www.asiepi.eu

Stimulation of better summer comfort and efficient cooling by EPBD implementation

"Summer comfort and cooling in the energy performance calculation methods"

Dirk Van Orshoven
BBRI – Belgian Building Research Institute
February 2010

Disclaimer.

The information contained in this report is based on the information known by the authors at the time they delivered the information. It must also be noticed that, in some countries, the legal framework is still under development and therefore is evolving quite quickly. While this document is believed to contain correct information, the authors makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information disclosed.

ASIEPI has received funding from the Community's Intelligent Energy Europe programme under the contract EIE/07/169/SI2.466278.

The sole responsibility for the content of this publication lies with the authors. It does not necessarily reflect the opinion of the European Communities. Neither the European Commission nor the authors are responsible for any use that may be made of the information contained therein.

Table of contents

1 Introduction

This report discusses the information collected in [1]. This analysis is also published on a wide scale as part of Information Paper P163 [2], which also includes information on any requirements with respect to overheating and cooling in different European countries.

Complementary to this report, which focuses on the details of the input data in calculation procedures, a more global, qualitative description of the major methods in the different countries is given in [3]. The reader is advised to consult that report in conjunction with the present one in order to obtain a more complete picture.

2 Survey method

Until recently, the focus of many EPB-regulations and much standardisation work has more strongly been on the energy consumption for space heating. However, in recent years growing attention is being given to the aspect of summer comfort (if possible without active cooling) or to the energy consumption caused by cooling. Nevertheless, it is clear that, generally speaking, the methods for summer comfort and cooling are not yet as advanced as the methods for space heating, where several decades of operational experience have led to proven and mature calculation methodologies and requirements.

In the framework of the IEE-ASIEPI project an inventory has been made of the state of the following aspects in the EPB-regulations of several European countries:

- the way in which the energy consumption for cooling is calculated
- the way in which summer comfort is evaluated, if at all

The observations that can be made are described in this report. The following countries have been surveyed: Belgium, Germany, Spain, France, Greece, Italy, the Netherlands, Poland (state in the summer of 2008), and in a second round additionally Hungary, Ireland, Lithuania, Romania and UK (state in the winter of early 2009). Sometimes the answers referred to draft calculation procedures or legislations that were not yet in force.

There were no Scandinavian countries in the survey, as it was thought beforehand that cooling and overheating were not an issue in this climate. Nevertheless, these countries afterwards orally reported that summer comfort is becoming a growing point of attention in this region too. They attribute this to different factors: larger glazing areas in recently constructed buildings, the mild outdoor summer temperatures that lower the acceptable indoor comfort temperature for overheating (adaptive comfort) and the long summer days with low solar positions generate a lot of solar gains.

It goes without saying that the EPB-regulations in the different countries are still in full change. This is all the more true for a relatively new domain such as summer comfort and cooling. This paper therefore gives only a snapshot of a rapidly evolving situation.

During the survey, it has been observed that a lot of misunderstandings occurred among the different countries when exchanging information. Although this is a more general experience when exchanging international experiences with respect to the EPBD, the problem proved to be particular difficult for cooling. In part, this can be ascribed to the fact that until recently there was little international standardisation that provided common concepts and uniform terminology. It is hoped that as the sector gradually becomes more familiar with the new European standards, this communication problem will become less severe.

3 Calculation methods: cooling

This paragraph gives a succinct overview of the situation in the different countries at the time of the enquiry. The inventory has focussed on the variables that enter as input in the calculation methods: these determine the degree of design freedom and the stimuli that the EPB-regulation generates.

3.1 General features

At the time of the enquiry 9 out of 13 countries reported to have already an EPB-regulation in place. Countries without were mostly situated in southern and eastern Europe, but most of them were working intensely on the preparation of a regulation. In the remainder of this chapter only the 9 countries with an EPB-regulation will be considered. In a few instances, the EPB-regulation related only to housing but not (yet) to (all) non-residential buildings, or vice-versa.

In line with the EPBD, in the 9 countries with a regulation, the consumption for cooling is always taken into consideration, albeit sometimes in an incomplete way or in a manner that is to a greater or lesser extent simplified. Monthly calculations were used in 5 cases, hourly in 4. Each time, the same method (monthly or hourly) is used for both the building and the system calculations.

Only in 2 out of the 9 countries is the EPB-requirement relaxed if cooling is applied, i.e. an extra allowance for the cooling is provided. In the other countries, the extra consumption for cooling must thus be compensated by better energy efficiency in other areas such as heating, lighting, etc.

In 4 countries there is some form of fictitious cooling consumption considered if no active cooling system is installed, e.g. in the instance when the risk of overheating is considered to be too high. This may be a sort of anticipation that active cooling could be installed later in the course of the building life cycle when the overheating problems manifest themselves. Ref. [4] gives an English description of the method as applied in Belgium. By already including such fictitious cooling from the start, designers are stimulated to pay proper attention in each and every one of their projects to the summer behaviour of the building.

3.2 Calculation methods: energy needs

The input variables in the 9 countries are as follows:

- thermal mass: all countries consider sensible heat storage, albeit sometimes in a simplified manner. But none includes latent heat storage (through phase change materials) as yet.
- solar irradiation: apart from 1 country, all determine direct, diffuse and ground reflected radiation separately.
- solar gains through transparent envelope components: obviously, the g-value of the glazing, the area, slope and orientation of the windows and the shading by fixed objects are (quasi) always considered. All 9 countries also report that solar protection devices, both mobile and fixed ones, are taken into consideration.
- solar gains through opaque envelope components: 5 countries report that these are (partly) taken into account, e.g. for non-residential buildings and/or roofs only. In such instances, the absorptance and U-value are usually input variables (but sometimes the absorptance is fixed).
- transmission heat transfer: only 2 countries report that the calculation is different between winter and summer calculations. In Belgium, in the case of a simple penalisation of thermal bridges, the default value (which as a matter of principle is always negative) is different: high in winter, zero in summer. In the Netherlands, the ground losses are treated differently in winter and summer.
- heat transfer through the hygienic ventilation system: only 5 countries report that air handling units are calculated on the basis of a separate heat balance, although obviously this is physically important. If calculated by itself, sensible and latent cooling and reheat are then generally considered in detail. In both these and in the other countries, heat exchanger by-passing, direct or indirect evaporative cooling, night-time operation or ground heat exchangers are only occasionally considered.
- heat transfer through intensive ventilation: although this is a major means of removing excess heat (only at night on hot days, both during the day and

at night on mild days), only 4 countries report to have it in the calculation method, but mostly in a strongly simplified, nearly fixed manner. Only France includes detailed input variables such as the area of the (supply and evacuation) openings (or stacks) and their flow characteristics, and mechanical extraction (including its electricity consumption).

- heat transfer through in/exfiltration: usually the airtightness is considered when calculating the consumption for cooling, and generally speaking a measurement of the airtightness can then serve as an input (instead of a default or estimated value). In only 3 countries the default value is reported to be different between heating and cooling calculations. In Belgium for instance, it is 12 $m^3/h/m^2$ of envelope area (i.e. very leaky) for space heating calculations and 0 $m^3/h/m^2$ (i.e. the theoretical limit value of perfect airtightness) for space cooling calculations, in line with the general philosophy of a default value.

3.3 Calculation methods: systems

The great variety of distribution and emission systems is not always included in the method, and if so, often in a simplified manner. Sensible thermal cold storage (e.g. chilled water tanks) is only considered in 2 countries, latent storage (e.g. ice banks) nowhere.

The generation efficiency of a cooling machine is usually included as a matter of principle, but sometimes in a very simplified manner such as a fixed value. Otherwise, a machine dependent EER or SEER is used.

If sorption cooling is considered at all, it is usually only for closed cycles. Open cycles (such as desiccant cycles) are only rarely integrated in the calculation method. In both instances, heat supply with conventional boilers or direct firing, cogeneration or district heating is commonly considered, but solar heating only rarely.

Passive means of centrally (i.e. in parallel with, or fully replacing cooling machines) disposing of excess heat are considered in a very variable manner. Surface water (from river or lake or sea) as natural heat dump is never considered in the standard calculation method. Heat rejection to the ambient air by means of a dry or wet cooling tower is only considered in 2 countries. Only 3 countries consider the ground (by means of ground water, closed-circuit boreholes, heat exchangers in pillar foundations) as heat dump in the standard method. Radiative cooling to the night sky (which is only effective in dessert-like conditions, with clear, dry night skies) is not considered in the calculation method of any European country.

Finally, the auxiliary energy consumed by pumps, fans and control & actuators is generally speaking more or less taken into account.

4 Calculation methods: summer comfort

Of the 9 countries that had an EPB-regulation at the time of the enquiry, 5 reported that the regulation included some kind of evaluation of the summer comfort. But the summer analysis did not necessarily apply to all types of buildings. Usually, an explicit requirement was associated with the analysis. The detailed situation was as follows:

- Belgium:
  - dwellings only (whether with or without air conditioning)
  - a maximum allowable value is imposed
  - if the indicator is in the range between a threshold and the maximum, fictitious cooling consumption is taken into account
- France:
  - all non air-conditioned buildings
  - a maximum allowable value is imposed (namely that of a reference building with reference technological measures)
- Germany (in the form of a “solar gains indicator”):
  - dwellings only
  - a maximum allowable value is imposed
- Ireland:
  - both domestic and non-domestic
  - no maximum, only as indicator
- the Netherlands:
  - dwellings only (whether with or without air conditioning)
  - no maximum, only as indicator
  - there is always fictitious cooling, only depending on the cooling needs, independent of the overheating indicator

In several of these countries, there was work in progress to extend the method, e.g. to all types of buildings.

Apart from a few exceptions, the same variables as for cooling calculations are considered for evaluating the risk of overheating on "room" level. However, none of the countries incorporates as yet passive cooling techniques with a central heat dump (ground, surface water, ambient air through a heat exchanger etc.) in the overheating analysis.

5 Summary and recommendations

5.1 Cooling calculation methods

Although a good deal of attention is already given to the consumption for cooling in the national/regional EPB-regulations, the methods usually cannot fall back on the same decade-long experience and detail that exists for space heating calculation methods in the framework of regulations. Generally speaking, the continued further refinement of the methods is therefore warranted so as to better evaluate the consumption of all possible means of cooling, including and in particular the low energy methods.

By not giving an extra allowance for the maximum allowed primary energy consumption in the case active cooling is applied (as compared to the situation without active cooling), the countries can stimulate that a cooling system as efficient as possible is applied and/or that the extra consumption for cooling is compensated for by extra savings in other domains (heating, lighting, etc.). All but 2 of the surveyed countries report to already follow this approach.

In addition, nearly half of the countries also consider a kind of fictitious cooling in some way or another. In this instance, even though no active cooling is installed, a (fictitious) consumption for cooling will nevertheless be considered, in particular when the risk of overheating is high. This takes into account that cooling may be installed later on during the life cycle of the building. It thus stimulates that also in buildings without active cooling proper attention is given to the summer situation, and that the design does not focus exclusively on minimising space heating needs in winter (through maximising solar gains), to the detriment of summer comfort. The inclusion of fictitious cooling also facilitates the application of the above rule that the EPB-requirement is made independent of whether or not active cooling is installed. It can thus be advised to all countries to consider whether integrating such fictitious cooling could also be productive in their country.

With respect to the calculation procedures, it is important that all aspects that have an impact on the cooling consumption, are integrated in the methods, in particular those variables that can contribute to the reduction of the consumption and that are cost-effective in a given country. Practically speaking, the following techniques are not yet well developed in the calculation in many countries and these techniques may deserve priority attention:

- Intensive ventilation, taking into account the sizing and real performance characteristics of the components (e.g. the flow features of ventilation openings). The new European standards that have been developed in recent years on this topic may provide a good starting base for national procedures.

- Active cooling devices (whether electrically or thermally driven) often still deserve better treatment by the inclusion of real product characteristics in the methods (EER, or better SEER) instead of simple, fixed performance numbers.
- Also, natural, passive cooling is not yet well developed for central heat dumps (thus discharging the cooling machines, or even making them superfluous).
- Further more, a great number of smaller variables are not yet systematically considered in the methods. These should not be forgotten in any future update of methods.

Attention should also be paid to the proper setting of default values, which by nature are on the negative side in most countries. However, what is negative may differ between heating and cooling calculations, and so a differentiated approach is often justified, certainly for the variables that have a major impact, e.g. air tightness and thermal bridges. In this manner, the right rewards continue to be given to proper design choices.

5.2 Evaluation of the summer comfort

About half of the countries surveyed already include some kind of evaluation of the risk of overheating in their EPB-regulation, but none of these countries is a truly Mediterranean country. However, the analysis was rarely systematic for all types of buildings.

It can be recommended that those countries already having an overheating analysis evaluate whether it isn't appropriate to extend it to all buildings (if not yet done so) and to include forms of central passive cooling.

The other countries can be advised to investigate whether an overheating analysis could not be useful for them too. It may be a means to strongly stimulate the attention which is being paid during design to the summer situation. In addition, it will draw attention to the passive cooling means to avoid overheating. Thus, the chance that an active cooling system will be installed later on in the building life cycle, can be reduced, and if it happens nevertheless, the cooling consumption will be much lower if the building has been designed with due attention to the summer situation.

6 References

1. D. Van Orshoven "ASIEPI survey of the EPB-determination methods for cooling and summer comfort." XL-file. See: www.asiepi.eu
2. D. Van Orshoven, Servando Alvarez, "Summer comfort and cooling: calculation methods and requirements." IP 163. See: www.asiepi.eu
3. M. Laskari, M. Santamouris "Evaluation of the calculation methods for summer comfort and cooling" See: www.asiepi.eu
4. A. Van Eycken, D. Van Orshoven, G. Flamant, P. Wouters "Some Aspects Regarding Summer Comfort and Cooling in Belgium" Presented at the international workshop, "Summer comfort and cooling", Barcelona, Spain - 31 March & 1 April 2009. See http://www.asiepi.eu/wp-7-summer-comfort/workshop.html

7 Contributions and acknowledgements

Information on the national situations is provided by Marianna Papaglastra, Marina Laskari and Mattheos Santamouris (NKUA, University of Athens, Greece), Servando Álvarez (Asociación de Investigación y Cooperación Industrial de Andalucia, Spain), Hans Erhorn and Heike Erhorn-Kluttig (Fraunhofer Institute for Building Physics, Germany), Hicham Lahmidi (Centre Scientifique et Technique du Bâtiment, France), Marleen Spiekman and Dick van Dijk (Nederlandse Organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek – TNO, The Netherlands), Michele Zinzi (Italian National Agency for New Technologies, Energy and Sustainable Economic Development – ENEA, Italy), Maciej Mijakowski (NAPE, Poland), Dirk Van Orshoven (Belgian Building Research Institute, Belgium), Patxi Hernandez (Energy Research Group University College Dublin, Ireland), Roger Hitchin (Building Research Establishment, United Kingdom), Andras Zold (University of Technology and Economics, Budapest, Hungary), Raimondas Bliudzius (Institute of Architecture and Construction of Kaunas University of Technology, Lithuania) and Cocora Octavia (Civil Engineering University of Bucharest, Romania).