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Information paper on EN 15316-1: "Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies – Part 1: General"

Several European Directives, e.g. the Energy Performance of Building Directive and the Energy using Product Directive, require that minimum requirements be specified. These minimum requirements may affect the building design and the technical building systems. The EN 15316-1 Standard defines the efficiency of heating systems or parts of them (subsystems) and introduces the relevant calculation methods. Dividing the general performance of a building, as indicated in EN 15603 [1], makes it possible to identify the strong and the weak points in the total energy performance of a building. EN 15316-1 could also help in the definition and application of specific requirements for heating systems as included in the recast of the Directive.

The present paper is an introduction to CEN standard EN 15316-1, the framework of a set of standards for space heating and domestic hot water systems (EN 15316-1, 2-1/2, 3-1/2/3, 4-1/.../7). It provides an explanation of the general structure of Part 1 of the Standard, giving more detailed information on the input and output data and providing links with other CEN standards.

1 > Scope of the standard

Due to the complexity of the issue and the number of sub-systems, a set of standards was developed which, taken together, specifies a calculation method for the determination of system energy requirements and system efficiencies of space heating systems and domestic hot water systems. Part 1 of the standard provides a framework for these standards.

It specifies the structure that should be used for the calculation of energy use in space heating systems and domestic hot water systems in buildings. The calculation methods facilitate the energy analysis of the different sub-systems of the heating system, including control (emission, distribution, storage, generation), through determination of the system energy losses and the system performance factors. This performance analysis permits the comparison between sub-systems and makes it possible to monitor the impact of each sub-system on the energy performance of the building.

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Calculations of the system energy losses of each sub-system of the heating system are defined in subsequent standards (EN 15316 parts 2-4). The system thermal losses, the recoverable system thermal losses and the auxiliary energy of the sub-systems of the heating system are added together. The system thermal losses of the heating system contribute to the overall energy use in buildings (EN 15603).

The energy performance of the generation sub-system is not covered in detail in this European Standard, but is directly taken into account in EN 15603.

2 > Principle of the method

The calculation method for determining the system thermal losses of a technical building system is based on an analysis of the following sub-systems of the space heating and domestic hot water systems:

— energy performance of the emission sub-system, incl. control;

— energy performance of the distribution sub-system, incl. control;

— energy performance of the storage sub-system, incl. control;

— energy performance of the generation sub-system, incl. control (e.g. boilers, solar collectors, heat pumps, cogeneration units).

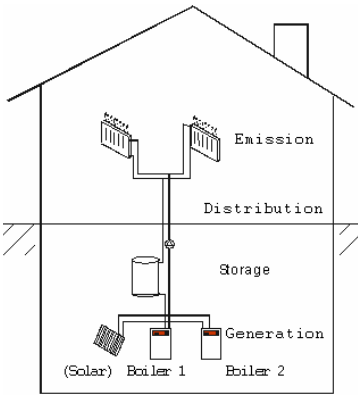

Figure 1:
Input and output data for technical building system i, sub-system j

The storage sub-system can be included in the generation sub-system or detailed separately as the storage sub-system. In the EN 15316-4 standards, the storage sub-system and buffer tanks are taken into account in the generation sub-system. This structure is similar to the physical structure of heating systems (see **figure 1**).

For each subsystem an energy balance is achieved, taking into account energy inputs, energy outputs, system thermal losses, auxiliary energy and recoverable system thermal losses. **Figure 2** illustrates the energy flows for a sub-system.

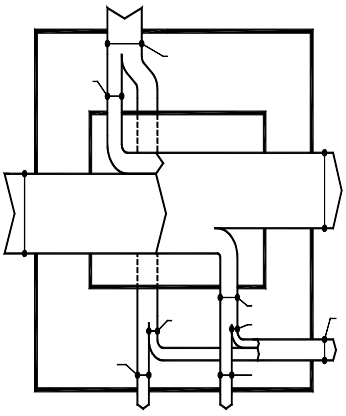

Figure 2:
Input and output data for technical building system i, sub-system j

Based on these data, the calculation results for the sub-system shall comprise:

- energy inputs: energy carrier, thermal energy, electrical energy;
- energy outputs: thermal energy, electrical energy;
- system thermal loss;
- auxiliary energy;
- recoverable system thermal loss.

Calculations may be based on tabulated values or may use values calculated in a more detailed analysis.

3 > Description of the method

Calculation period

The objective of the calculation is to contribute to the evaluation of the annual energy use of the space heating and domestic hot water systems. If there is seasonal heating in the building, the year should at least be divided into two calculation periods, i.e. the heating season and the rest of the year.

Operating conditions

The complexity of the systems considered has to be taken into account by the system designer, through selection and adaptation of the calculation methods. Some guidance on this is provided in Annex C of the standard.

The different parts of EN 15316 contain different methods or indications for the determination of the operating conditions. Several alternative methods may be used to determine the operating conditions. This approach may also be applied to obtain data on the heat contribution of different heat generators in multi-generator installations.

The method(s) selected the relevant input parameters and how to link these methods to determine the energy performance, will be stipulated in a national annex.

Energy performance indicators of space heating and domestic hot water systems or sub-systems

Efficiency is a dimensionless term used to indicate the effectiveness of a technical building system. Efficiencies make possible a practical and straightforward comparison of the effectiveness of systems or sub-systems, of different types and/or of different sizes.

The energy efficiency of a sub-system defined in this standard uses primary energy in the ratio. The energy conversion factor that is used to calculate primary energy will be specified at a national level. Information is provided in EN 15603.

The efficiencies can be calculated per sub-system (e.g. distribution efficiency, emission efficiency, generation efficiency). The global efficiency of the entire system should be calculated after summing up the system thermal losses and the energy supplies for all relevant sub-systems.

Another way of expressing the energy performance of a system or sub-system is the expenditure factor. This expression is the reciprocal value of the efficiency.

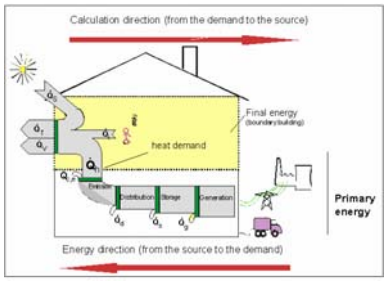

Figure 3:
Energy flow and calculation direction

Energy calculation for a space heating and domestic hot water system

The calculation direction goes from the energy needs to the source (e.g. from the building energy needs to the primary energy). The calculation direction is the opposite of the energy flow in the system (see **figure 3**). The calculation is structured according to the components of the heating system (emission, distribution, storage, generation).

For each sub-system, its system thermal loss is calculated and added to its heat output, to determine its required heat input. The auxiliary energy is calculated separately (if there is one) and contributes to the energy losses of the sub-system.

A distinction is made between:

- those parts of the system thermal losses that are recoverable for space heating;
- those parts of the system thermal losses that are recovered directly in the sub-system and which are therefore subtracted from the system thermal losses of the sub-system.

The recoverable system thermal losses for space heating are input values for EN ISO 13790 [2] and EN 15603, in which the recovered system thermal loss for space heating is to be calculated. Two different approaches may be chosen, either the holistic or the simplified approach (see also IP 95)

The system thermal losses recovered in the sub-system (heat recovery) improve the performance of the sub-system, e.g. stack losses that are recovered for preheating the combustion air, water cooled circulation pumps where the cooling water is the distribution medium.

Simplified and detailed methods for the calculation of system energy losses

For each sub-system, simplified and/or detailed calculation methods for determination of system energy losses may be available (according to current technical knowledge and what standards available) and may be applied according to the accuracy required.

The level of detail can be classified according to the following:

Level A — Losses or efficiencies are given in a table for the entire space heating and/or domestic hot water system. Selection of the appropriate value is made according to the typology (description) of the entire system.

Level B — For each sub-system, losses, auxiliary energy or efficiencies are given as tabulated values. Selection of the appropriate value is made according to the typology (description) of the sub-system.

Level C — For each sub-system, losses, auxiliary energy or efficiencies are calculated. The calculation is performed on the basis of the dimensions of the system, its duties, loads and any other data, which are assumed to be constant (or averaged) throughout the calculation period. The calculation method may be based on physics (detailed or simplified) or on correlation methods.

Level D — Losses or efficiencies are calculated by means of dynamic simulations, taking into account the time history of variable values (e.g. external temperature, distribution water temperature, generator load).

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:

- energy input;
- energy output;
- system thermal losses;
- recoverable system thermal losses;
- auxiliary energy;

in order to ensure proper links to calculations for the following sub-systems and development of a common structure.

4 > FAQ

What is the specific use of the EN 15316 standard, when EN 15603 covers the overall energy use?

The set of EN 15316 standards defines only the performance of heating systems, which are to be included in the overall energy performance defined by EN 15603. By splitting up the overall energy performance, it is possible to identify the strong and weak points in the global performance of a building, so that minimum requirements can also be set up for a sub-system (e.g. heat distribution).

Why does EN 15316 not take into account heat generation?

In order to be coherent with the structure defined in EN 15603 and to enable a direct reference to EN 15316-1, heat generation is not taken into account in the sum of the system losses.

Nevertheless the methodology described in EN 15603 also makes it possible to define performance indicators which take into account the heat generation, in order to evaluate the whole heating system.

5 > References

1. EN 15603 Overall energy use and definition of energy ratings
2. EN ISO 13790 Calculation of building energy use for space heating and cooling

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