THE EUROPEAN ENERGY PERFORMANCE OF BUILDINGS DIRECTIVE (EPBD)

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Abstract

From the beginning of 2006 all new European buildings (residential, commercial, industrial etc.) must have an energy declaration based on the calculated energy performance of the building, including heating, ventilating, cooling and lighting systems. This energy declaration must refer to the primary energy or CO_2 emissions. The directive also states that the energy performance calculation must take into account the indoor climate, but gives no guidelines.

The European Organisation for Standardization (CEN) is now preparing a series of standards to cover the requirements for the indoor environment, energy performance calculations for buildings and systems, ways of expressing energy performance, inspection of heating-cooling-ventilation systems and conversion to primary energy. This paper presents the EPBD and related standardisation. It also gives the status of the on-going implementation of the directive and discusses the issues related to the indoor and outdoor environment.

***Keywords*:** Energy performance, Indoor climate, Standards
Category: Environmental policy

1. Introduction

Heating, ventilation and cooling of buildings is the biggest consumer of energy and is responsible for a significant amount of CO_2 emission. Most European countries have national building codes requiring a minimum insulation level of buildings. Some countries give the requirements as an energy frame for the whole building or the building including the heating system. In 2003 the European Commission (EC) issued a directive, 2002/91/EC. This directive requires all member countries by January 2006 to implement building codes on a national level. For new and existing buildings this requires a calculation of the energy performance of the building including heating, ventilation, cooling and lighting systems, based on primary energy. Each building must have an energy certificate and regular inspections of heating, cooling and ventilation systems must be performed. The objective of this directive is to promote the improvement of the energy performance of buildings within the community, taking into account outdoor climatic and local conditions, as well as indoor climate requirements and cost-effectiveness. The directive refers to the energy use and does not take into account a life cycle energy demand (energy used to produce the products used for the building).

2. Concept for standardisation related to the EPBD

A mandate to the European Standards Organisation (CEN) from the Commission, M343-EN-2004 has been issued. This mandate asks CEN to elaborate and adopt standards for a methodology, calculating the integrated energy performance of buildings and estimating the environmental impact, in accordance with the directive.

To coordinate the standardization related to the EPBD, CEN has established an EPBD-Project Group including the following Technical Committees (TC's):

TC 89 THERMAL PERFORMANCE OF BUILDINGS AND BUILDING COMPONENTS
TC156 VENTILATION FOR BUILDINGS
TC169 LIGHT AND LIGHTING

TC228 HEATING SYSTEMS IN BUILDINGS
TC247 BUILDING AUTOMATION, CONTROLS AND BUILDING MANAGEMENT

The standards under the mandate shall thus constitute an integrated and interacting methodology for the calculation of the energy uses and losses for heating and cooling, ventilation, domestic hot water, lighting, natural lighting, passive solar systems, passive cooling, position and orientation, automation and controls, and auxiliary installations necessary for maintaining a comfortable indoor environment. The methodology shall integrate, where relevant, the positive influences of active solar systems and heat and electricity from renewable energy sources, as well as quality co-generation heating plants (CHP, including micro-CHP) and district heating and cooling systems. It should also facilitate an estimation of the environmental impact from this energy use and provide data requirements for carrying out standard economic evaluations for the use of different systems.

The mandate lists 31 work items (WI, Annexe A), which must be developed under this mandate to support the directive. By April 2005 the documents will be issued as draft standards (prEN) for public enquiry. This allows the member states to use these drafts during 2005 to write the national laws and building codes needed to implement the directive. The standards will then be finalized in accordance with normal procedures and agreed target dates. Corresponding work item numbers from the mandate are listed.

A basic standard for the calculation of the building energy demand (revised EN ISO 13790) will form the central point of the calculation procedure. The existing EN ISO13790 covers the calculation of the building heating demand. This will be extended to include also cooling. To perform this calculation, input data for indoor climate requirements, internal loads, building properties and climatic conditions are needed. Standards and methods for these input data exist already to a great extent. Some work related to Lighting (TC169) is needed. The calculation of the building energy demand does not take into account the heating-cooling-ventilation system. The calculated building energy demand serves then as an input to the calculation of the system energy requirement.

An umbrella document gives the EU-member countries and the names of people responsible for the implementation of the EPBD, together with an overview and information concerning the output parameters. Figures 1 and 2 show the concept for the calculation procedure supported by the existing, ongoing and planned standardisation. In Figure 1 the relation to the different articles in the directive and corresponding work item numbers from the mandate are listed.

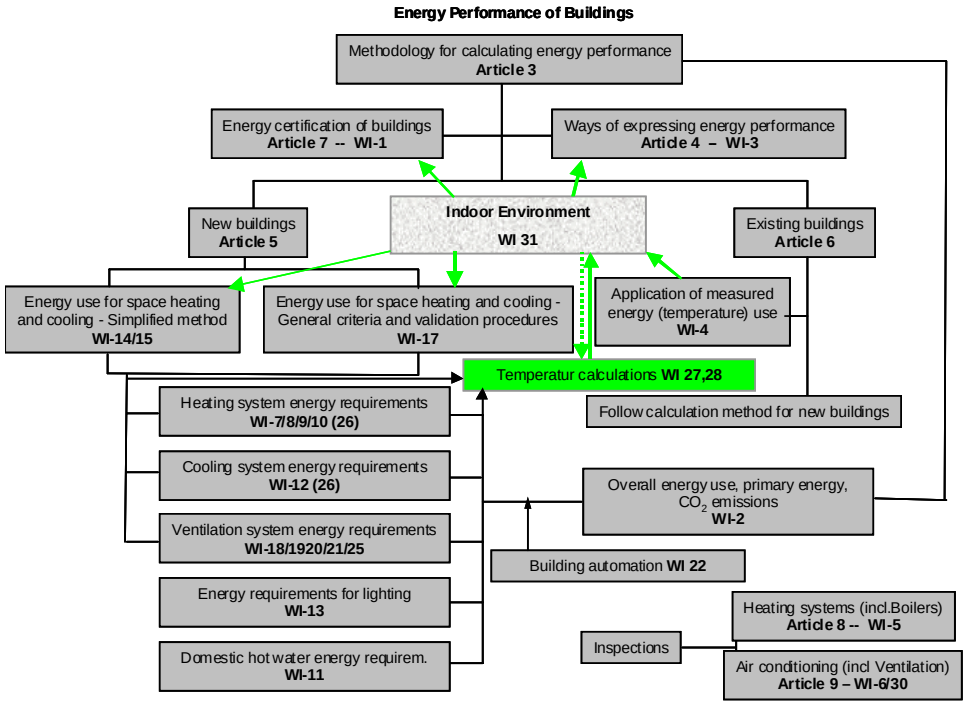

Figure 1. Concept for standardisation related to the EPBD. The WI-numbers refer to the listing in Annex A.

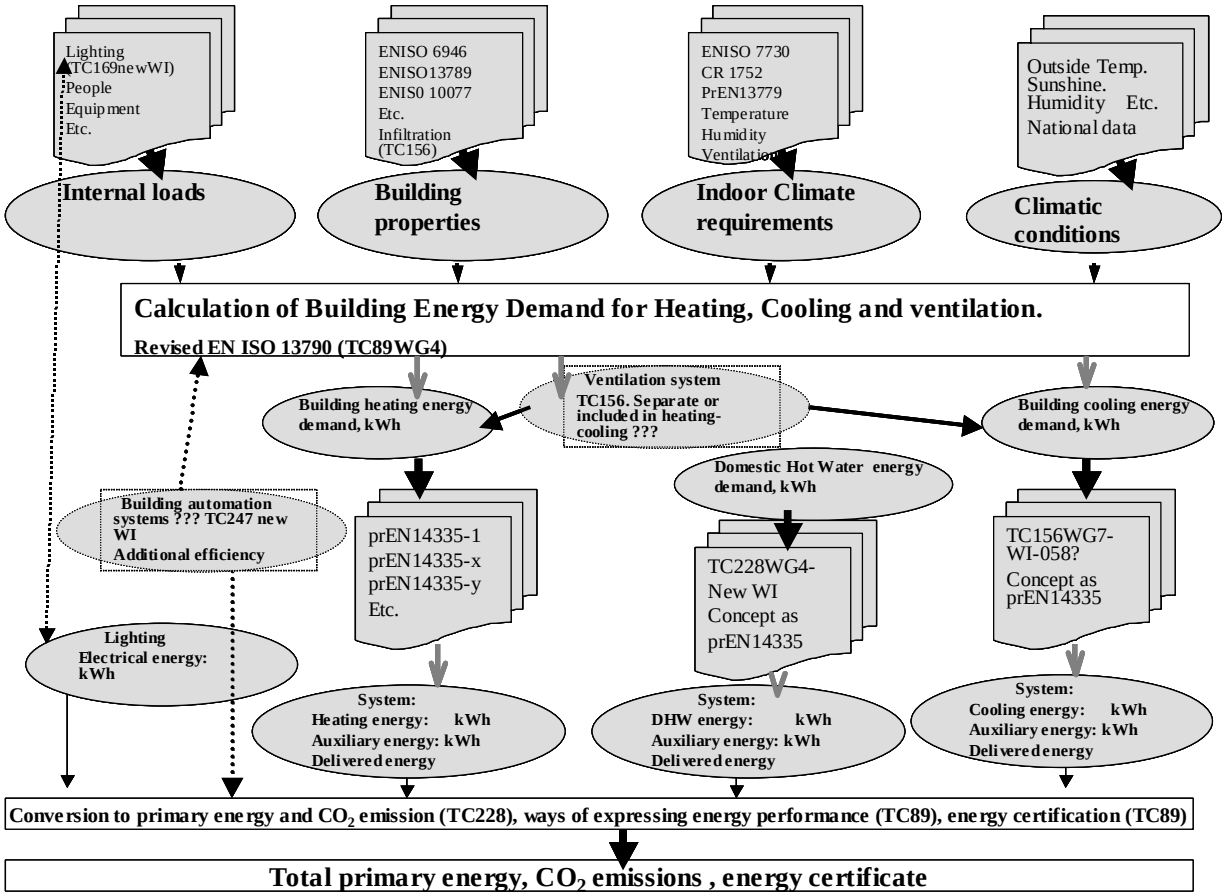

Figure 2 The relation between some of the standards in the calculation procedures

The boundary between building and system is shown in Figure 3 for a heating system.

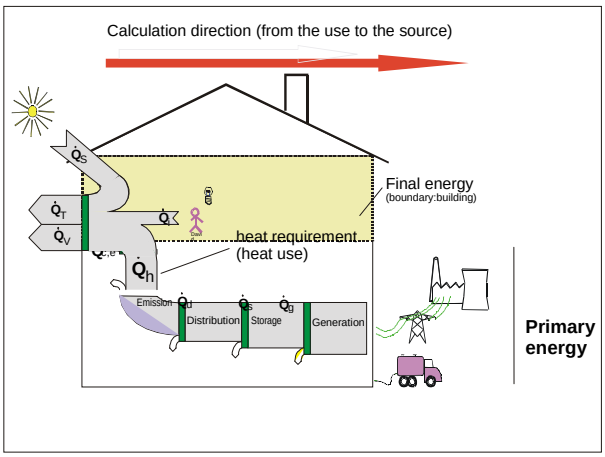

Figure 3. Calculation concept and building-system boundaries for heating

For the heating system the additional losses are calculated for heat emission, distribution, storage and generation. A similar concept will be used for the cooling systems, ventilation system and domestic hot water system. The auxiliary electrical energy needed for fans, pumps etc. will also be calculated.

The effect of the control system is included in the building energy demand as well as the additional losses from the system due to sub-optimal control. The additional energy savings obtained with a whole building automation system (heating, cooling, ventilation, electrical appliances, light etc.) will be taken into account in a separate standard from TC247 (see Figure 2).

Output from the calculation (Figure 2) will be the building energy demand together with the required heating/cooling ventilation energy for the HVAC systems, including the auxiliary energy. Finally, the total energy required for the building/system can be calculated by adding the required energy for all the systems, including lighting. This will be converted to Primary Energy, taking into account renewable energy sources and national conversion factors.

3. Energy certificates and inspections

All new and existing buildings must have an energy certificate. This certificate will be renewed whenever a building is sold and for larger building as a minimum every 10th year. An example of a certificate is shown in figure 4:

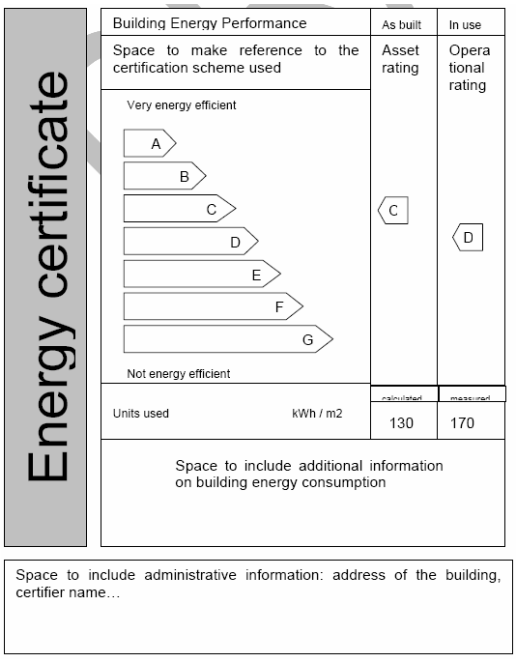

Figure 4: Example of building energy certificate.

In public buildings this certificate must be visibly displayed at the entrance to the building. When issuing a certificate for an existing building, it must be accompanied by a report on technical measures that can be taken to reduce the energy consumption. In Denmark, where energy certificates have been required for some years, practice has shown that when building a new house and issuing a new certificate, the new owner implements 40% of the suggested measures within the first year.

Also regular inspection of heating systems (incl. boilers) and air-conditioning systems (incl. ventilation system) is required under this directive.

4. Required indoor environment

As stated several times in the directive, the indoor environment and people's comfort and health must not be sacrificed for energy savings. Therefore a separate standard is made to recommend criteria for the indoor environment including thermal comfort, indoor air quality, lighting and noise. Criteria will be established for the design of buildings and systems and indoor environmental data (temperature, ventilation rates, lighting levels) as input for energy calculations and methods for whole-year evaluation of the indoor environment. They will be based mainly on existing international standards and guidelines (CEN CR 1752, 1998); ISO 7730, 2005); EN 13779, 2004; ASHRAE-55, 2004)

It would not be reasonable to require the criteria for the indoor environment to be fulfilled 100% of the operation time. Often in national building codes or standards it is allowed to deviate from the comfort range during a limited time (100 hours in the Danish standard DS-474, Danish Standards Association, 1993). A measure of the yearly quality of the indoor environment could be how much of the time of occupancy the indoor environment is within the specified criteria (70, 80 or 95%).

Also, if the declaration of the indoor environment in existing buildings is based on measured conditions, there is a need for a standardised method to calculate a yearly summation or average of measured indicators like temperature and CO_2 concentration.

5. Conclusions

The new directive for energy performance of buildings requires considerations of the indoor environment. It must therefore not be possible to fulfil requirements for the energy performance by decreasing the indoor environmental quality.

6. References

ASHRAE 2004. Standard 55-2004. Thermal environment conditions for human occupancy. Standard 55-2004, ASHRAE, Atlanta.

CEN CR 1752, 1998 Ventilation for Buildings : Design Criteria for the Indoor Environment, Brussels,

DS 474, 1993, Standard for specification of the indoor thermal environment. Copenhagen, Danish Standards Association.

EN ISO 13790, 2001 Thermal Performance of Buildings-Calculation of Building Energy Demand for Heating, Brussels.

EN 13779, 2004. Ventilation for non-residential buildings - performance requirements for ventilation and room-conditioning systems, Brussels

ISO EN 7730, 2005. Moderate thermal environments – Determination of the PMV and PPD indices and specification of the conditions for thermal comfort,, Geneva, International Standards Organization.

ISO EN 13790, 2001 Thermal Performance of Buildings-Calculation of Building Energy Demand for Heating, Brussels.

ANNEX A: Titles, WI number, responsible technical committee (TC) and Working Group (WG)

Section 1: Standards concerned with <u>overall energy use</u> in buildings (based on results from standards in section 2)

No	Work item	TC	WG
1.	Energy performance of buildings – Methods of assessment to be used for the energy certification of buildings (Including guidelines for developing certification schemes)	89	4
2.	Energy performance of buildings – Overall energy use, primary energy and CO_2 emissions	228	4
3.	Energy performance of buildings – Ways of expressing energy performance of buildings	89	4
4.	Energy performance of buildings – Application of calculation of energy use to existing buildings	89	4
5.	Energy performance of buildings – Systems and methods for the inspection of boilers and heating systems.	228	4
6	Energy performance of buildings – Guidelines for the inspection of air-conditioning systems	156	10

Section 2: Standards concerned with calculation of <u>delivered energy</u> (based where relevant on results from standards in section 3)

No.	Work item	TC	WG
7.	Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies – Part 1: General	228	4
8.	Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies – Part 2.1: Space heating emission systems	228	4
9.	Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies – Part 2.2: Space heating generation systems: Part 2.2.1. Boilers Part 2.2.2. Heat pumps Part 2.2.3. Thermal solar systems Part 2.2.4 The performance and quality of CHP electricity and heat (incl. on-site and micro-CHP). Part 2.2.5. The performance of quality district heating and large volume systems. Part 2.2.6. The performance of other renewables heat and electricity.	228 (312) .	4
10.	Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies – Part 2.3: Space heating distribution systems	228	4
11.	Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies – Part 3.1: Domestic hot water systems, including generation efficiency and the tap water requirements.	228	4
12.	Dynamic calculation of room temperatures and of load and energy for buildings with room conditioning systems (including solar shading, passive cooling, and position and orientation)	156	7
13.	Energy performance of buildings – Energy requirements for lighting (including day lighting)	169	9
14.	Thermal performance of buildings – Calculation of energy use for space heating and cooling – Simplified method	89	4
15.	Thermal performance of buildings – Calculation of energy use for space heating – Simplified method with extension of scope of EN ISO 13790	89	4

Section 3: Standards concerned with calculation of <u>net energy for heating and cooling</u>

No.	Work item	TC	WG
16.	Thermal performance of buildings – Sensible room cooling load calculation – General criteria and validation procedures	89	6
17.	Energy performance of buildings – Calculation of energy use for space heating and cooling – General criteria and validation procedures	89	6
18.	Ventilation for buildings – Calculation methods for the determination of airflow rates in dwellings including infiltration	156	7
19.	Ventilation for buildings – Calculation methods for the determination of airflow rates in buildings including infiltration. (The items 18 and 19 could possibly merge).	156	7
20.	Ventilation for buildings – Calculation methods for energy requirements due to ventilation systems in buildings	156	7
21.	Ventilation for buildings – Calculation methods for energy requirements due to ventilation systems in dwellings.	156	7
22.	Calculation methods for energy efficiency improvements by the application of integrated building automation products and systems	247	
23.	Review of standards dealing with calculation of heat transmission in buildings. – 1st set	89	
24.	Review of standards dealing with calculation of heat transmission in buildings. – 2nd set	89	
25.	Ventilation for non-residential buildings – Performance requirements for ventilation and room conditioning systems.	156	7
26.	Design of embedded water-based surface heating and cooling systems, to facilitate renewable low temperature heating and high temperature cooling.	228	5
27.	Performance requirements for temperature calculation procedure without mechanical cooling.	89	6
28.	Performance requirements for temperature calculation procedure with mechanical cooling.	89	6
29.	Data requirements for standard economic evaluation procedures, including for renewable energy sources.	228	4
30.	Inspection of ventilation systems	156	11
31.	How to specify criteria for the internal environment, (thermal, lighting, IAQ)	156	12