# EPB standard EN ISO 52016: Calculation of the building's energy needs for heating and cooling, internal temperatures and heating and cooling load



DICK VAN DIJK
MS Applied Physics,
Senior advisor TNO
Team leader set of EPB standards related to CEN/TC 89
Project leader EN ISO 52003, EN ISO 52016 and EN ISO 52017
dick.vandijk@tno.nl

MARLEEN SPIEKMAN
Msc Civil Engineering
TNO, Heat Transfer and Fluid Dynamics; team EPB
Co-team leader EPB standards related to CEN/TC 89
marleen.spiekman@tno.nl

LINDA HOES - VAN OEFFELEN
MSc Built Environment (Building physics)
TNO, Heat Transfer and Fluid Dynamics; team EPB
Co-team leader EPB standards related to CEN/TC 89
linda.hoes@tno.nl

**EN ISO 52016-1 presents a coherent set of calculation methods at different levels of detail, for the (sensible) energy needs for the space heating and cooling and (latent) energy needs (de)humidification of a building and/or internal temperatures and heating and/or cooling loads, including the influence from technical buildings systems, control aspects and boundary conditions where relevant for the calculation. EN ISO 52016-1 is currently in a final drafting stage.**

**Keywords**: energy performance of buildings, EPB, EPB regulations, heating need, cooling need, thermal balance, indoor temperature, heating load, cooling load.

Following CEN Mandate M/480 [1] a comprehensive series of European (CEN) and international (CEN & ISO) standards is at an advanced stage of development. The series is called the "set of EPB standards" and aims at the international harmonization of the methodology for the assessment of the overall and partial energy performances of buildings. The first issue of the 2015 REHVA journal focused on the EPB standards. Article [2] contained a broad overview of the subset of EPB standards on the energy use and the thermal performance of buildings and building elements.

This article provides further information on one of this subset, namely the standard EN ISO 52016-1, which is being developed in ISO/TC 163/SC 2/WG 15.

EN ISO 52016-1 [3], accompanied by the technical report CEN ISO/TR ISO 52016-2 [4], contains a (new) simplified hourly calculation method and a monthly calculation method for the calculation of the (sensible) energy need for heating and cooling and the (latent) energy need for (de)humidification. This standard cancels and replaces EN ISO 13790:2008.

Additional applications covered in the hourly method of EN ISO 52016-1, with specifically adapted boundary conditions, simplifications and input data, are:

– calculation of internal temperatures, e.g. under summer conditions without cooling or winter conditions without heating;

– calculation of design heating or cooling load.

The calculations are done per so called "**thermal zone**", a concept that is introduced in EN ISO 52000-1 [6]. It is up to national or regional choice to calculate different zones separately or thermally coupled. The main reasons for choosing for uncoupled zones is the lack of reliable input data on the heat exchange properties (thermal transmission, air circulation and ventilation) between zones plus the impact of variable user behaviour.

The effect of specific system properties can also be taken into account, such as the maximum heating or cooling power and the impact of specific system control provisions. This leads to **system-specific** loads and needs.

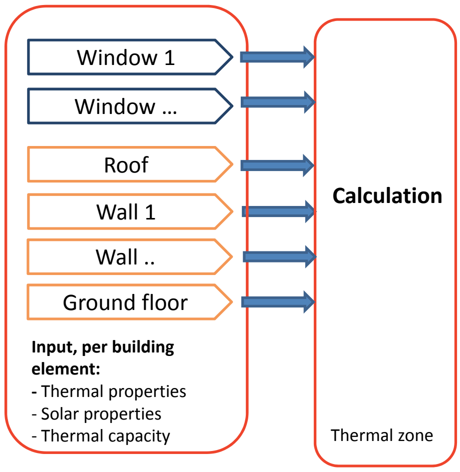
## Hourly versus monthly calculation method

The hourly and the monthly method in EN ISO 52016-1 are closely linked: they use as much as possible the same input data and assumptions. And the hourly method produces as additional output the key monthly quantities needed to generate parameters for the monthly calculation method. This means that a number of (nationally) representative cases can be run with the hourly method and from the key monthly quantities the monthly correlation factors can be derived (see [2]).

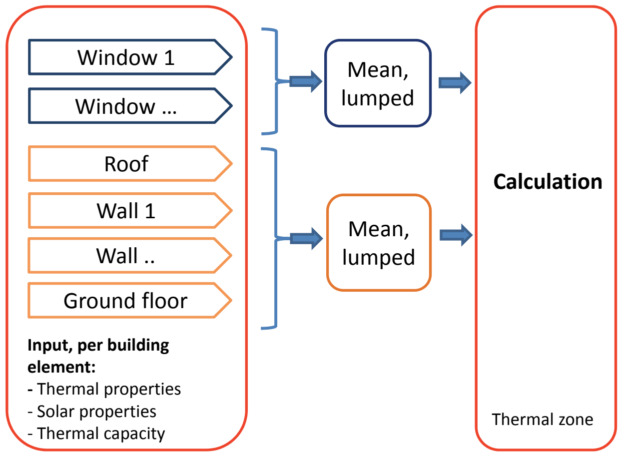
This article focuses mainly on the hourly calculation method.

With the hourly calculation method, the thermal balance of the building or building zone is made up at an hourly time interval. The method is a specific application of the generic method provided in EN ISO 52017-1 [5].

The hourly method in EN ISO 52016-1 is more advanced than the simplified hourly method given in EN ISO 13790:2008. The main difference is that the building elements are not aggregated to a few lumped parameters, but kept separate in the model. This is illustrated in **Figure 1**.




a) Improved hourly method (and similar for monthly method) in EN ISO 52016-1




b) Simplified hourly method in EN ISO 13790:2008

**Figure 1.** Improved hourly method in EN ISO 52016-1 (b) compared to simplified method in EN ISO 13790:2008 (a).

This makes the method more transparent and more widely usable, e.g. because:

- there is no worry about how to combine e.g. the heat flow through the roof and through the ground floor, with their very different environment conditions (ground temperature and ground inertia, solar radiation on the roof);
- the thermal mass of the building or building zone can be specified per building element and there is no need for an arbitrary lumping into one overall thermal capacity for the building or building zone;
- the mean indoor surface temperature (mean radiant temperature) can be clearly identified and distinct from the indoor air temperature.

Only the standard writers will have to introduce extra data: hourly operation schedules and weather data. On the other hand, the standard writers don't need to prepare tables with pre-calculated factors (on operation of blinds, effect of solar shading, etc.).

The main goal of the hourly calculation method compared to the monthly method is to be able to take into account the influence of hourly and daily variations in weather, operation (solar blinds, thermostats, heating and cooling needs, occupation, heat accumulation, etc.) and their dynamic interactions for heating and cooling. This limited goal enables to avoid the need for extra input to be supplied by the user compared to the monthly calculation method (with national/regional options for slightly more detailed data).

The hourly climatic data are given in EN ISO 52010-1 and the hourly and daily patterns of the conditions of use (operating schedules) are given in the relevant other EPB standards.

## Unambiguous but flexible

All EPB standards follow specific rules to ensure overall consistency, unambiguity and transparency.

All EPB standards also provide a certain flexibility with regard to the methods, the required input data and references to other EPB standards, by the introduction of a normative template in Annex A and Annex B with informative default choices. Also EN ISO 52016-1 offers different options, at various levels, that are open for choice at national or regional level. This enables to take into account differences due to national or regional climatic conditions, regulatory context and policies, building tradition and status of technology (current, for new buildings; and past, for assessing existing buildings). This is particularly important because of the application in the context of building regulations, e.g. for energy performance (EP) rating, EP certificates and EP requirements. See also the parallel article on EN ISO 52003.

## Validation

In line with the common template for all EPB standards, a spreadsheet has been prepared for demonstration and validation. This spreadsheet shows an overview of all input variables, the hourly and monthly calculation procedures and an overview of all output variables.

In the previous REHVA Special on the EPB standards [2] the many links of EN ISO 52016-1 with other EPB standards were introduced. Special attention in this respect has been paid to testing the link with the procedures to calculate the thermal transmission through the **ground floor**, taking into account the inertia of the ground. These procedures are given in EN ISO 13370 [7], for monthly or seasonal calculation methods, but also for hourly calculation methods (based on dynamic simulations as described in [8]). Because of the dynamic, time dependent interactions, these procedures were also integrated in the spreadsheet for EN ISO 52016-1. With minor adaptations in EN ISO 13370 compared to the current published version, the calculation procedures of EN ISO 13370 have been proven to work as intended as input for the monthly and hourly building calculations of EN ISO 52016-1.

The hourly calculation procedures on the **thermal zone** level have been validated by using relevant cases from the so called BESTEST series. The BESTEST cases are well established since decades (several IEA ECBCS annexes and IEA SHC tasks), widely used worldwide, well described (e.g. ASHRAE 140, [9]) and regularly extended with additional cases. The successive series of test cases are also very powerful as diagnostic tool. Renowned institutes participate in the set-up of the test cases. The calculation results of several renowned software tools are available for comparison. Examples of input data for BESTEST cases are available for several building simulation tools and within different ICT environments.

The "drawback" of the BESTEST series is that there is no single reference "true" result and no acceptance criteria. The hourly calculation procedures in EN ISO 52016-1 are fully described ('prescribed'). This means that the results of the test cases should be the same for all users, if the same input data and boundary conditions are used. So there is no need to validate application of EN ISO 52016-1. As a consequence, the test cases and the results are presented in the standard, not to validate the method, but to enable a verification by others (e.g. software developers).

Of course, as part of the development of this standard, it is interesting to compare the results with the results available from the renowned software tools; some results are presented below.

The same BESTEST cases are also used for the validation of the procedures in EN ISO 52010-1, to calculate the distribution of solar radiation on a non-horizontal plane based on measured hourly solar radiation data on a horizontal surface. These results are presented in a parallel article. The results of that calculation, the hourly irradiation at vertical planes of different orientation, are input for the validation tests of EN ISO 52016-1.

The selected BESTEST cases with case identifier:

| **Case identifier** | Continuous heating and cooling | Intermittent heating and cooling | No heating and cooling (free float) |
|---|---|---|---|
| Lightweight construction | 600 | 640 | 600FF |
| Heavyweight construction | 900 | 940 | 900FF |

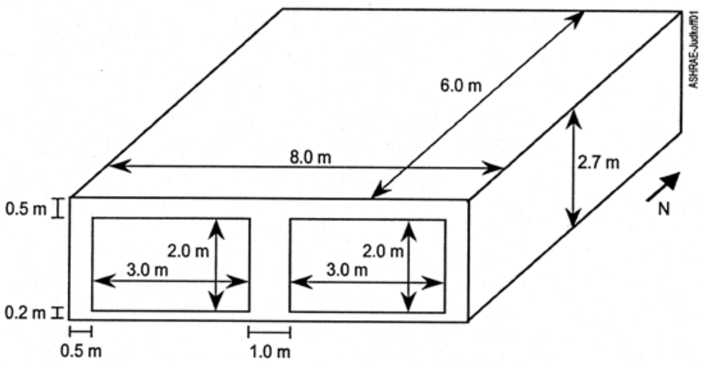



**Figure 2.** BESTESTS: Geometry of the test room.

Note that the selected BESTEST test cases do not include for instance:

- Ground floor heat transfer coupled to ground.
- Thermal coupling between two or more zones.
- The effect of thermal bridges.
- Sunspace or other thermally unconditioned spaces.
- Solar shading by external obstacles (distant, remote or from own building elements).
- Complex control patterns (e.g. weekend interruption of mechanical ventilation and/or heating and cooling and/or solar shading, etc.; night time ventilation as free cooling, heat recovery by pass, …)

The ground floor heat transfer was tested separately, as described above. In the selected BESTEST cases the heat transfer is decoupled from the ground. The other features may be tested analytically or require dynamic links with system related calculation standards.

The composite **Figure 3** provides the main results of the Case 600 and 600FF.

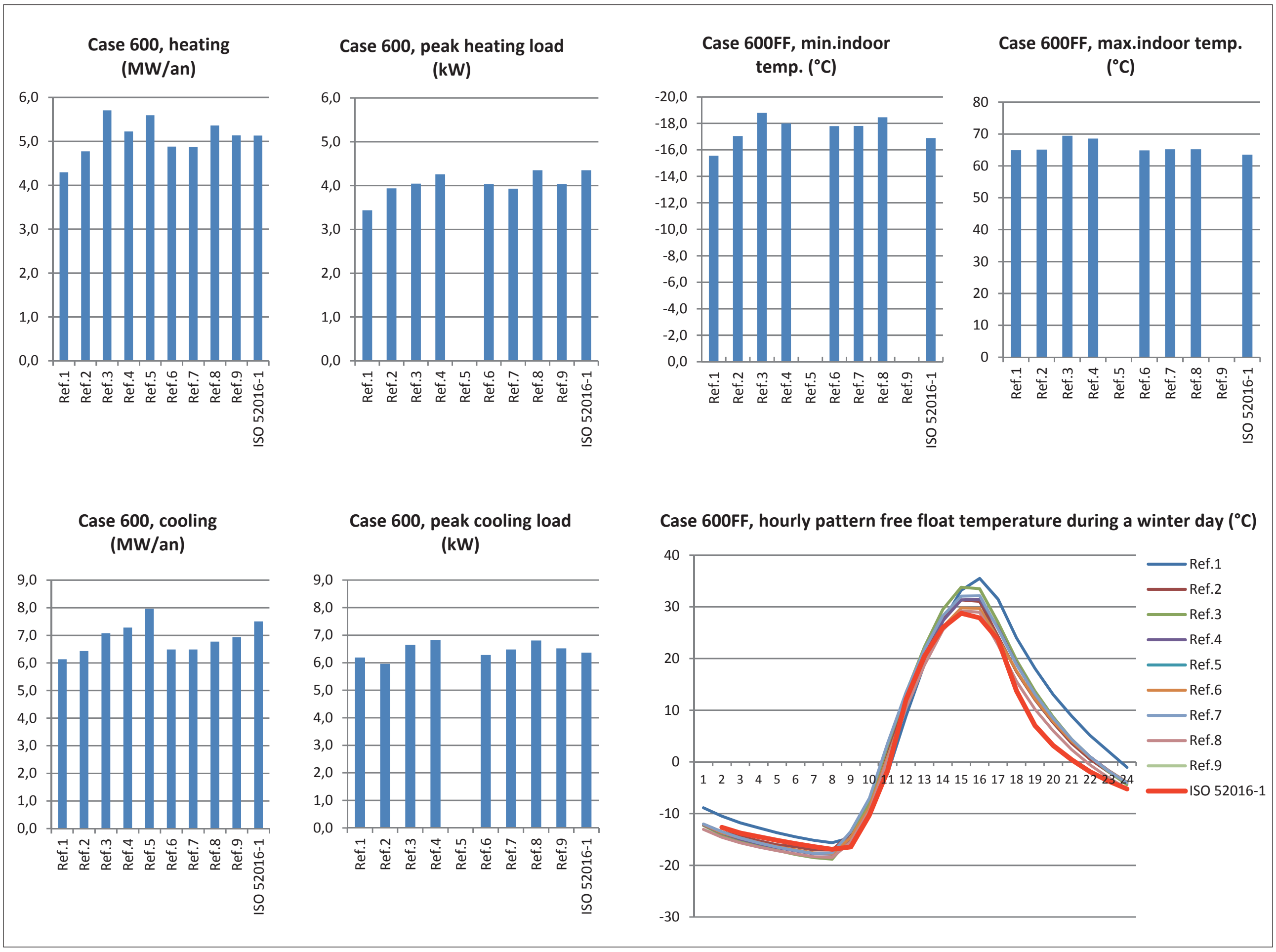



**Figure 3.** BESTESTS: Main results for Case 600 and 600FF, EN ISO 52016-1 compared with the available 9 reference tools.

Note that the climate is Denver (Col., USA), with quite cold but sunny winter and warm and sunny summer.

It also has to be taken into consideration that not each software program whose results are available for the comparison use nowadays state-of-the-art algorithms (in that sense these are not reference results). This is because these base cases of the BESTEST series were created and tested many years ago.

The technical report CEN ISO/TR ISO 52010-2 provides background information, explanation (including examples) and justification (including more validation cases).

## Conclusion

EN ISO 52016-1, currently in a final drafting stage, presents a coherent set of calculation methods at different levels of detail, for the (sensible) energy needs for the space heating and cooling and (latent) energy needs for (de-)humidification of a building and/or internal temperatures and heating and/or cooling loads, including the influence from technical buildings systems, control aspects and boundary conditions where relevant for the calculation.

Choices are possible at national or regional level to accommodate the specific national or regional situation.

The new hourly calculation method is more powerful than the simplified method in its predecessor EN ISO 13790:2008. It still requires no more input data from the user than the monthly method. The method has been successfully validated using relevant BESTEST cases.

More information will become available in the accompanying technical report, CEN ISO/TR 52016-2 [4]. ■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[7] EN ISO 13370, Thermal performance of buildings — Heat transfer via the ground — Calculation methods (in preparation; submission of FDIS to final ballot expected in 2016).

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[9] ANSI/ASHRAE standard 140, Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs, 2014.