	Gas **23389** Oil Electricity **890** District heating Etc.	Gas **31809** Electricity **2794**
		Energy exported (Unweighted energy carriers)	
		Thermal:	
			34603
		Renewable energy produced on site	
		Thermal **1130**	
		Electrical	

*) includes electricity for ventilation, lighting and the auxiliary energy for thermal systems; does not include electricity for heating, cooling, DHW, humidification and dehumidification.

Table 7: Reporting overall energy use (example table 9 EN 15603, values in kWh/a)

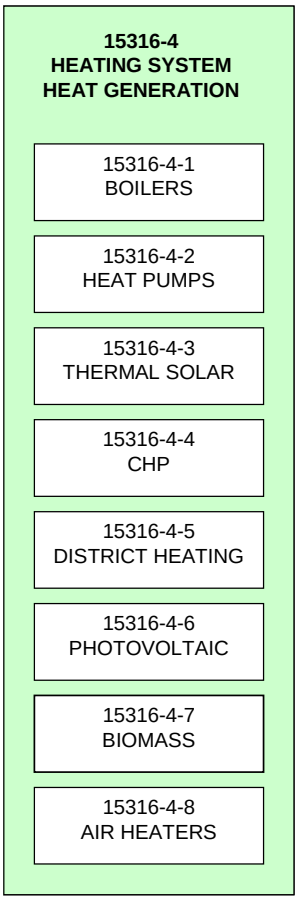

Figure 3:
Energy generation standards available developed by CEN; example for heating systems

7 > How to fill in the general structure?

The example before has shown that the general structure defined in EN 15603 is:

- well structured with defined inputs and outputs;
- simple, complete and consistent, starting from the product standards until and including the overall energy use;
- flexible, because only the method is standardised. The method can be parametered at national level by national annexes. Simplified and detailed methods can be used, because different uses require different methods.

The general structure can gradually be filled in by the Member States:

- as a first immediate step, with national methods;
- then, with CEN standards (with or without national annexes).

It is also possible to mix up CEN standards for some modules and national methods for other modules. For example for the energy generations systems different CEN standards are available (see **figure 3**). If a Member State prefers, for the time being, to use national methods, the CEN standards can be replaced by national methods but the national method must provide the standardised outputs of the CEN standards in order to be integrated in the general approach.

8 > FAQ

Why the general structure defined in EN 15603 could fit to most existing building regulation? Is it reliable?

The general structure defined in EN 15603 is a very simple structure based on the physical description of the major effects on the building energy

performance. In mostly all existing or foreseen national building regulations in the Member States the calculation starts with the calculation of the building needs and then efficiencies or losses are added for the various parts of the technical building systems.

The basic "connection points" to the general structure are:
- the energy needs;
- the distribution input;
- the generation input (the delivered energy);
- the weighted energy (rating).

EN 15603 has a consistent and flexible structure, adapted for simplified methods and for more detailed methods. The structure is based on the physical description of a building and the technical building system and integrates the results of subsequent standards in the overall energy use.

Are there already some experiences for the implementation of EN 15603, and the defined structure, on national level?

In Italy the use of European standards is well advanced. Even software is already available. In Switzerland documents are prepared to implement EN 15603. Also other countries intend to adopt the structure (The Netherlands, Germany, see also Information Paper P90)

Where do the outputs needed to fill in the general structure come from? From tabulated values or from calculation methods?

Both approaches are possible. The method chosen depends on the accuracy required which depends on the application (e.g. first assessment at preliminary stage, rough method for existing single family houses with simple and comparable design). The required data and accuracy is also related to building elements which have major or minor effects on the building energy performance.

9 > References

1. EN 15603, Overall energy use and definition of energy ratings, CEN, January 2008
2. EN 15316-1, Method for calculation of system energy requirements and system efficiencies – General part, CEN, July 2007

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