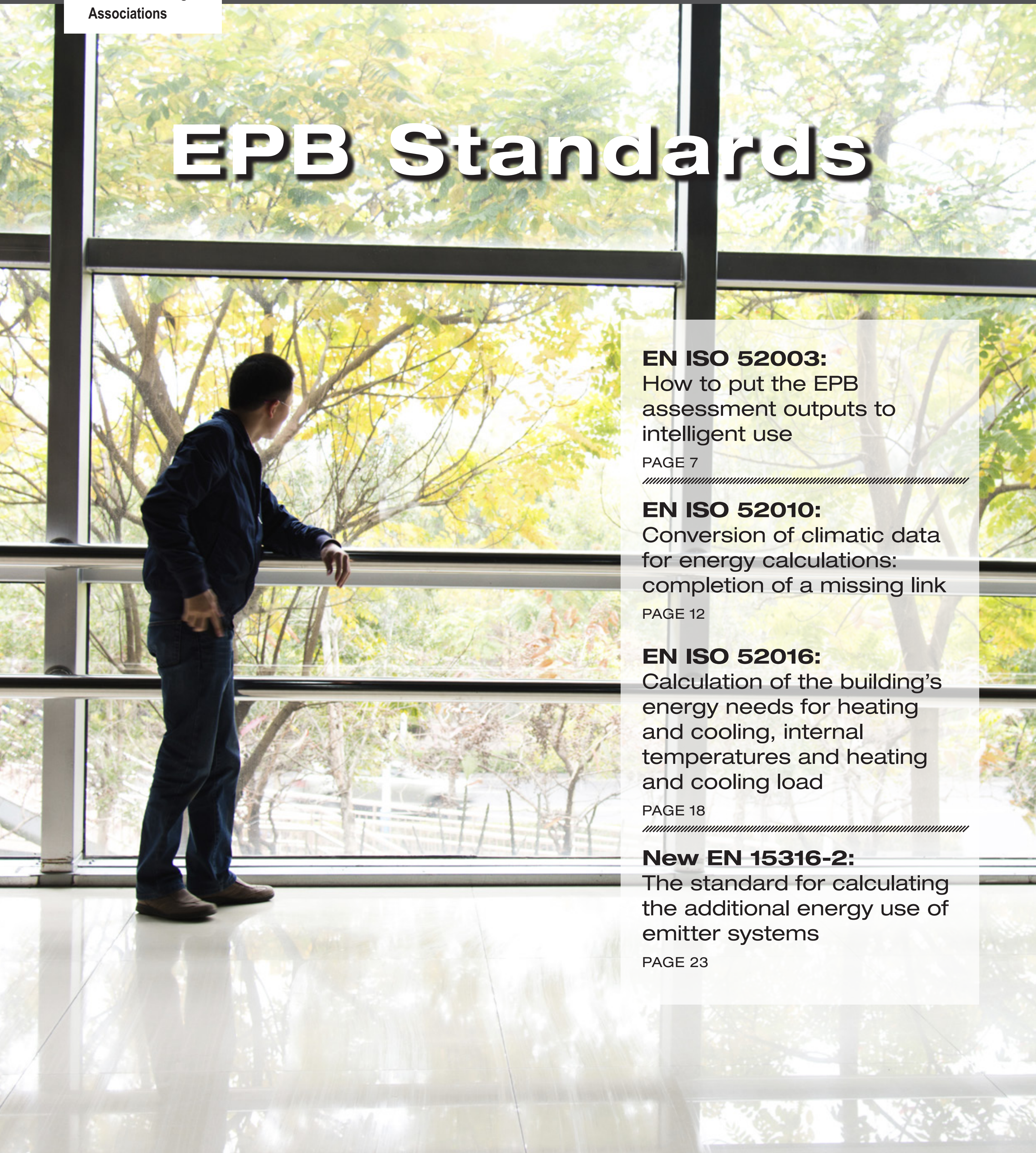
ISSN 1307-3729

REHVA

Federation of European Heating, Ventilation and Air Conditioning Associations

The REHVA European HVAC Journal

Volume: 53 Issue: 3 May 2016 www.rehva.eu



EPB Standards

EN ISO 52003: How to put the EPB assessment outputs to intelligent use
PAGE 7

EN ISO 52010: Conversion of climatic data for energy calculations: completion of a missing link
PAGE 12

EN ISO 52016: Calculation of the building's energy needs for heating and cooling, internal temperatures and heating and cooling load
PAGE 18

New EN 15316-2: The standard for calculating the additional energy use of emitter systems
PAGE 23

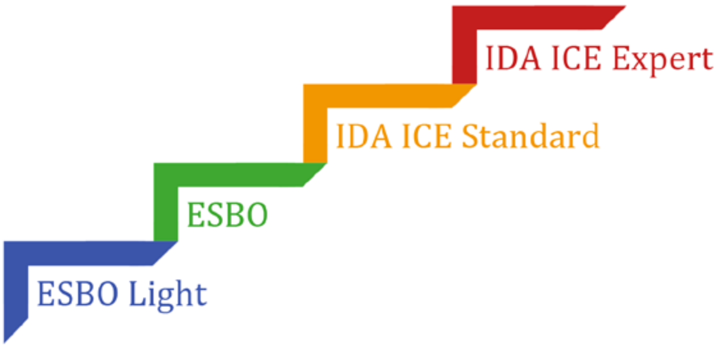
EUROPEAN SOLAR-SHADING ORGANIZATION

Energy Savings & Comfort

Solar shading - from component to concept

Saving energy and costs	Increasing comfort, health, productivity and wellbeing
For cooling	Maximize natural daylight
For heating	Keep the full colour rendering of transmitted light
For artificial lighting	Reduce glare and filter daylight
	Reduce overheating

Building simulation made easy



EQUA
SIMULATION TECHNOLOGY GROUP

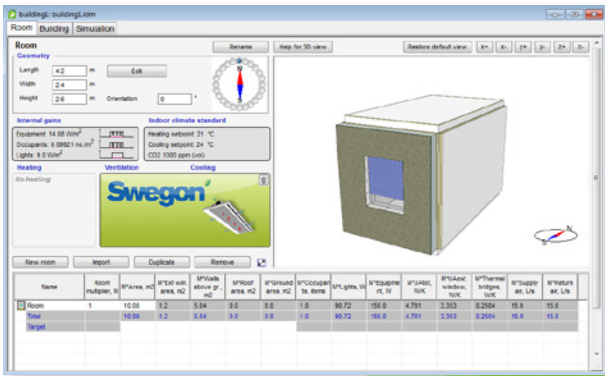
Swegon

Swegon**ESBO**

will aid you during the whole process, from prospect to the finished building, supporting you to deliver the best indoor climate.

Some of the unique functions are:

- Room templates with prepared solutions offer a quick start for your calculations
- Connection to the Swegon product selection tool - ProSelect
- Calculate demand controlled ventilation with all the surrounding factors



We make every breath count.

The REHVA European HVAC Journal

www.rehva.eu

Volume: 53 Issue: 3 May 2016

Editor-in-Chief: Jaap Hogeling
jh@rehva.eu

Associate Editor: Stefano Corgnati, Italy
stefano.corgnati@polito.it

General Executive: Süleyman Bulak

Editorial Assistant: Chiara Girardi

ADVERTISEMENTS
Ms Chiara Girardi, cg@rehva.eu

SUBSCRIPTIONS and CHANGES OF ADDRESSES
REHVA OFFICE:
Washington Street 40
1050 Brussels, Belgium
Tel: 32-2-5141171, Fax: 32-2-5129062
info@rehva.eu, www.rehva.eu

PUBLISHER
TEKNİK SEKTÖR YAYINCILIĞI A.Ş.
Balmumcu, Barbaros Bulvarı Bahar
Sk. Karanfil Apt. No:2/9
Beşiktaş /İstanbul, Turkey

Cover photo: iStockphoto

Contents

Download the articles from **www.rehva.eu** -> REHVA Journal

EDITORIAL

5 Set of EPB standards out for formal vote at CEN and ISO level, a step closer to more reliable and transparent EPB declarations
Jaap Hogeling

ARTICLES

7 EPB standard EN ISO 52003: How to put the EPB assessment outputs to intelligent use
Dirk Van Orshoven & Dick van Dijk

12 EPB standard EN ISO 52010: Conversion of climatic data for energy calculations: completion of a missing link
Wim Plokker & Dick van Dijk

18 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, Marleen Spiekman & Linda Hoes - van Oeffelen

23 The new EN 15316-2: The standard for calculating the additional energy use of emitter systems
Joachim Seifert & Martin Knorr

24 Calculation of the energy performance of ventilation and cooling systems
Gerhard Zweifel

28 Energy performance assessment of district energy systems
Boris Lubinski

30 Why is it important to have a standard on Indoor Environmental Quality as part of the EPB standards?
Bjarne W. Olesen

32 Estimation of energy requirements for lighting in buildings
Lou Bedocs & Sohéil Moghtader

35 Heating control – Main control functions are standardised, how to apply these functions?
René Cyssau

40 Contribution of CEN/TC247 Building Automation and Control (BAC) for EPB standards
Jean Daniel Napar, Roland Ullmann & Klaus Waechter

43 About the contribution of BAC and BMS to energy performance of buildings
Clemens Felsmann

46 Industry perspective on the holistic approach to buildings
Drake H. Erbe

49 The Ecodesign Preparatory Study on Smart Appliances
Koen Vanthournout & Sarah Bogaert

52 NZEB 2.0: interactive players in an evolving energy system
Roberta D'Angiolella, Maarten de Groote & Mariangiola Fabbri

56 Nearly Zero Energy Buildings in reality, not just theory
Robert Cohen, Paul Bannister & Bill Bordass

60 The road to energy efficient buildings through the eyes of environmental NGOs
Friedemann Stelzer & Christoforos Spiliotopoulos

62 **EU POLICY NEWS**

64 **NEWS**

70 **REHVA WORLD**

73 **PRODUCT NEWS**

78 **PUBLICATIONS**

80 **EVENTS**

Advertisers

- ✓ ES-SO, Swegon, Equa ....Front cover interior
- ✓ GSHP project............................ 4
- ✓ Friterm 6
- ✓ Rettig 11
- ✓ Rhoss...................................... 17
- ✓ Eurovent Certita Certification ... 27
- ✓ DencoHappel 33
- ✓ Lindab...................................... 39
- ✓ WSED 2017.............................. 67
- ✓ LG Electronics.......................... 69
- ✓ Belimo..................................... 72
- ✓ Swegon 79
- ✓ Sustainable Building Alliance..Back cover interior
- ✓ REHVA Guidebooks .....Back cover

Next issue of REHVA Journal

Instructions for authors are available at **www.rehva.eu**
(> Publications & Resources > HVAC Journal > Journal information)

Send the manuscripts of articles for the journal
to Jaap Hogeling **jh@rehva.eu**

WS 16: How to make cheaper GSHPs in Europe? How to diffuse GSHPs in Europe?

Date: Tuesday, May 24th, 15.00 – 16.30, Meeting room: Latinerstuen

Workshop organizer
EU H2020 Cheap-GSHPs Project

www.cheap-gshp.eu

Presenters
Chair: Prof. Michele De Carli, Ph.D. — **University of Padova, Italy**
Co-chair: Prof. Robert Gavriliuc, Ph.D. — **Romanian Geoexchange Society**

BACKGROUND

The market of heat pumps in Europe is increasing. Even though the most efficient solution is represented by GSHP, air-to-water heat pumps are mostly used in residential and commercial buildings, due to the lower investment costs.

Hellicoidal heat exchanger

SCOPE

Based on the experience of the speakers and based on the recent work begun in the Horizon 2020 European Project "Cheap-GSHPs" the workshop's intent is to show the recent advances in the frame of the drilling and in the heat pump solutions to improve the market of the GSHPs.
Discussion will be driven on current limits and potential of the GSHPs. In particular the discussion will be on the possible introduction of a CEN standard committee or working group on the GSHP systems.

ATTENDEES

Legislators, market surveillance authorities, building owners, energy managers, Installation and design professionals of HVAC systems, drillers, HVAC System Maintenance, academics with an interest in this area.

Programme

1. **Market of GSHP's, costs and potentialities.**
Fabio Poletto - Galletti Group, Italy
2. **Technical aspects related to the ground and the drilling.**
David Berterman - University of Erlangen, Germany
3. **CHEAP GSHPs project: presentation and aim of the H2020 project**
Luc Pockele - RED, Italy

Drilling machine

Discussion topic

- How can we improve the techniques for drilling? (10 minutes)
- How can we help designers and final users? (10 minutes)
- What kind of economic benefits can we introduce in the GSHP sector? (10 minutes)
- Can we find some synergies with other plants/renewables? (10 minutes)
- Discussion on the possible EN standard (10 minutes)

We estimate that the whole amount of time needed to cover the above mentioned topics and to allow time for discussions is around 2 hours.

Set of EPB standards out for formal vote at CEN and ISO level, a step closer to more reliable and transparent EPB declarations

JAAP HOGELING
Editor-in-Chief

In the REHVA Journal of January 2015 the enquiry for these 52 standards have been announced. Until April 2016 all standards have finalised based on the 2014 drafts and the many comments received. All experts and working/task groups did an excellent job to finalise this complex task. Now all standards are in the CEN and ISO system for final editing and translations. This is also valid for the almost. 40 connected technical reports. They all are expected to be published for a formal vote starting in October 2016 (2 months' period). Assuming their acceptance, the set of EPB standards is expected ready for publication by the national standard bodies (NSB's) by the beginning 2017. Meanwhile the NSB's are encouraged to investigate at national level the possible need for national annexes to include national defaults choices and options as described in Annex A of most EPB standards. It is beneficial to start this process at national level based on the current drafts at CEN and ISO level. This will allow the NSB a swift publication of these possible national annexes at the same time the standards are published.

This journal includes 12 articles around several EPB standards. These articles are offering further explanation and very often focussing on the final work done since the enquiry. But also article related these EPB standards about the need for product standards to interlock to the EPB standards, future steps needed to achieve nZEB 2.0, nZEB in reality, and what about smart appliances.

The EU Commission communicated a policy document to the EU parliament an EU Strategy on Heating and Cooling was published (COM(2016) 51) stressing the importance of reducing the energy use for heating and cooling buildings. The now developed set of EPB standards will contribute to the evaluate measures to achieve this reduction.

Reduce the energy need of buildings, apply renewable based and efficient heating and cooling systems. Apply smart technologies and innovative solutions. In numbers the focus is on heating systems but when improving the buildings and adapting to climate change effects energy use of cooling systems will increase. Two thirds of the EU's buildings were built when energy efficiency requirements were limited or non-existent; most of these will still be standing in 2050. The low hanging fruits are simple renovations such as insulating the attic, walls and foundations, and installing double or triple glazing. These are cheapest when they are done in parallel with the HVAC system renovations. The EPB standards support this holistic approach. This in combination with nature-based solutions, such as well-designed street vegetation, green roofs and walls providing insulation and shade to buildings also reduce energy demand by limiting the need for heating and cooling. ■

EPB standard EN ISO 52003: How to put the EPB assessment outputs to intelligent use

Documents EN ISO 52003-1 & -2 describe the relation between the indicators to express the energy performances of buildings (EPB) and the EPB requirements and EPB ratings. These documents provide general insight to private prescribers and public regulators (and all stakeholders involved) on how to make best use of the outputs of the EPB assessment methods. This article gives a brief overview of these documents, which are in a final drafting stage.

Keywords: Energy Performance of Buildings, EPB, EPB regulations, EPB requirements, EPB rating, EPB certificate, EPB indicators, EPB features, EPB tailoring.

DIRK VAN ORSHOVEN
MS Mechanical Engineering
Independent energy engineer
dirk.van.orshoven@skynet.be

DICK VAN DIJK
MS Applied Physics
Senior advisor TNO
dick.vandijk@tno.nl

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 [2] gave a broad overview of these standards. This article provides further information on 1 of them, namely draft EN ISO 52003, which is being developed in ISO/TC 163/WG 4 (joint working group of ISO/TC 163 with ISO/TC 205) and which is due to replace EN 15217:2007 and ISO 16343:2013.

Draft standard EN ISO 52003-1 [3], together with its accompanying draft technical report CEN ISO/TR 52003-2 [4], gives guidance on the main uses that can be made of the outputs (EPB indicators) of the EPB assessment standards, in particular their use for EPB requirements and EPB ratings. This can be called the "post processing" of the results of the EPB assessment. The standard itself (i.e. part 1) lists and clarifies the different steps that still need to be taken in order to make full use of the EPB methodologies. The technical report (i.e. part 2) provides background information supporting these tasks. Due to its overarching nature, EN ISO 52003 is closely linked to the EPB overarching standard, EN ISO 52000-1 [5].

By describing explicitly the different policy making aspects, all parties involved can gain a better understanding of the issues at hand, thus facilitating the policy making process. In the case of public regulations, the parties include not only the regulators themselves, but also all stakeholders involved in the policy development, notably diverse organizations representing citizens, designers, industry, craftsmen, etc.

Overview of the document

Figure 1 shows the relations between different EPB aspects that may be part of the post-processing. (The numbers refer to the paragraphs in the standard.) EPB indicators are the output provided by the EPB assessment standards. Two main uses of these variables are the setting of requirements and the judgment of how well/poor they perform, i.e. the rating. All this information can be included in an EPB certificate.

For certain EPB indicators, a specific, but important aspect is the tailoring of a requirement or of a rating reference to each individual building (dashed lines). This tailoring is a function of the building's category (dwelling, office, etc.), location (determining the outdoor climate), size, etc. For many outputs such variable (rather than constant) requirement/reference values are essential. E.g. in order to arrive at a technical and economical strictness of requirements that is comparable for all individual projects. To this end some new ('post-processing') calculations may need to be defined (see below), beyond what is already specified in the EPB standards. Sometimes this leads to the definition of a new, derived indicator, notably by taking the ratio of the original indicator and the tailored reference.

EPB requirements

Setting EPB requirements involves several aspects:

- defining the different objectives that are pursued: e.g. a healthy and comfortable indoor environment, energy efficiency, fabric and equipment preservation, etc.;
- carefully selecting an adequate mix of EPB indicators for which requirements are set: usually a judicious combination of overall energy performances (e.g. with and without renewable energy) and partial energy performances (e.g. on the fabric, or the systems) is needed to fully achieve all objectives;
- choosing the appropriate type of quantitative requirement for each of the selected indicators, notably whether a constant value or a variable value (see "tailoring" below);
- determining the actual strictness and its evolution over time.

Each of these aspects is discussed in detail in draft EN ISO 52003.

EPB rating

A numeric indicator for an EPB feature (as produced by the EPB assessment methods) does not yet automatically reveal the energetic quality of the building with respect to that EPB feature. The EPB indicator needs to be compared to one or more reference values in order to judge (rate) the good or poor performance of the EPB feature under consideration.

A typical reference value is for instance a representative value for new buildings or a representative value for the average building stock.

Energy (performance) rating is the evaluation of the energy performance against one or more reference values, which may include ranking on a continuous or discrete scale.

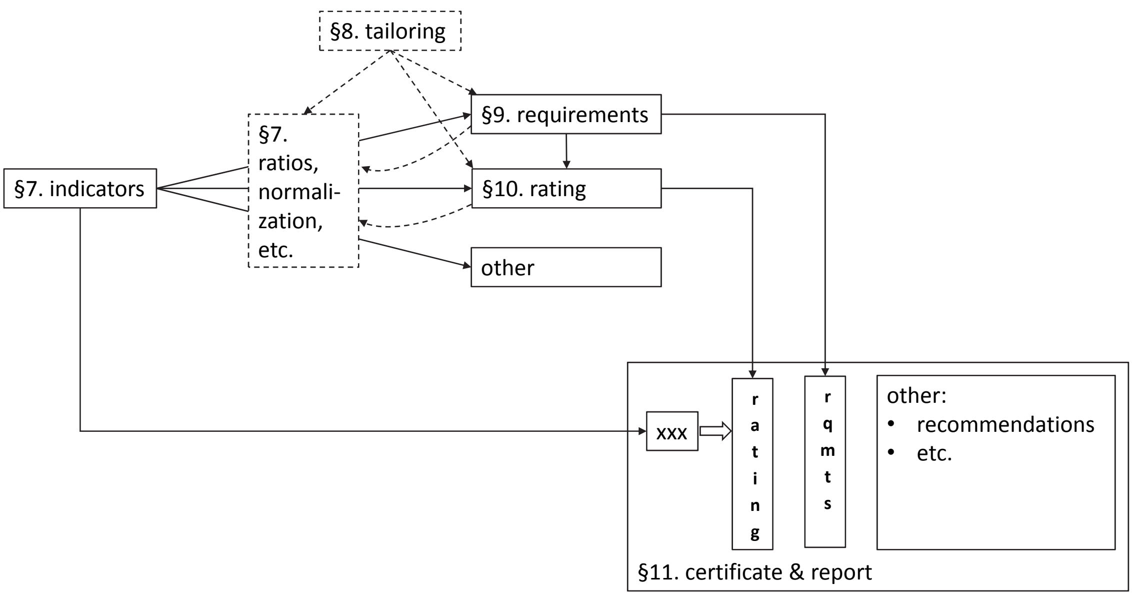


Figure 1. Schematic overview of the relations between various EPB aspects.

Figure 2 shows an example of a rating (scale) based on one reference in position of energy class D (n_{ref}=4). Upper boundaries of energy classes A to G (n=1 to 7) are presented as the ratio to this reference.

Figure 3 shows an example of a subsequent graphical representation for an energy label.

Tailoring for requirements and for ratings

For several important EPB indicators (e.g. overall energy performances, heating and cooling needs, mean thermal transmittance of the thermal envelope) the numeric value that corresponds to the technical and economic optimum often varies strongly from 1 construction project to another, depending on function, size, shape, etc.

Similarly, for such indicators the numeric gradation between "good" and "bad" in a rating can also vary strongly from 1 project to another.

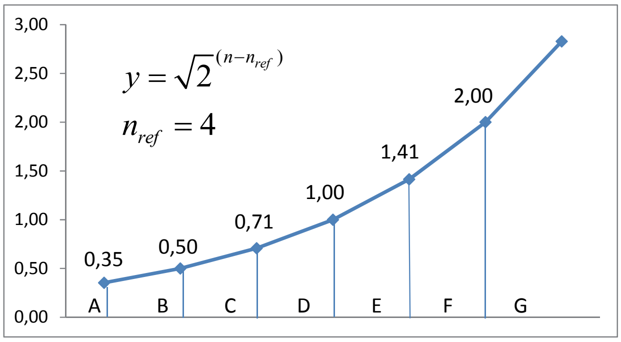


Figure 2. Example of an energy performance rating (scale).

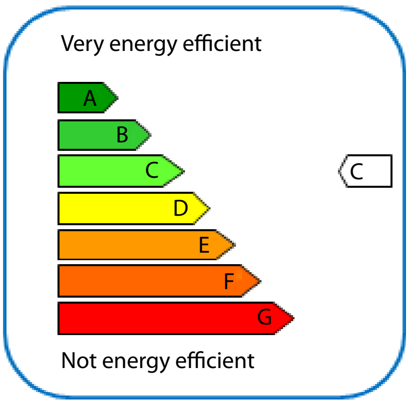


Figure 3. Example of graphical representation of the energy performance classes for an energy label.

In order to treat all buildings in the same manner (e.g. reflecting the same technical and economic strictness), it is for these indicators thus of crucial importance to use variable value requirements or references that take into account all relevant specific features of each individual building. This is called tailoring. The 2 practical manners for such tailoring that are found in practice are:

- the notional reference building approach
- the formula approach

Although both approaches may appear very different at first sight, they actually result in identical, or very similar, results if the same technical starting assumptions are taken. They can thus both serve the purpose well.

Figure 4 illustrates on the basis of some 200 real dwelling shapes (each individual cross) how for a given set of technical measures (level of thermal insulation, type of boiler, degree of airtightness, etc.) the numeric value of an overall energy performance indicator per useful floor area can strongly vary from one project to another. The x-axis is the ratio of the area of the envelope to the useful floor area.

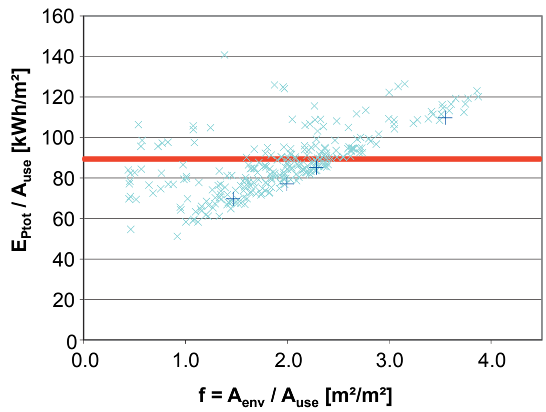


Figure 4. Example of the impact of a fixed (constant value) requirement versus a more appropriate variable value (tailored).

If the reference value that is used for rating and/or to set a requirement is a fixed value (in casu: requirement expressed as maximum value in kWh/m² floor area disregarding building shape or size: e.g. red horizontal line), then buildings with a relatively large envelope area[1] (compared to the floor area) would need a large

[1] I.e. to the left of the graph. For instance, small detached dwellings.

technological-economic effort to meet the requirement, while on the other hand buildings with a relatively small envelope area would need only a small technological-economic effort to meet the same requirement. A more appropriate reference for the rating and/or requirement takes into account this variation and determines project-specific, tailored quantitative requirements.

Conclusion

The new draft texts of EN ISO 52003 list explicitly the different actions that need to be taken into account and provide background information on various post-processing tasks (selecting EPB indicators for requirements and ratings, tailoring and certification). In doing so, they, first of all, provide support to the regulators. In addition, the texts inform all stakeholders, so, that these can engage in a productive dialogue with the regulators. In this manner, a well-considered regulation can be developed matching the sophistication of the actual EPB assessment methods. ■

Acknowledgements

The authors would like to acknowledge, for their valuable input and comments, all the active experts in the ISO and CEN working groups to which the preparation of these standards has been assigned, as well as all the commenters who have provided feedback.

References

[1] Mandate M480, Mandate to CEN, CENELEC and ETSI for the elaboration and adoption of standards for a methodology calculating the integrated energy performance of buildings and promoting the energy efficiency of buildings, in accordance with the terms set in the recast of the Directive on the energy performance of buildings (2010/31/EU) of 14th December 2010.

[2] D. van Dijk, M. Spiekman, D. Van Orshoven, W. Plokker, Subset of EPB standards on the energy use and the thermal performance of buildings and building elements The REHVA European HVAC Journal, Volume: 52 Issue: 1 January 2015.

[3] EN ISO 52003-1, Energy performance of buildings – Indicators, requirements, ratings and certification – Part 1: General aspects and application to the overall energy performance (in preparation; submission of FDIS to final ballot expected in 2016).

[4] CEN ISO/TR 52003-2, Energy performance of buildings – Indicators, requirements, ratings and certification – Part 2: Explanation and justification of ISO 52003-1 (in preparation; submission to Committee Approval expected in 2016).

[5] EN ISO 52000-1, Energy performance of buildings — Overarching EPB assessment – Part 1: General framework and procedures (in preparation; submission of FDIS to final ballot expected in 2016).

THE RIGHT PRODUCT IN THE RIGHT PLACE

DEFINING A **WORLD OF COMFORT** WITH PURMO

ONE SUPPLIER, MULTIPLE BENEFITS
In a world of choice, few things are simple. As an contractor, architect or specifier, you are faced with countless decisions every day, as you work to ensure your plan comes perfectly to life. Thankfully, there is one decision we can help you with— which supplier to choose when you're working on how best to provide the perfect indoor comfort for your project.

LONG HISTORY OF RELIABILITY
Purmo is part of Rettig ICC, a global leader in radiators and underfloor heating. One supplier, with a vast array of products and an international logistics network to make sure they reach you on time, every time.

PROVEN AND TRUSTED
When you choose Purmo, you choose a reliable partner with over 60 years of experience. We pride ourselves in being the first choice for architects and specifiers the world over. They keep coming back because of our quality, reliability and service.

Take a look at what we offer on our website **www.purmo.com**

°CLEVER
LOW TEMPERATURE RADIATORS

bsi. ISO 9001 Quality Management

PURMO
clever heating solutions

Rettig Lämpö Oy, PL 16, Tupakankatu, FI-68601 Pietarsaari, Finland   Tel. 06-786 9111   info@purmo.fi   www.purmo.fi

EPB standard EN ISO 52010:
Conversion of climatic data for energy calculations: completion of a missing link

The new standard EN ISO 52010-1 provides the common standard climatic data to be used as input by all EPB standards. It builds on EN ISO 15927 (part 1, 2, and 4) and completes a missing link: the calculation of the distribution of solar irradiation and illuminance on a non-horizontal plane based on measured hourly solar radiation data on a horizontal surface; with or without taking into account solar shading.

Keywords: energy performance of buildings, EPB, EPB regulations, climatic data, solar radiation, daylight, Perez model.

WIM PLOKKER
Msc Applied Physics
VABI Software b.v.
Project leader EN ISO 52010
w.plokker@vabi.nl

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

A comprehensive series of European (CEN) and international (CEN & ISO) standards is at an advanced stage of development, following CEN Mandate M/480 [1]. The series, called the "set of EPB standards", 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 new standard EN ISO 52010-1, which is being developed in ISO/TC 163/SC 2/WG 15.

EN ISO 52010-1 [3], accompanied by the technical report CEN ISO/TR ISO 52010-2 [4], provides the common standard climatic data to be used for all relevant EPB standards (see also [12]). It gives procedures to calculate the hourly distribution of solar irradiation on a non-horizontal plane based on measured hourly solar radiation data on a horizontal surface, obtained from EN ISO 15927 (part 1, 2 and 4) [5].

The procedures include assumptions to assess the impact of surrounding obstacles on the irradiation (shading). A simple method for conversion of hourly solar irradiance to illuminance is also provided. The solar irradiance and illuminance on an arbitrary surface are needed as input for energy and daylighting calculations.

The standard also contains procedures for the use of (other) output from EN ISO 15927 (part 1, 2, and 4) as input for the EPB assessment.

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

In addition, 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 (step by step) hourly calculation procedures and an overview of all output variables.

Calculation of the distribution of solar irradiation on a non-horizontal plane

The model is named after Mr Perez ([6], [7], [8]). Several improvements were made in the course of time. The calculation procedure described in this standard is based on the "simplified Perez model" proposed in the early 90's. The explanation and justification is given in CEN ISO/TR 52010-2 [4]. Essentially, the model is composed of three different components:

1) a geometric representation of the sky dome;
2) a parametric representation of the insolation conditions, and;
3) a statistic component linking both components mentioned before.

It is a model of anisotropic sky, where the sky dome is geometrically divided into three areas, each of them showing a constant radiance, different from the other two.

These three areas are (see **Figure 1**):

- Isotropic diffuse (for the sky hemisphere);
- Circumsolar radiation;
- Horizon brightness.

For the purposes of this International Standard the following is added:

- Isotropic ground reflected radiation

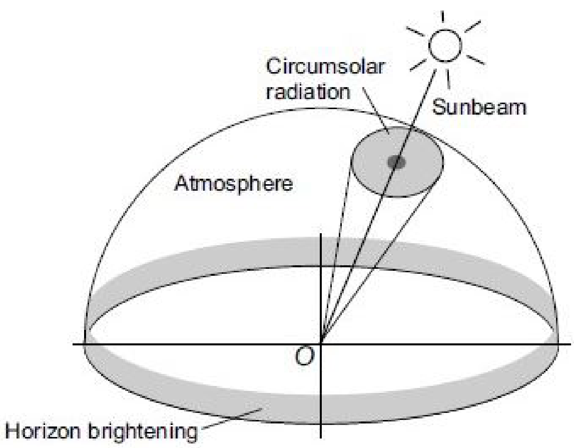


Figure 1. Sky hemisphere areas according to Perez.

The diffuse (sky) radiation for the surface uses as input hourly values of diffuse horizontal and direct beam solar radiation. Other inputs to the model include the sun's incident angle to the surface, the surface tilt angle from the horizontal, and the sun's zenith angle.

Calculation of illuminance

For the luminance distribution of the sky and ground the irradiation is converted into illuminance by multiplication with the global luminous efficacy (Lm/W).

Calculation of shading by external objects

Shading by distant objects is taken into account through a shading correction coefficient for the direct radiation. Shading of diffuse radiation and reflection by distant objects is not taken into account, as explained below. Shading by fins and overhangs is calculated in EN ISO 52016-1.

Objects in the environment may block part of the solar irradiation on a plane (e.g. hills, trees, other buildings). The same or other objects may also reflect solar radiation and consequently lead to a higher irradiation. For example, a highly reflecting surface (e.g. glazed adjacent building) in front of the (on the Northern hemisphere) North facing façade of the assessed building.

In order to avoid that for those objects specific solar reflectivity data have to be gathered, it is, as simplification, assumed that:

a) The direct radiation (including circumsolar irradiation) is partially blocked, if the object is in the path between sun and plane;
b) the diffuse irradiation (including irradiation from ground reflectance) remains unaffected.

This is physically equal to the situation where the radiation reflected (and/or transmitted) by the objects in the environment is equal to the diffuse radiation blocked by these objects.

This approach is chosen for simplicity. The effects on the accuracy of the calculated solar radiation has to be determined. An alternative method is to take diffuse shading into account. In order to do this sky view, factors have to be calculated. This can be simplified by dividing the skyline in different segments and calculate the sky view factors for each segment separately assuming an equal skyline height over the segment.

Other climatic data

The standard also contains procedures for the use of (other) output from EN ISO 15927 (part 1, 2, and 4) [5] as input for the EPB assessment, such as:

- air temperature;
- atmospheric humidity;
- wind speed;
- precipitation;
- solar radiation;
- longwave radiation.

The reason for passing these data via this standard is to have one single and consistent source for all EPB standards and to enable any conversion or other treatment if needed for specific application.

Spatial distribution

In addition, CEN ISO/TR 52010-2 [4] contains an informative calculation procedure for the spatial distribution of solar radiation and luminance as seen from a window or another plane.

It was Tregenza [10] who suggested the distribution of the sky into 145 elements (**Figure 2**). Van Dijk [10] adapted and extended the distribution rules to enable a direct conversion from the components obtained from the Perez model (beam, circumsolar, isotropic diffuse, horizontal diffuse and ground reflected radiation) to 145 elements seen from an arbitrary plane.

Flexibility

Typical inputs for the standard are the hourly values for diffuse horizontal and direct beam solar irradiation. However, these quantities are not necessarily directly measured. In many cases, only the global horizontal irradiation is available as measured parameter, and the two components need to be calculated with a model. There are alternative models provided, open for choice at national or regional level.

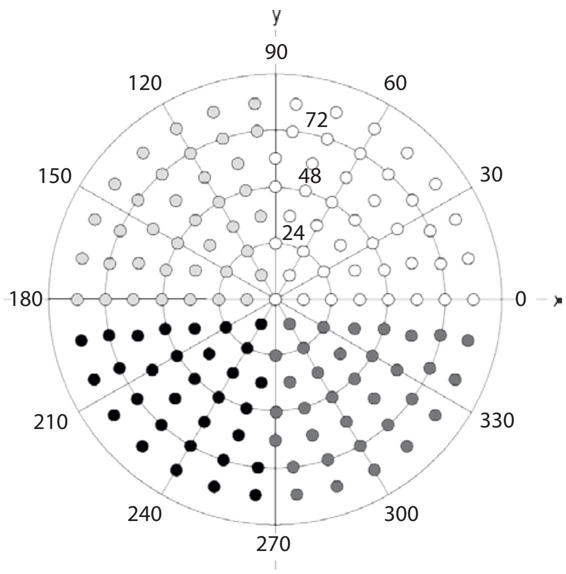


Figure 2. Spatial distribution according to Tregenza.

For ground reflectivity often a constant value of e.g. 0,2 is used. However, the value depends greatly on the surface conditions, and the influence on the irradiation is not negligible. Therefore, the option of providing hourly values is included. This may be especially of importance for mountain regions or for high latitudes.

For the solar shading calculation, the height and distance of each shading object are given per sector of the horizon (360 degrees). The subdivision into sectors (small or large) is open for national or regional choice. The same solar shading calculation procedure is adopted in EN ISO 52016-1, for the calculation of the building energy needs and loads. This is especially important because if there are different shading objects in the same sector, it will not be correct to calculate the effects separately in different standards. It is up to national or regional choice to decide about the details of the solar shading calculations.

Validation

The calculation procedures 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, [11]) 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.

Relevant BESTEST cases are also chosen for the validation of the hourly calculation procedures of EN ISO 52016-1, as presented in a parallel article.

The relevant BESTEST cases are the calculation of the solar irradiation at vertical planes, using the measured data from the climate file provided for this purpose: DRYCOLD.TMY (Denver, Col., USA).

Figures 3-5 show examples of the validation results.

The results of the comparison show that the hourly method in EN ISO 52016-1 is very fit for purpose. It 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.

Another basic test is the calculation of the hourly diffuse and total irradiation on a horizontal plane. These should match the measured hourly values of

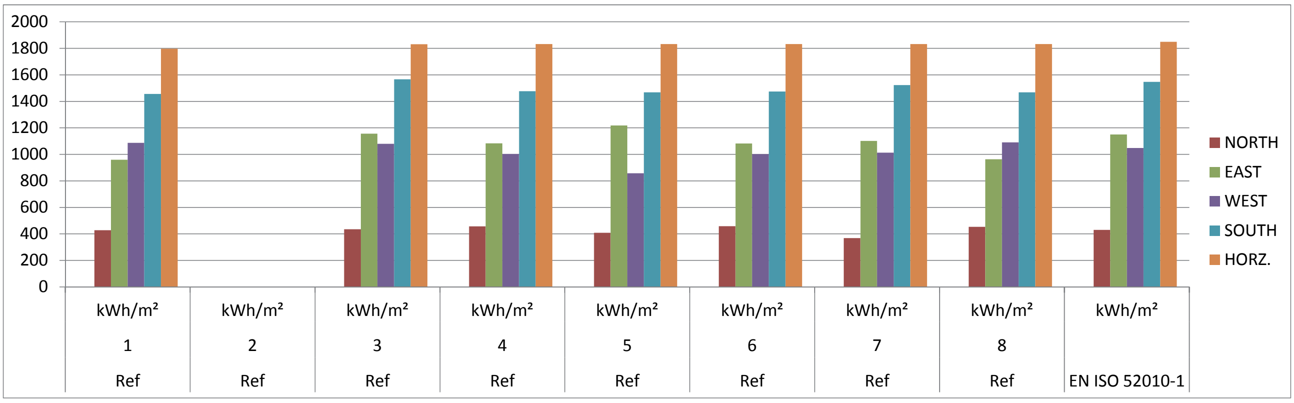


Figure 3. BESTEST validation result: Annual solar radiation on five different planes.

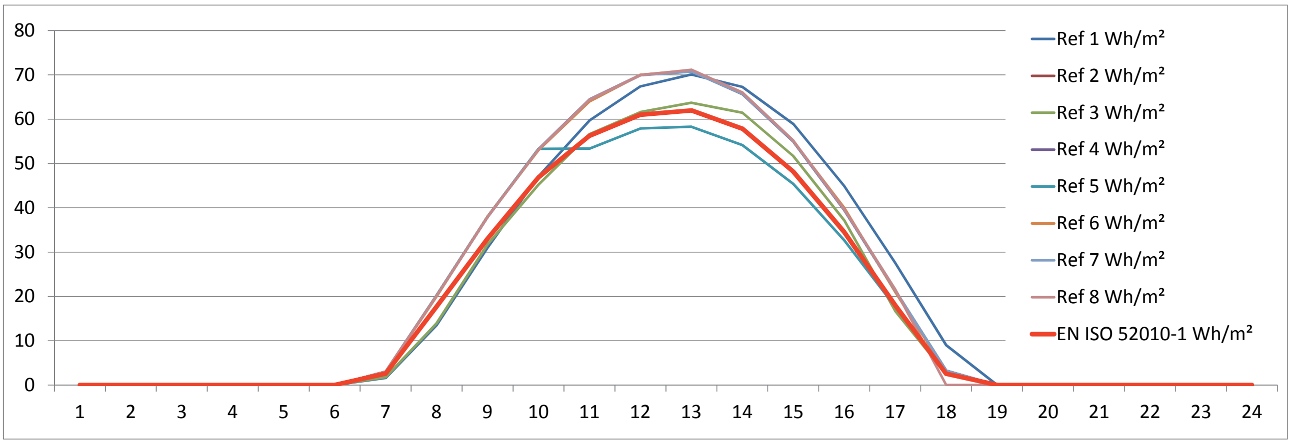


Figure 4. BESTEST validation result: Hourly irradiation on vertical West plane, cloudy day.

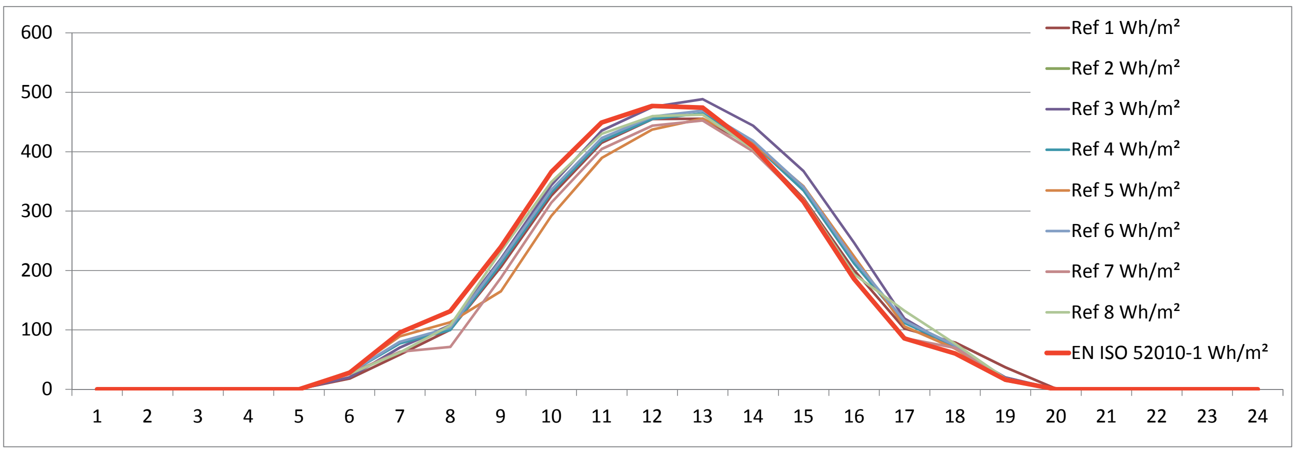


Figure 5. BESTEST validation result: Hourly irradiation on vertical South plane, clear day.

the same properties that are used, together with the measured beam radiation normal to the sun, as the source for the calculation of irradiation on tilted and vertical planes. This test gave also satisfying results [4]. Note that a perfect match should not be expected, because of the use of several empirical correlation coefficients (Perez model). Plus: at very low sun position (e.g. a few degrees above horizon), the conversion of solar direct normal beam irradiance to irradiance at horizontal plane (multiplication by the sinus of solar altitude) is extremely sensitive for the correct calculation (and correct measurement) of the solar time. A few minutes' difference can already have a significant effect. Also the apparent size of the sun disc may play a role. This may even result in small negative values of the diffuse irradiance. The effects when the time series is applied on a building or system component is normally negligible.

Conclusion

The new EN ISO 52010-1 completes the (until now) missing link in the conversion of climatic data for energy calculations. The procedures have been validated. Choices are possible at national or regional level to accommodate the specific national or regional situation. ■

Acknowledgements

The authors would like to acknowledge the contributions of the other experts in the team that is responsible for the preparation of EN ISO 52010, especially **José L. Molina** (Universidad de Sevilla, Spain) and **Francisco José Sánchez de la Flor** (Universidad de Cádiz, Spain) who developed the solar shading calculation procedures for EN ISO 52010 and EN ISO 52016.

The authors would also like to acknowledge, for their valuable input and comments, all the active experts in the ISO and CEN working groups to which the preparation of these standards has been assigned, as well as all the commenters who have provided feedback.

References

[1] Mandate M480, Mandate to CEN, CENELEC and ETSI for the elaboration and adoption of standards for a methodology calculating the integrated energy performance of buildings and promoting the energy efficiency of buildings, in accordance with the terms set in the recast of the Directive on the energy performance of buildings (2010/31/EU) of 14th December 2010.

[2] D. van Dijk, M. Spiekman, D. Van Orshoven, W. Plokker, Subset of EPB standards on the energy use and the thermal performance of buildings and building elements The REHVA European HVAC Journal, Volume: 52 Issue: 1 January 2015.

[3] EN ISO 52010-1, Energy performance of buildings — External climatic conditions — Part 1: Conversion of climatic data for energy calculations (in preparation; submission of FDIS to final ballot expected in 2016).

[4] CEN ISO/TR 52010-2, Energy performance of buildings — External climatic conditions — Part 2: Explanation and justification of ISO 52010-1 (in preparation; submission to Committee Approval expected in 2016).

[5] EN ISO 15927-1 to 6, Hygrothermal performance of buildings – Calculation and presentation of climatic data – Parts 1 to 6.

[6] Perez et al., 1987 R. Perez, R. Seals, P. Ineichen, R. Stewart and D. Menicucci, A new simplified version of the Perez diffuse irradiance model for tilted surfaces, Solar Energy 39 (1987) (3), pp. 221–231.

[7] Perez, R.; Ineichen, P.; Seals, R.; Michalsky, J.; Stewart, R. (1990). "Modeling Daylight Availability and Irradiance Components from Direct and Global Irradiance." Solar Energy, 44(5), pp. 271-289.

[8] Solar Energy Volume 80, Issue 7, July 2006, Pages 746-750, New equations for the calculation of the horizon brightness irradiance in the model of Perez, J.L. Torres, M. De Blas, and A. García.

[9] Van Dijk, H.A.L., et al. (2000). REVIS, Daylighting products with redirecting visual properties. Final Project Report. Research project (1999-2000) under the European DG XII Joule Programme. Contract JOE3-CT98-0096. August 2000.

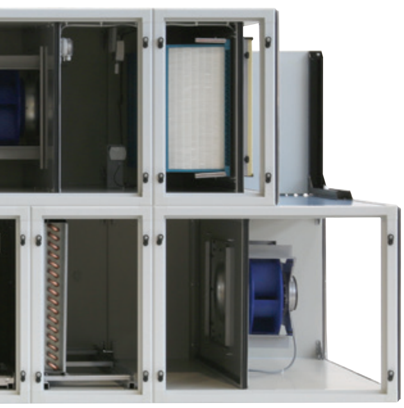
[10] Tregenza, P. (1987), Subdivision of the sky hemisphere for luminance measurements, Light. Res. Technol. 19, 13-14.

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

[12] EN ISO 52000-1, Energy performance of buildings — Overarching EPB assessment – Part 1: General framework and procedures (in preparation; submission of FDIS to final ballot expected in 2016).

ADV Next Air

The air treatment evolution



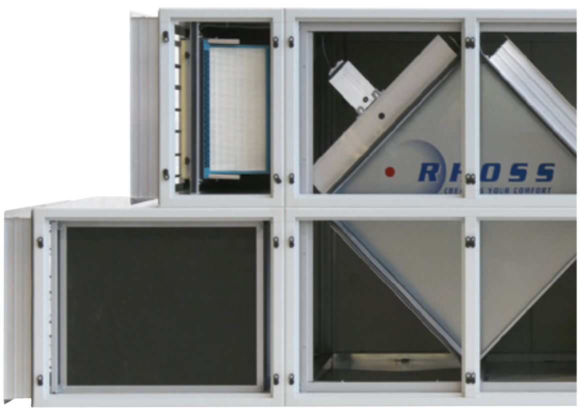
A new comfort level

Perfect in any weather conditions

No Waste

Best efficiency in minimum space

Built-in intelligence



RHOSS S.P.A.
Via Oltre Ferrovia, 32 - 33033 Codroipo (UD) - Italy - tel. +39 0432 911611 - fax +39 0432 911600
rhoss@rhoss.it - www.rhoss.it - www.rhoss.com

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.

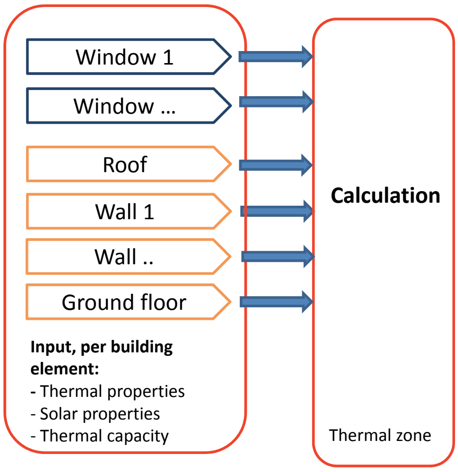
Hourly versus monthly calculation method

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]).

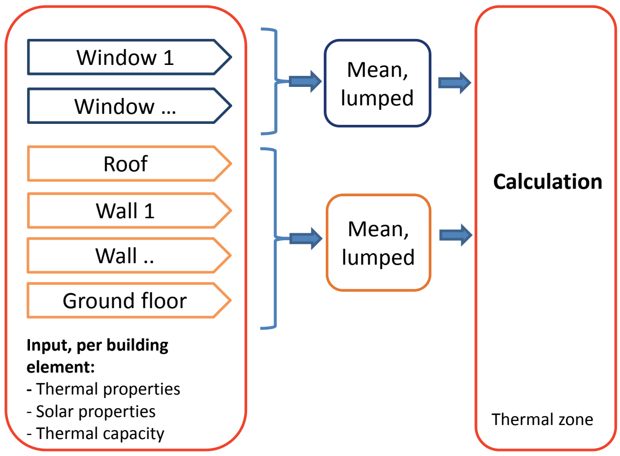
This article focuses mainly on the hourly calculation method.

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

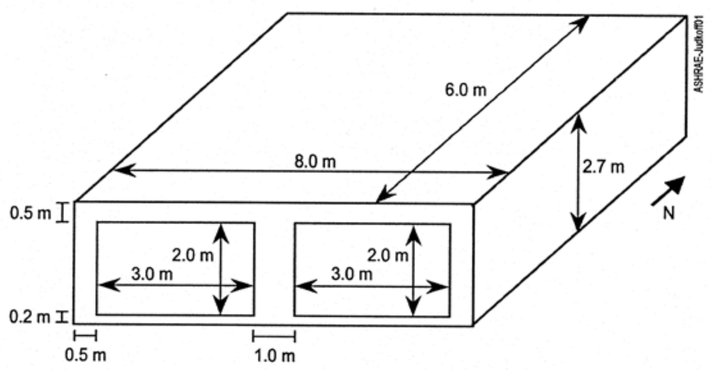


Figure 2. BESTESTS: Geometry of the test room.

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.

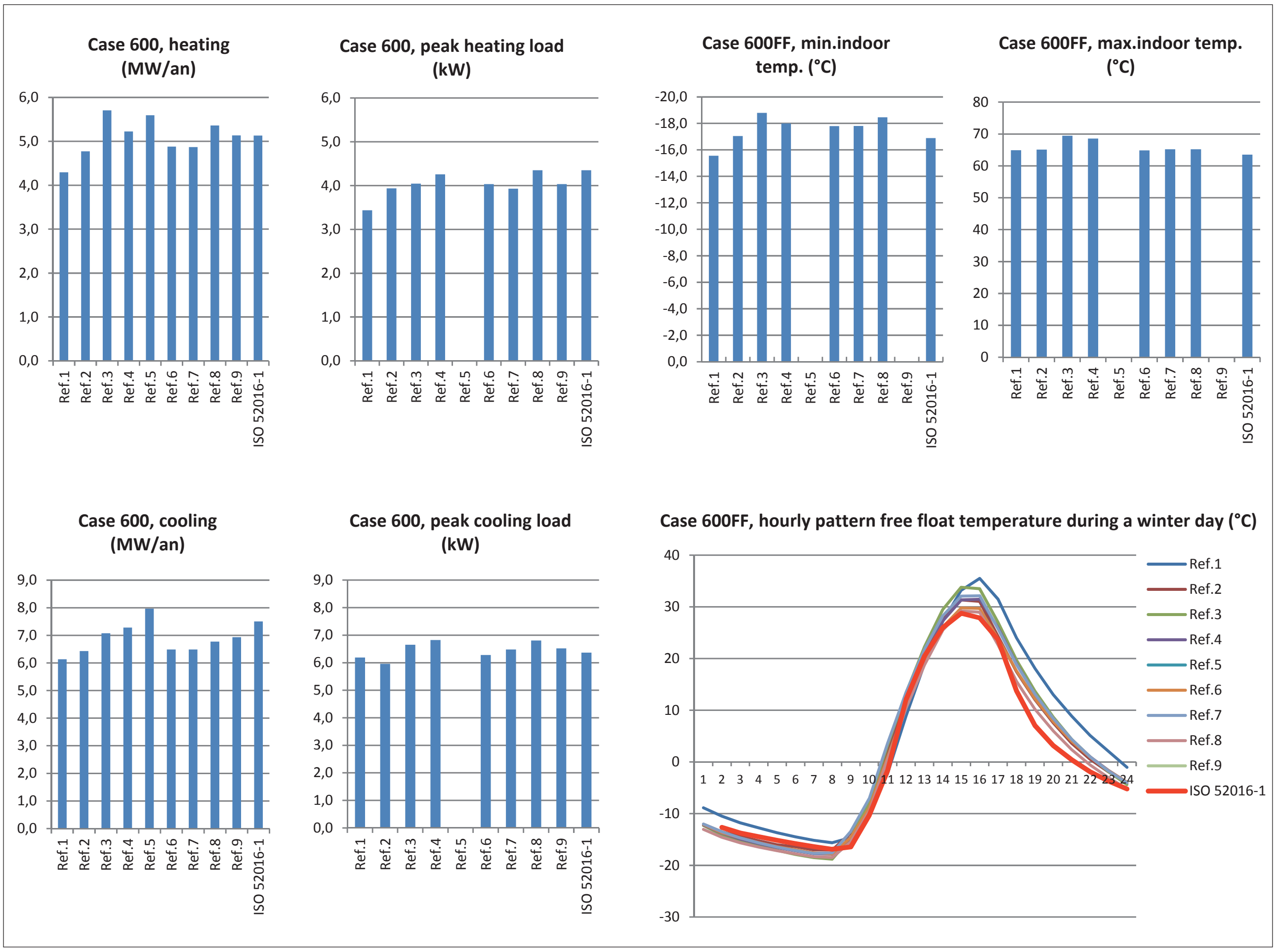


Figure 3. BESTESTS: Main results for Case 600 and 600FF, EN ISO 52016-1 compared with the available 9 reference tools.

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]. ■

Acknowledgements

The authors would like to acknowledge the contributions of the other experts in the team that is responsible for the preparation of EN ISO 52016: **Dirk Van Orshoven** (DVO, Belgium), who significantly contributed to the updating of the monthly method, **Gerhard Zweifel**, who developed the application for design cooling load calculations and contributed to the setup of the latent heat calculation (including link with the EPB ventilation and cooling system standards under CEN/TC 156), **Matjaž Zupan** (Planta, Slovenia) for preparing calculation examples and running tests and **José L. Molina** (Universidad de Sevilla, Spain) and **Francisco José Sánchez de la Flor** (Universidad de Cádiz, Spain) who developed the solar shading calculation procedures for EN ISO 52010 and EN ISO 52016.

The authors would also like to acknowledge, for their valuable input and comments, all the active experts in the ISO and CEN working groups to which the preparation of these standards has been assigned, as well as all the commenters who have provided feedback.

References

[1] Mandate M480, Mandate to CEN, CENELEC and ETSI for the elaboration and adoption of standards for a methodology calculating the integrated energy performance of buildings and promoting the energy efficiency of buildings, in accordance with the terms set in the recast of the Directive on the energy performance of buildings (2010/31/EU) of 14th December 2010.

[2] D. van Dijk, M. Spiekman, D. Van Orshoven, W. Plokker, Subset of EPB standards on the energy use and the thermal performance of buildings and building elements The REHVA European HVAC Journal, Volume: 52 Issue: 1 January 2015.

[3] EN ISO 52016-1, Energy performance of buildings — Calculation of the energy needs for heating and cooling, internal temperatures and heating and cooling load in a building or building zone — Part 1: Calculation procedures (in preparation; title subject to revision; submission of FDIS to final ballot expected in 2016).

[4] CEN ISO/TR 52016-2, Energy performance of buildings — Calculation of the energy needs for heating and cooling, internal temperatures and heating and cooling load in a building or building zone —Part 2: Explanation and justification of ISO 52016-1 and ISO 5207-1 (in preparation; title subject to revision; submission to Committee Approval expected in 2016).

[5] EN ISO 52017-1, Energy performance of buildings — Calculation of the energy needs for heating and cooling, internal temperatures and heating and cooling load in a building or building zone -- Part 1: Generic calculation procedures (in preparation; title subject to revision; submission of FDIS to final ballot expected in 2016).

[6] EN ISO 52000-1, Energy performance of buildings — Overarching EPB assessment – Part 1: General framework and procedures (in preparation; submission of FDIS to final ballot expected in 2016).

[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).

[8] CEN ISO/TR 52019-2, Energy performance of buildings (EPB) — Hygrothermal performance of building components and building elements — Part 2: Explanation and justification (in preparation; submission to Committee Approval expected in 2016).

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

The new EN 15316-2:
The standard for calculating the additional energy use of emitter systems

The actual European standard EN 15316-2.1 “Heating systems and water based cooling systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 2: Space emission systems (heating and cooling)” from 2007 includes two methods for the calculation of the additional energy use for heat emission systems. To have two methods in a standard is sometimes difficult, because the user can choose between a calculation method based on temperatures and based on efficiency values. During the revision of the prEN 15316-2:2014 this situation was resolved in the way that the new calculation method works only with one mathematical approach. The influences of various phenomena are taken into account in the FprEN 15316-2:2016 by the calculation of the additional energy use due to often called emission (emitter[1]) losses. Although these are sometimes not real losses but additional energy use, it is a convention to speak of “emission losses”. These losses are related to physic phenomena like:

- Embedded emission in the building structure (e.g. floor heating);
- Radiation (e.g. meaning air temperature can be lowered due to radiation effects);
- The stratification (higher air temperatures in the near of the ceiling for convective dominated systems);
- Intermittency.

Some other effects, also based on physics are additional influenced by the behavior of the user related to the quality of the building automation and control, the hydraulic balance and the building management systems (BMS). It is observed that if the quality of control is low, the user will compensate by increasing the set point temperature in order to obtain the desired comfort. This is modeled by acting on the set point temperature. The standard proposes to represent all these phenomena by the temperature difference in order to get a unique performance indicator for the classification of the products. The temperature variation based on all

JOACHIM SEIFERT
Dr.-Ing. habil.
Technical University of Dresden,
Faculty of Mechanical Engineering
Taskleader prEN 15316-2
joachim.seifert@tu-dresden.de

MARTIN KNORR
Dr.-Ing.,
Technical University of Dresden,
Faculty of Mechanical Engineering
Expert prEN 15316-2
martin.knorr@tu-dresden.de

influencing factors can be calculated with equation 1. For some cases (e.g. for Temperature variation based on room automation $\Delta\theta_{roomaut}$) also negative values of the temperature variations are possible.

$$\Delta\theta_{int;\,inc} = \Delta\theta_{str} + \Delta\theta_{ctr} + \Delta\theta_{emb} + \Delta\theta_{rad} + \Delta\theta_{im} + \Delta\theta_{hydr} + \Delta\theta_{roomaut} \qquad (1)$$

The calculation of the thermal input for the cooling/heating emission system can be performed on a monthly or on an hourly basis. In the monthly method the emission losses are calculated as follows (equation 2).

$$Q_{em;ls} = Q_{em;out} \cdot \left(\frac{\Delta\theta_{int;inc}}{\theta_{int;inc} - \theta_{e;comb}} \right) \qquad (2)$$

For heating systems $\Delta\theta_{e;comb}$ is the average external temperature during the calculation period. For cooling systems, the fictive external temperature is corrected. In the hourly calculation method, the user behavior related to the set point temperature can be represented as such. In this case, the additional losses are determined by applying the hourly energy needs calculation of EN ISO 52016-1 with the corresponding modified set point temperature. The new standard FprEN 15316-2:2016 gives a lot of default values as input parameters for different systems. As an alternative to these default values products parameters can be used based on the European product standards. ■

[1] On overarching EPB level, in EN-ISO 52000-1 the term emission is replaced by the more correct term emitter.

Calculation of the energy performance of ventilation and cooling systems

In the present paper, an update is given on the calculation related standards from CEN TC 156 in the area of ventilation and cooling, the EN 16798-family. The main changes in comparison with the public enquiry versions are described.

GERHARD ZWEIFEL
Professor, Lucerne University of Applied sciences and Arts, Lucerne School of Engineering and Architecture
Convenor CEN TC 156/WG21
Gerhard.zweifel@hslu.ch

The purpose of this short article is to give an update on the set of EPB standards on the calculation of ventilation and cooling systems, described in [1]. The changes made on the EN 16798 family from CEN TC 156 "Ventilation for buildings" since the public enquiry process are summarized.

General changes, made on all standards, concern the Annex A/Annex B approach for the referencing of the EPB standards, to provide the step by step implementation of the standards in the EU member states, plus different other adjustments according to the revised template given by the collective of team leaders (CTL).

Ventilation standards

In the module M5-5 "emission" standard EN 16798-7 (the former EN 15242), two major technical changes had to be made:

- the calculation of heating/cooling emission losses due to non-ideal control in case of air based heating and/or cooling, taking the temperature correction as an input from the module 3-5/4-5 heating/cooling emission standard (EN 15316-2);
- the description of the control dependent air flow rate calculation in case of demand controlled ventilation had to be taken out of the normative part and was moved to the Annexes A and B.

In the detailed method 1 of "distribution" and "generation" EN 16798-5-1, the changes are:

- The calculation method for the heat and moisture recovery behavior of rotary heat exchangers was eliminated from the normative part. Instead, a generic function for the description was introduced, to be defined on a national basis. This reduced considerably the need for input data. The method was, however, saved in an informative annex, including the default input data which had been in the Annex B before. This annex is referenced as a default function in Annex B. This method is an important contribution which goes beyond what many commercial simulation programs offer in this area, and can be used by referring to Annex D in EN 16798-5-1.

- The fan energy calculation, the background of which is described in detail in [2], contained implicitly a – rather theoretical - fan characteristic. This was eliminated and replaced by a generic function for the fan characteristic, giving the relation between the pressure difference and the volume flow rate. The principle of the calculation, however, with the different control options, was not influenced by this measure.

In method 2, EN 16798-5-2, the calculations of humidification were eliminated. Both standards have one common technical report, CEN/TR 16798-6.

Cooling calculation standards

General

The most extensive changes were applied to the "general" part, EN 16798-9. As this standard connects the calculation pieces of the other standards for emission, distribution, storage and generation to a complete system (as explained in [1]), covering the possible setups and aspects of a hydronic system, the method was in its general application rather complicated. Some simplification possibilities had been provided, e.g. for direct expansion (DX) systems, where the whole hydronic calculation can be skipped. But this was done in some sub clauses within the same method.

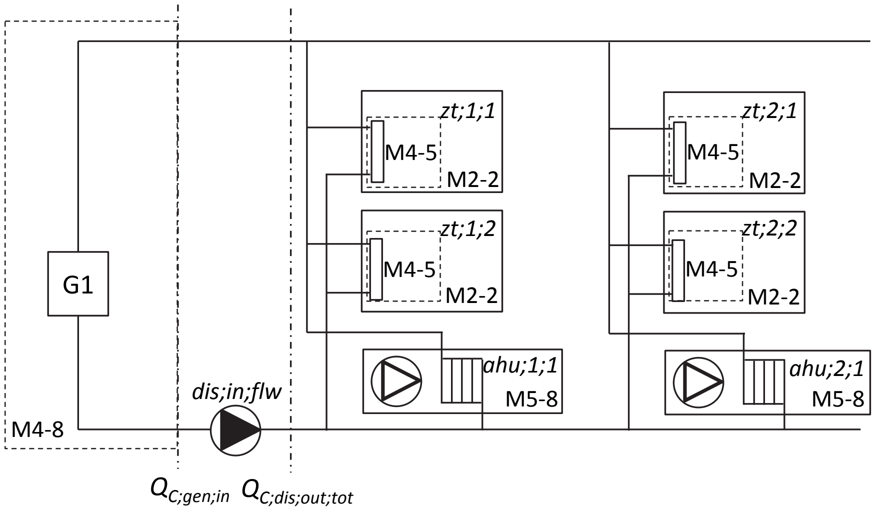


Figure 1. Hydronic cooling system scheme with module boundaries and nomenclature as given in CEN/TR 16798-10 for the simplified method.

In the revised version, a completely separate new simplified method has been added. This is not only supposed to be used for DX systems, but also for hydronic systems where the details of the system setup are not known or the effort to collect all the date needed would take inappropriate time. This new simplified method does not include the detailed calculation of the distribution losses and auxiliary energy provided by EN 15316-3, but uses a simple factor based approach for the estimation of these issues. Due to this, it is not possible to consider the special effects of a hierarchical network as with the detailed method. The simplified scheme is shown in **Figure 1**. It also does not include any storage calculation.

For DX systems, the distinction is made between zone based emitters and an air based distribution. The schemes are shown in **Figure 2**. It can be seen that the number of involved modules is very small. What remains in all cases are the emission parts, in order to keep the non-ideal control losses.

This new simplified method reduces dramatically the need of input data. To make this transparent was the main reason why the method has been added. Also, it can easily be applied for longer calculation intervals like monthly calculations.

In the accompanying technical report CEN/TR 16798-10, examples are given for the simplified and detailed calculation methods, where the spreadsheets are provided for. This includes also an example with

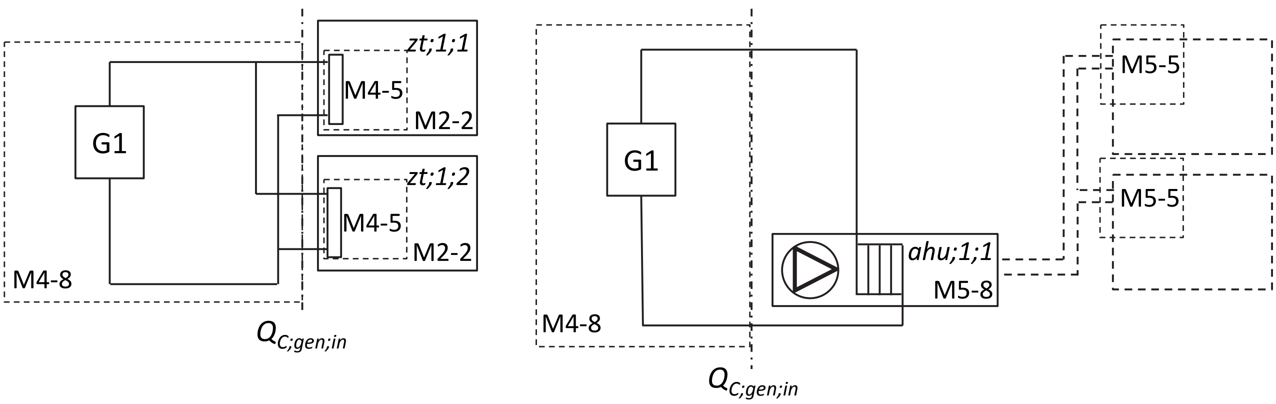


Figure 2. DX cooling system schemes for zone based emitters (left) and air based distribution (right) as given in CEN/TR 16798-10 for the simplified method.

a whole set of linked spreadsheets for the setup [1]. According to the number of zones, AHUs and distribution branches, there are multiple instances of several of the spreadsheets. With this setup, the functionality of the whole set of calculations in the cooing area can be demonstrated.

The partial performance indicators as given in the equations (1) and (2) of [1] have been modified with additional factors in order to include an optional weighting of thermal and electrical energies.

Generation

In method 1 of the cooling generation calculation standard EN 16798-13, flexibility was added to the calculation of the EER. The calculation based on the EN 14825 SEER base values has been kept but modified to better comply to EN 14825 and to avoid the necessity to have a 5th measuring point (which is still of advantage, but can be replaced by a default assumption). In addition to this, the method has been extended to include the case relying only on the nominal EER according to EN 14511, or, if even this is missing, a default nominal EER value. The approach for this case is a constant energetic efficiency. This was needed because it is not mandatory for the suppliers to provide the EN 14825 based SEER and the related EER values before 2018, and therefore it cannot be expected to get these values in all cases.

Method 2 was not principally changed, but improved based on the spreadsheet experiences.

No principle changes needed to be done on the cooling storage standard EN 16798-15.

Conclusion

With these modifications, a consistent set of calculation standards in the ventilation and cooling area will be provided. ■

Literature

[1] Gerhard Zweifel: Calculation of the energy performance of ventilation and cooling systems; REHVA Journal, 01-15, January 2015, p 31 ff.

[2] Jürg Tödtli: The impact of control on the energy use of fans in building ventilation systems; REHVA Journal 05-15, October 2015, p 50 ff.

Referred standard titles:

EN 16798-7:2016 Energy performance of buildings — Module M5-5 — Ventilation for buildings— Calculation methods for energy requirements of ventilation and air conditioning systems — Part 7: Emission (determination of air flow rates, revision of EN 15242).

EN 15316-2:2016 Energy performance of buildings, modules M3-5, M4-5 – Space emission systems (heating and cooling).

EN 16798-5-1:2016 Energy performance of buildings — Modules M5-6, M5-8, M6-5, M6-8, M7-5, M7-8 — Ventilation for buildings — Calculation methods for energy requirements of ventilation and air conditioning systems — Part 5-1: Distribution and generation (revision of EN 15241) — method 1.

CEN/TR 16798-6:2016 Energy performance of buildings — Modules M5-6, M5-8, M6-5, M6-8, M7-5, M7-8 — Ventilation for buildings — Calculation methods for energy requirements of ventilation and air conditioning systems — Part 6: Technical report - interpretation of the requirements in EN 16798-5-1 and EN 16798-5-2.

EN 15316-3:2016 Energy performance of buildings, Modules M3-6, M4-6, M8-6 – Space distribution systems (DHW, heating and cooling).

CEN/TR 16798-10:2016 Technical report to energy performance of buildings — Modules M4-1, M4-4, M4-9 - Ventilation for buildings - methods for the calculation of the energy performance of cooling systems — Part 10: General - Technical report - interpretation of the requirements in EN 16798-9.

EN 16798-13:2016 Energy performance of buildings — Module M4-8 - Ventilation for buildings - methods for the calculation of the energy performance of cooling systems — Part 13: Generation

EN 16798-15:2016 Energy performance of buildings — Module M4-7 — Ventilation for buildings — Calculation of cooling systems — Part 15: Storage.

EN 14825:2016 Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling - Testing and rating at part load conditions and calculation of seasonal performance.

EN 14511-family (2013) Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling.

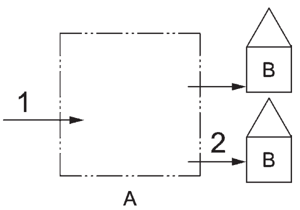
Energy performance assessment of district energy systems

The upcoming revised European standard FprEN 15316-4-5:2016 "Heating systems and water based cooling systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-5: District heating and cooling" provides calculation methods and default values for primary energy factors, emission factors and the Renewable Energy Ratio (RER). These indicators can be used as external input data for the energy performance calculations for buildings.

BORIS LUBINSKI
GFW | energy efficiency association for heating, cooling, chp
Stresemannallee 30
60596 Frankfurt/Main
b.lubinski@agfw.de
http://www.agfw.de

What is the scope of the standard?

The vast majority of district energy systems are district heating systems. So the standard is primarily written for heating systems. But there are also district cooling systems in Europe that are now in the scope of this revised standard. In some cases, there is an efficiency improvement or renewable energy potential that can only be realized on local or district level. So the European Commission asked for methods that facilitate the assessment of small district electricity systems. Thus the former district heating standard evolved to a more general standard with universal calculation methods applicable to various energy carriers.



Key
A system boundary
B energy consumer
1 E_{in} energy input to the system
2 E_{del} energy delivered from the system

Figure 1. Single-output district energy system as a black box.

$$f_{we;des} = \frac{\sum_{cr} E_{in;cr} \cdot f_{we;cr}}{\sum E_{del}} \quad (1)$$

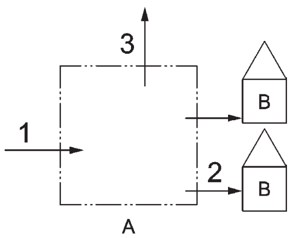
where

$f_{we;des}$ weighting factor of the district energy system;
$E_{in;cr}$ energy content of input to the system of energy carrier cr;
$f_{we;cr}$ weighting factor of energy carrier cr;
E_{del} delivered energy;
Weighting factor means e.g. primary energy factor or emission factor.

What is the universal approach of the standard?

The district energy system is regarded as a black box (see **Figures 1 and 2**). The energy performance indicators are determined as the ratio of weighted energy input to the system and energy delivered from the system.

Multi-output generation systems like cogeneration units or tri-generation of heating, cooling and electricity deliver more than one energy carrier. The energy carriers can be delivered to the same area or a different area or to another energy system. If the energy carriers are delivered to different areas or different systems, the exported weighted energy is counted as a bonus (see **Figure 2**). It represents the avoided production in the external system or area.



Key
A system boundary
B energy consumer
1 E_{in} energy input to the system
2 E_{del} energy delivered from the system
3 E_{exp} exported energy

Figure 2. Multi-output district energy system with exported energy.

$$f_{we;des} = \frac{\sum_{cr} E_{in;cr} \cdot f_{we;cr} - E_{exp} \cdot f_{we;exp}}{\sum E_{del}} \quad (2)$$

where

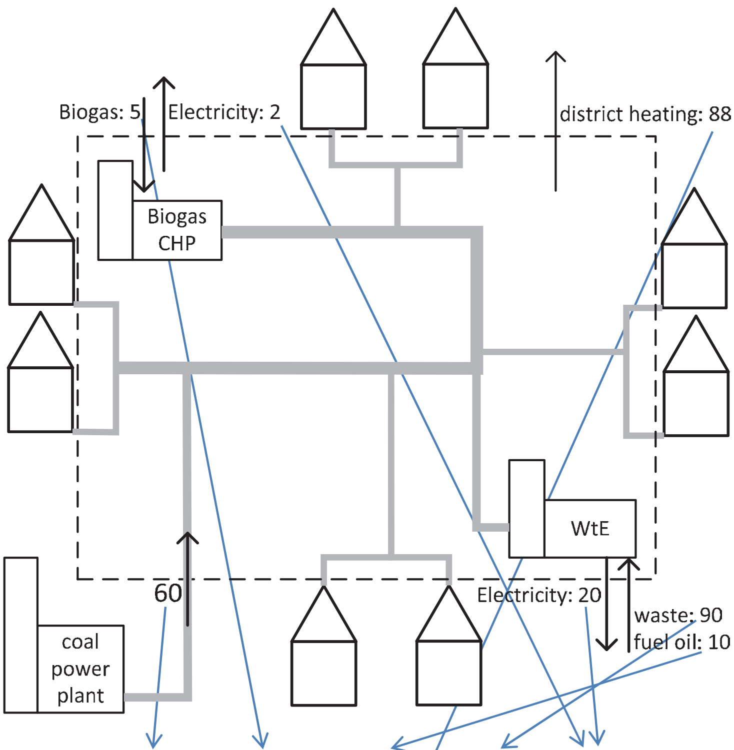
E_{exp} energy exported to an external system or area;
$f_{we;exp}$ weighting factor of the exported energy;

As long as the system boundaries are clearly defined and all energy carriers that cross the system boundary are considered, the black box approach leads to reasonable results. (Exception: district heating system exporting much electricity from non-cogeneration mode).

What is the purpose of default weighting factors?

District energy systems are supplied with energy from other energy systems. The required weighting factors of these systems can be calculated with the same black box approach. But in many cases this calculation is not possible due to lack of information. Therefore, the standard provides a set of default values that can always be used instead of calculating. **Figure 3** illustrates an example for a coal power plant outside the assessment boundary that delivers heat to the district heating system. This external heat delivery is weighted with the default value f_{Pnren} = 0,8. Though calculating system specific indicators is more accurate than using default values, the set of default values is a helpful means of appropriate simplification for complex tasks. ■

$$f_{\mathrm{Pnren,dh}} = \frac{E_{\mathrm{in,heat,ext}} \cdot f_{\mathrm{Pnren,heat,ext}} + E_{\mathrm{in,biogas}} \cdot f_{\mathrm{Pnren,biogas}} + E_{\mathrm{in,oil}} \cdot f_{\mathrm{Pnren,oil}} + E_{\mathrm{in,waste}} \cdot f_{\mathrm{Pnren,waste}} - E_{\mathrm{el,exp}} \cdot f_{\mathrm{Pnren,el,exp}}}{Q_{\mathrm{del}}}$$



$$f_{\mathrm{Pnren,dh}} = \frac{60 \times 0,8 + 5 \times 0,4 + 10 \times 1,1 + 90 \times 0 - 22 \times 2,3}{88} = 0,12$$

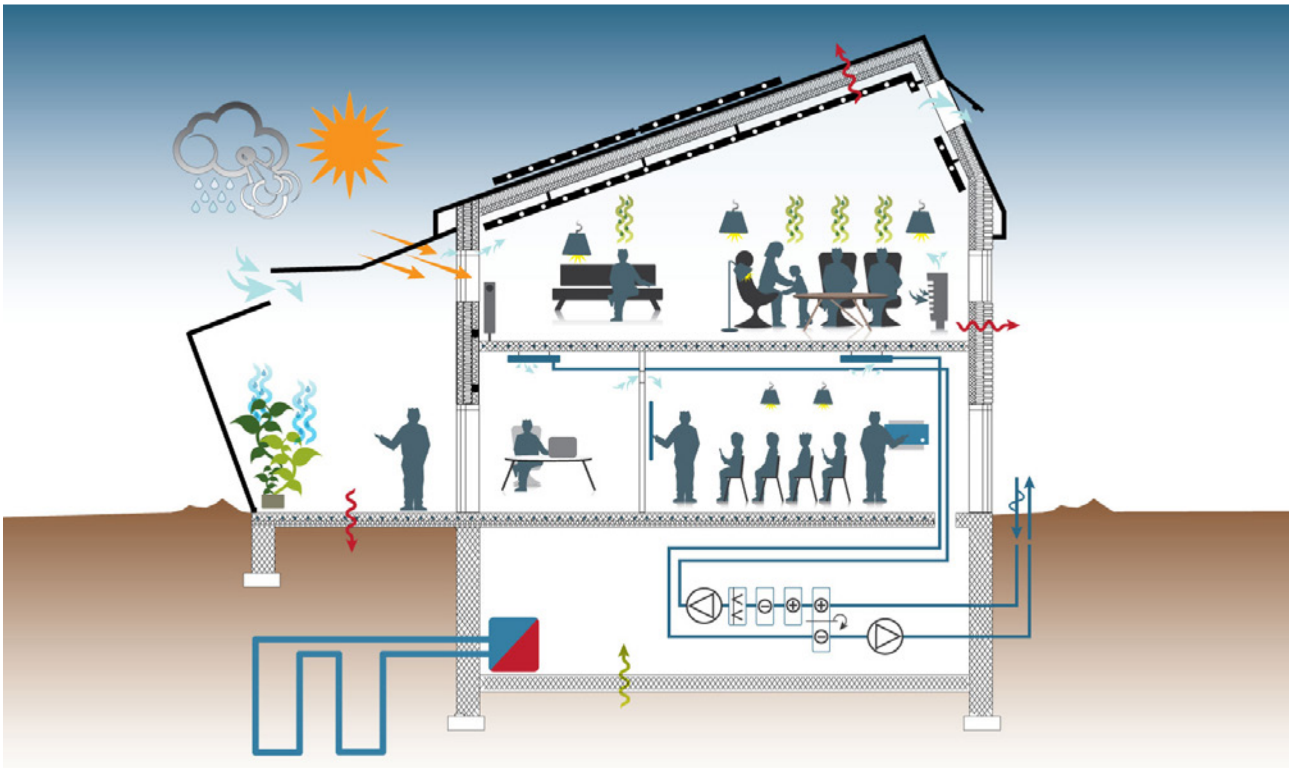
default values								
	heat	f_{Pnren}	f_{Ptot}	f_{CO2}	**fuel**	f_{Pnren}	f_{Ptot}	f_{CO2}
from boilers	solid fossil fuel	1,7	1,7	530	solid fossil	1,1	1,1	360
	liquid fossil fuel	1,6	1,6	400	liquid fossil	1,1	1,1	290
	gaseous fossil fuel	1,5	1,5	310	gaseous fossil	1,1	1,1	220
	solid bio fuel	0,4	1,8	70	solid bio	0,2	1,2	40
	liquid bio fuel	0,7	2,1	110	liquid bio	0,5	1,5	70
	gaseous bio fuel	0,6	2,0	150	gaseous bio	0,4	1,4	100
from CHP	solid fossil fuel	0,8	0,8	500	waste	0	0	0
	liquid fossil fuel	0,7	0,7	330	sewage sludge	0	0	0
	gaseous fossil fuel	0,7	0,7	160	land fill gas	0	0	0
	solid bio fuel	0	1,8	0	mine gas	0	0	0
	liquid bio fuel	0	1,7	0				
	gaseous bio fuel	0	1,4	0	electricity	2,3	2,5	420
from	industrial process	0,4	0,4	90				
	waste-to-energy	0,2	0,2	50				
geothermal		0	0	0				

Figure 3. An example of a coal power plant outside the assessment boundary that delivers heat to the district heating system.

Why is it important to have a standard on Indoor Environmental Quality as part of the EPB standards?

BJARNE W. OLESEN
Ph.D. Fellow REHVA and ASHRAE,
Professor, International Centre for
Indoor Environment and Energy
Department of Civil Engineering
Technical University of Denmark
bwo@byg.dtu.dk

The Indoor Environment is mentioned several places in the 2010 EPBD recast (Table 1). To fulfil these requirements and to safeguard an acceptable and healthy indoor environment the standard EN16798-1 "Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics" has been developed. The first international standard that dealt with all indoor environmental parameters (thermal comfort, air quality, lighting and acoustic) was published in 2007 as EN 15251. This standard prescribed input parameters for design and assessment of energy performance of buildings and was a part of the set of standards developed to support the implementation of the Energy Performance of Buildings



Buildings are for people and building service systems and building envelope must provide an acceptable indoor environment.

Directive from 2003 in Europe. This standard has now been revised and will be issued for formal vote with a new number: FprEN 16789-1:2016. To support and give more detailed guidance for the use of the standard, a Technical Report, prCEN/TR16789-2 is also being developed. The standard is now written in normative language and all the informative text is included in the technical report. The standard includes default criteria given as 3 to 4 categories for the indoor environmental parameters. The values for the recommended default criteria are listed in tables in an informative annex B. Individual countries can decide if they want to use these default values, only use one category, or use quite different values, which then will be included in a national annex A with similar structure as annex B.

The standard includes both criteria for design and input values for energy calculations as required in the recast EPBD (Table 1, Annex 1–3). These criteria are established based on the preferences and expectations of the occupants and are basically independent of the building and systems used.

The EPBD refers several places to "cost-effectiveness". The standard for indoor environment does not address this directly. It is however important to be aware of the fact that in an office the energy costs for heating-cooling-ventilation is only 1 % of the salary costs. It is also well known that the indoor environment has a significant influence on people's productivity, so just 1% decrease of productivity will be equal to the total energy budget. This means any investment that will improve the indoor environment and increase productivity is cost effective. The technical report will include some information on this.

The recast also mentions the importance of "natural daylight" and "natural lighting" (Table 1, para 9, Annex 1–4). This is now also included in the standard, where minimum requirements and categories of daylight factors are included.

For energy calculations the result will also depend significantly on the assumed occupant schedules. It may then be very difficult to compare same type of building if different occupant schedules have been used in the calculations. Therefore, the standard list several recommended default occupant schedules for different type of spaces like residential, offices, schools, restaurants, meeting rooms, department stores, etc. The schedules include criteria for the indoor environment based on the default values, time and level of occupancy and internal loads from other equipment.

Although users or national regulators can choose different indoor environmental criteria as basis for the design or Energy Performance assessment, this standard will make it clear that when comparing different building constructions and building service systems on which input values for the indoor environment the comparison is based. ■

Excepts from the EPBD Recast (DIRECTIVE 2010/31/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 May 2010) on the energy performance of buildings:

Para. (8) Measures to improve further the energy performance of buildings should take into account climatic and local conditions as well as indoor climate environment and cost-effectiveness…

Para. (9) The energy performance of buildings… That includes, in addition to thermal characteristics, other factors that play an increasingly important role such as …, indoor air-quality, adequate natural light and design of the building…

Para. (25) Recent years… Priority should be given… to application of passive cooling techniques, primarily those that improve indoor climatic conditions and the micro- climate around buildings.

Article 1. Subject matter. This Directive promotes the improvement of the energy performance of buildings within the Union, taking into account outdoor climatic and local conditions, as well as indoor climate requirements and cost-effectiveness.

Article 4. Setting of minimum energy performance requirements. These requirements shall take account of general indoor climate conditions, in order to avoid possible negative effects such as inadequate ventilation, as well as local conditions and the designated function and the age of the building.

Annex 1:

3. The methodology shall be laid down taking into consideration at least the following aspects: (h) indoor climatic conditions, including the designed indoor climate;

4. The positive influence of the following aspects shall, where relevant in the calculation, be taken into account: (d) natural lighting.

Estimation of energy requirements for lighting in buildings

All buildings occupied by humans require some form of lighting to ensure that people have visibility to circulate, be able to take part in activities and carry out visual tasks. The required quantity and quality of lighting varies for buildings, activities and visual tasks and for good practice the design conditions are defined in the CEN lighting application standards EN 12464-1 for indoor work places, EN 12193 for sports facilities and EN 1838 for emergency lighting. These lighting conditions can be achieved with electric light or daylight or a combination of the two.

LOU BEDOCS
C Eng, MIET, FCIBSE, FSLL, Hon. President LIF
Convenor CEN/TC169WG9
Thorn Lighting Limited

SOHÉIL MOGHTADER
Dipl.-Ing.
Chairman CEN/TC 169 and member of CTL M480
ZVEI – German Electrical and Electronic Manufacturers' Association

As we now live in 24 hour society almost no buildings can be illuminated by daylight only. Therefore electric lighting has to be installed. In the interest of energy efficiency it is important that the lighting schemes are designed to provide the right light in the right place at the right time. Also important that the electric lights used are energy efficient, conforming to the Ecodesign regulations and are managed by suitable lighting controls system.

Carrying out a comprehensive lighting design (daylight and electric lighting) for new or refurbished buildings will yield both effective and energy efficient lighting solutions that fulfil all the lighting criteria specified in the lighting application standards. The lighting design process will show how much daylight will be available and how much electric lighting is needed and what scheme solutions will satisfy the required lighting conditions during the occupied periods.

The energy required and the energy efficiency (LENI) of the electric lighting scheme can be estimated by using the procedure given in the European standard EN 15193:2007. This standard has been updated and will soon be published as EN 15193-1. This article gives an overview of the new standard.

The new standard specifies two methods for calculations and one for direct metering of the energy required for lighting. The standard provides the necessary steps, equations and some data required for the evaluation of the amount of energy used for indoor lighting inside buildings. The standard also introduces a new method called "expenditure factor" that evaluates the relative performance of each element in the energy calculation. In the eight Annexes it gives tables with default data, template for entry of local default data and detailed instructions for the calculation of the dependency factors. **Figure 1** shows the process involved in the three methods.

The standard will be supported by a Technical report CEN/TR 15193-2 that not only gives more helpful advice on calculation steps but also provides worked out examples, benchmark LENI values for sample lighting installations, descriptions of integrated lighting controls and a domestic lighting guide.

The role of LENI

The methodology of energy estimation not only provides values for the Lighting Energy Numeric Indicator (LENI) but it will also provide input from lighting contributed energy to the heating and cooling

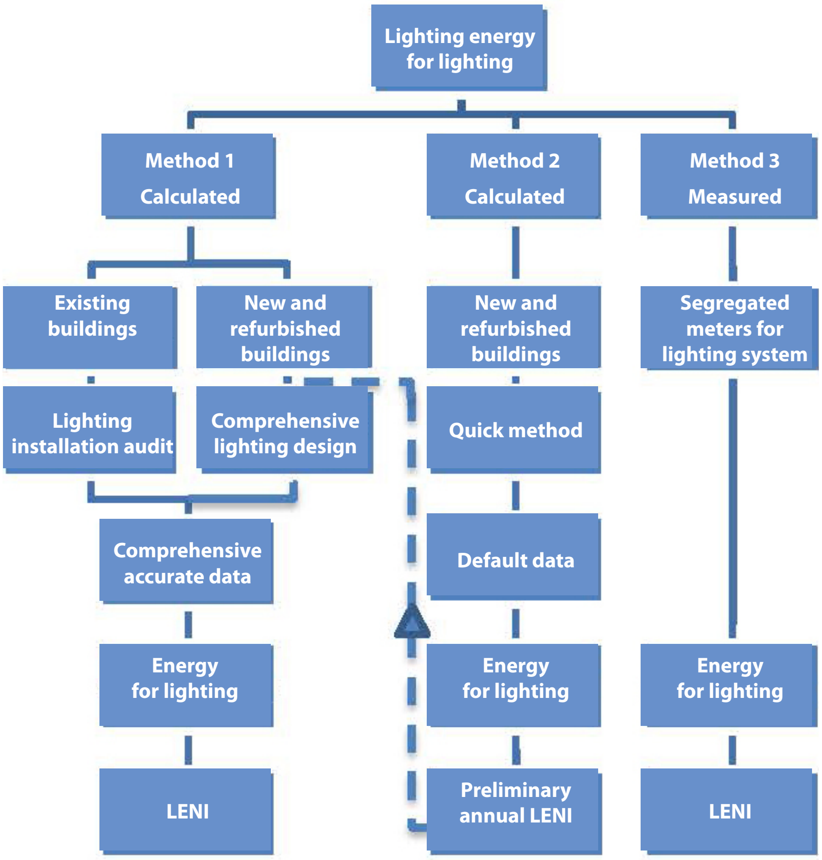


Figure 1. Overview of the flow of the process to determine the required energy for lighting and LENI, the indicator of the energy efficiency of the lighting, in buildings.

load estimations and for use in the energy performance of building certification. LENI is a simple concept and offers a valuable measure for the energy efficiency of lighting in areas or buildings. The measure can be used for comparing the performance of similar areas or building types in the EU. The measure also lends itself to set lighting efficiency ratings or benchmarks for designers for lighting solutions. LENI has been in use since 2007 and several EU member states have adopted it as the tool for setting lighting efficiency measures in buildings.

Application of the new standard

In the new standard methods 1 and 2 may be applied to new, existing or refurbished buildings whilst method 3 is for existing buildings where where the lighting circuit is sufficiently segregated to allow separate metering. The standard deals with fixed general lighting systems and does not cover the design of lighting systems, the planning of lighting installations, the characteristics of lighting equipment (lamps, control gear and luminaires) or the systems used for display lighting, desk lighting and luminaires built into furniture.

Method 1, the preferred route for the energy requirements for lighting over specified time step, follows a comprehensive procedure in which accurate real data on the daylight availability, electric lighting including lighting control performance and occupancy periods are available from the lighting scheme design for all areas and zones of a building type. It will also yields the most accurate value for LENI. Method 1 is the most accurate calculation method and it can also be used for existing building where a comprehensive lighting survey or audit is carried out to establish the installed lighting load.

Method 2 is a simplified quick method that relies substantially on default data provided in the standard for activity areas of different buildings for use in the annual estimation of the energy requirement for lighting. Method 2 is suited for use at concept stage of design and will yield preliminary annual energy requirements and LENI. These budget values are used for the initial energy performance certificate in planning applications but will need to be recalculated using method 1 when the lighting design is completed.

Method 3 is by metering the energy used for lighting and will give the most accurate measure of LENI. The metering can also provide regular feedback on the energy used and the effectiveness of the lighting controls.

Energy for lighting calculations

In Methods 1 and 2 the energy requirement for lighting for an area, zone or building is calculated by summing the energy needed for illumination (W_{Lt}) and for standby systems (W_{Pt}) for a specified time step (t_s) by using the equation

$$W_t = W_{L,t} + W_{P,t}\ [kWh\ /\ t_s].$$

LENI for the space where A is the useful area under consideration is calculated by the equation

$$W_t\ /A\ [kWh/t_s\ m^2].$$

The energy for illumination (W_{Lt}) is given by the summed up installed lighting power load (P_N) and as modified by the lighting controls during the operational time step (t_s) as given by the equation

$$W_{L,t} = \sum\{(P_n \cdot F_c) \cdot F_o\ [(t_D \cdot F_D) + t_N]\}\ /\ 1\ 000\ [kWh\ /\ t_s].$$

The lighting controls can respond to daylight availability (F_D daylight dependency factor), occupancy (F_o occupancy dependency factor), overdesign (F_C constant illuminance factor) that compensates for light losses in a maintenance cycle and the day (t_D) and night (t_N) time occupancy periods.

The energy for standby systems ($W_{P,t}$) required during non-lighting periods to provide charging power (P_{em}) for emergency lighting during charge time (t_e) and the lighting activation power (P_{pc}) for lighting controls for the period (t_s) where no electric light during daytime (t_D) or night time (t_N) is used in an area or zone of the building, is calculated by the equation

$$W_{P,t} = \sum\{\{P_{pc} \cdot [t_s - (t_D + t_N)]\} + (P_{em} \cdot t_e)\}/1\ 000\ [kWh\ /\ t_s].$$

Expenditure factors for lighting systems

The standard gives a procedure for the calculation of the expenditure factor or effort factor. This measure gives an indication of the energy efficiency of the chosen lighting solution compared to a reference system. The expenditure factor (e_L) for the lighting system is the ratio of the energy required or used (W_{us}) for the actual lighting to the reference energy (W_{nd}) needed for the lighting as shown by the equation

$$e_L = W_{us}\ /\ W_{nd}.$$

It can also be derived by the products of the individual influences as given in the equation

$$e_L = e_{L,C} \cdot e_{L,O} \cdot e_{L,D} \cdot e_{L,ES}.$$

Where

- $e_{L,C}$ is the partial expenditure factor for constant illuminance control
- $e_{L,O}$ is the partial expenditure factor for occupancy dependent lighting control
- $e_{L,D}$ is the partial expenditure factor for daylight dependent lighting control
- $e_{L,ES}$ is the partial expenditure factor for the electric lighting system

The higher the expenditure factor the less efficient is the lighting system. Applying the methodology allows a quick analysis of the energy flows in an electric lighting system, separately for each of its technical components. As specific conventions are required for the energy assessment of lighting systems, such as luminous efficacy and luminous intensity distribution, the absolute values received for the expenditure factor are specific for lighting and cannot be directly compared with other technical building services. The Technical report describes the background and detailed operation of the concept and also gives worked example of expenditure factor for a lighting scheme.

The new standard together with the technical report will provide a comprehensive yet easy way of estimating the energy requirements for new and existing lighting installations. LENI can provide a good measure for the energy efficiency of the installed scheme whilst the expenditure factor can identify the elements that merit further performance improvements. Good lighting is essential for people in all buildings and this light should be provided by the most appropriate and efficacious solutions. ■

Heating control – Main control functions are standardised, how to apply these functions?

Control systems present a large economic potential, adapting energy delivery to meet the comfort demand profile as close as possible. This applies in particular to heating, the largest part of buildings energy use in Europe is for heating purposes. The keys of the control system performances are: standardized quality products, closely adapted to heating systems and properly operated and used. EN 12098 series of standards and technical reports will provide specifications and recommendations to achieve these goals.

RENÉ CYSSAU
Former chief engineer in COSTIC
Associated member of ACR
French BAC Trade Union
CEN TC247/TC371 Technical
Expert for BAC
r.cyssau@sfr.fr

Standards EN 12098 (parts 1, 3, 5) prepared under CEN/TC247/WG6 committee describe ability of devices and integrated functions to control heating systems. These standardised functions are leading and necessary. They are completed by added functions for specific applications and performance improvements.

Associated draft Technical Reports CEN/TR 12098 (parts 6, 7, 8) summarise some recommendations for how to design, how to use these functions for energy efficiency of heating systems. Energy impact of these control functions are detailed in EN 15232-1.

Many of these EN and CEN/TR (Technical Reports) are formally drafts until mid of 2016 and will go out for Formal Vote by October 2016. Publication by the national standards bodies of CEN is expected by the beginning of 2017. They were prepared in the frame of the standardisation mandate M480 with the terms set in the recast of the EPBD (2010/31/EU).

Efficiency of control imply properly divided heating systems

First, application of control functions implies that the building is properly divided into elementary spaces and zones according to various conditions of use.

For this, **EN ISO 52000-1**, “Energy performance of buildings – Overarching EPB assessment – Part 1: General framework and procedures” gives pertinent indications for zoning in clause 10. Although this clause is formally applicable to calculated energy performance, it may be applied to design and realisation of separated zones. Reality of zoning is a necessity for control, limited areas up to 1 000 m² is recommended.

Controllers distributed on zones of buildings shall be related to hierarchical level in the zoning and organised in a coordinated system. Energy performance of heating systems involves suited BAC functions.

The major function for saving energy: start-stop scheduling

Properly heating system zoning is a prime importance for application of this simplest but most effective function.

Note that energy use is approximately proportional to the ambient temperature related to outside temperature. Any stopping or reducing heating lowering this temperature brings savings.

For this, **12098-5 standard** describes characteristics of scheduling clocks for the operation requirements.

Five categories cover all technologies on the market, from mechanical clocks mains frequency synchronised to networked clocks put in sync with a high precision master clock like the European emitter in Mainflingen (D) giving real time, date, and automatic summer-winter time change.

Categorized clocks may differ by programming periods, number of switch times per day, number of daily programs. Accuracy is given for the clock itself and for switch time settings.

Basic scheduling function should be completed with added functions.

For adaptation to different user needs:

- Derogate or overlap scheduling for temporary demand,
- Start timer function for a single start-stop cycle.

For adaptation to technical constraints:

- Fixed start period anticipating inertia of heating before the normal occupation time,
- Tariff compensation in case of variable tariff energy price, like electricity, for start switching with respect to the tariff rising time. This function provides cost saving.

Put rhythm of energy use in buildings

CEN/TR 12098-8 recall that switching on-off energy services related to actual or predictable use of rooms, zones or buildings is the basic, simplest and more effectiveness function. Special attentions shall be given to keep watch for update schedulers to real conditions of use, during exploitation.

Figure 1 indicates where start stop functions may be applied to heating systems parts:

- Generation: switch on-off or allow-prohibit operating of generators and related auxiliaries: pumps, valves.
- Distribution: switch pumps and tree ways valve controlling temperature at the head of distribution zones. In some cases, elementary spaces and zones may be switched by on-off seal valves.
- Emission: scheduling clocks are normally included in each room controller for local adaptation of heating needs. Programming of generation and/or distribution take priority to local programming, avoiding forgetful use or malfunctioning room controllers (**Figure 2**).

Scheduling functions in heating parts and heating zones imply a digital network linking these functions for easily coordinate and manage.

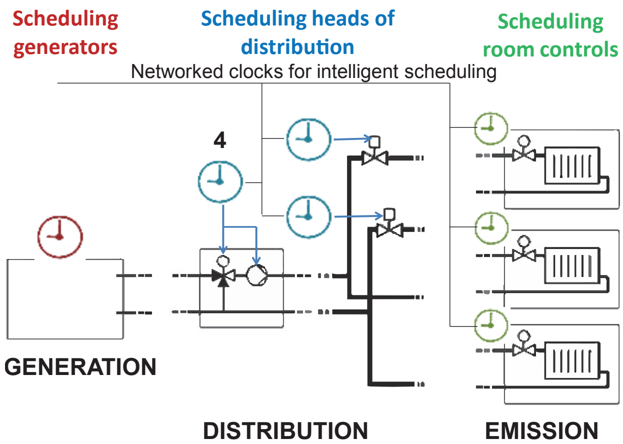


Figure 1. Scheduling clocks on different parts and zones of heating systems are efficiently synchronized and managed by the way of a digital network dedicated to HVAC applications.

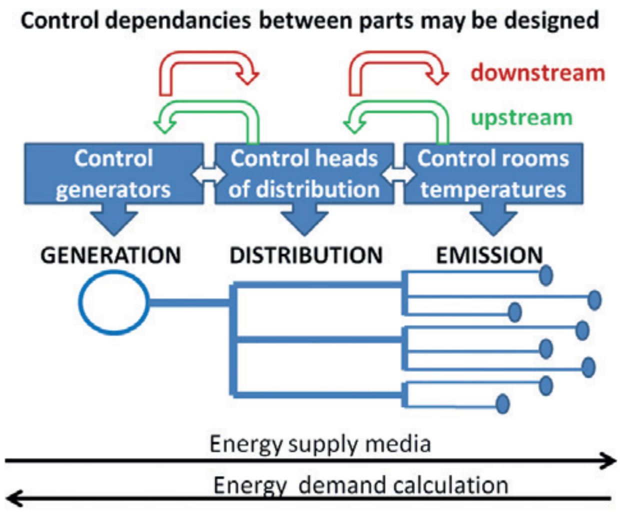


Figure 2. Energy demand and supply model for heating plant. The control system may follow an upstream or downstream model. The difference is the freedom allowed to users acting set-points in view to take account user behaviour encouraged or not.

Clock scheduling intermittences is completed with derogation possibilities for override programmed periods. A timer function for single period may also be proposed. These added functions started manually or automatically satisfy unexpected needs.

The lot of individually programmed clocks distributed in buildings imply to link schedulers on a BAC (Building Automation and Control) system by the way of a digital network.

A BAC is - at least - a super, multi ways scheduling clock to put rhythm of energy use in buildings.

To pilot heating: two main functions

Piloting heating systems necessitate two main functions: Outside Temperature Control (OTC) and improved scheduling, the Start-Stop Optimiser (SSO). For an efficient heating control these two functions are inseparable and integrated on a heating pilot controlling many parts of these systems (**Figure 2**).

The **EN 12098-1** describes operating requirements of OTC and SSO functions and tolerances limits for their ability. This standard concerns either standalone devices or integrated functions in BAC systems.

OTC – Outside temperature controlling flow temperature may be completed by these useful functions:

- Auto tuning heating curve parameters;
- Compensation by emitters energy demand transmission;
- Other meteorological variables and forecast.

OSS – Optimum start-stop function may be completed by these switchings:

- Pumps control;
- Summer-winter switch related to calculated mean forecast outside temperature.

CEN/TR 12098-8 points out that the role of heating outside temperature control acting generation and/or distribution parts remains alone for the room temperature control in some cases:

- Heated spaces don't permit to measure a representative temperature for individual (closed loop) control (e.g.: entrance, corridor, reception hall, exhibition hall, atrium…),
- Users are not encouraged to adapt set point of their room temperature controller,
- Emitters are equipped with inefficient or damaged individual emitters thermostats.

And even if each room is equipped with emitter's controller:

- Limit the higher room temperature able to be reached, even in case of maladjusted settings,
- Adapt the water temperature to the actual heating load, allowing to avoid hanging of the closed loop room controls, and permitting the room control accuracy.

This rule applies specially to mechanical and electronic thermostatic radiator valves, water temperature must be adapted to the heating charge, i.e. outside temperature.

Energy impact of these functions: OTC, intermittent control and pump control may be fund on many parts of EN 15232-1.

Thermal calculations impact of these functions may also be found in EN 15316 series:

- Improve efficiency of generators, reduce losses: EN 15316-4-1 gives algorithms for calculates efficiency related to the mean temperature,
- Reduce heat losses of thermal storages, pipes, auxiliaries, and other equipment (e.g. valves): EN 15316-3 gives algorithms for calculate heat losses for these periods,
- Reduce pumps consumption during intermittent periods and summer-winter switch: see EN 15316-3.

Control of electrical heating systems follows the same principles

Energy efficiency of electrical heating requires central functionalities for improve control and scheduling of terminals and their thermostats.

The **EN 12098-8** describe Outside Temperature Control (OTC) and improved scheduling the Start-Stop Optimiser (SSO) for electrical heating control systems.

Although these functions are similar to principles applied to water heating, technical solutions and constraints specific to this electrical heating necessitate this separated standard.

Optimum start function may take account of the variable price of energy, for that the switch time for rise to normal room temperature should be anticipated with respect to the tariff rising time.

CEN/TR 12098-7 point out the roles of outside temperature control limiting electrical energy available at the emitter. This CEN/TR indicates also energy impact of central control and intermittent control on distribution and emission electrical heating, as it can be found in EN 15232-1.

Content of this EN standard and accompanying CEN/TR presents many similarities with water heating documents EN 12098-1 and CEN/TR 12098-6. It's an advantage for technicians to find similar concepts for starting up and commissioning heating controls, whatever energy source is used.

Concepts for heating control systems: upstream or downstream?

For energy calculation following EN ISO 52000-1, emitter's energy demand begins on an upstream calculation process, distribution and production delivery follows.

Physical is opposite: energy is supplied from generators to emitters through distribution, control falls water temperature or flow along the chain.

A control system allows choosing subordinations between parts (**Figure 2**). Two directions are feasible:

- The upstream control process: demand of room temperature controllers govern distribution, storage and generation water temperature. This satisfies a comfort point of view: delivered energy must satisfy demand.
- The control system may behave on a downstream process: generation and distribution control water temperature available for each elementary spaces or rooms. Delivered energy respond to a predicted demand, no more. This satisfies an energy point of view. This control is based on models.

OTC and OSS are basic functions for this downstream principle (but recommended in any cases). Through this way, control may receive many refinements like TABS control (Thermally Active Building Systems).

> Note that these subordinations may confer a "character" to a control system: "obedient" or "authority" over users.

An "obedient" system, i.e. allowing some settings access, convene to encouraged users to pay attention to energy conservation. In other cases, an "authority", i.e. closely pre-set system convene to not encouraged users.

Conception of control systems based on data networks and intelligent controls allow such possibilities, introducing expected behaviour of contributors.

For that, man-machine-interface is an important topic for any contributor. In this way, CEN/TC247 standards refer to graphical symbols for users in CEN/TS 15810 (Technical Specification, **Figure 3**). ■

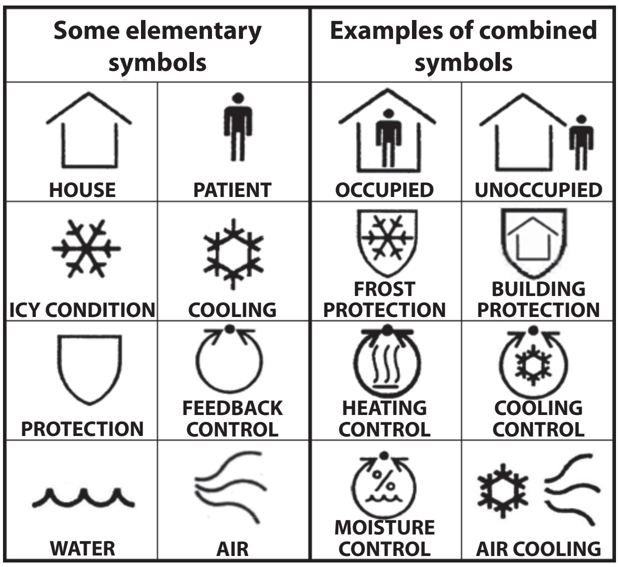


Figure 3. Some symbols fund on CEN/TS 15810"graphical symbols for use on integrated building automation equipment" designed from elementary symbols.

Upgraded and simplified DCV system for a perfectly sustainable indoor climate.

Lindab's DCV system Pascal has now become better and even more flexible. Pascal is now available with new integrated web interface that makes it easier to set up and maintain your ventilation system on a day-to-day basis. With direct online access, you can now install and commission your system in a quick and easy way.

In addition, we have upgraded Pascal with a new application for DCV control of chilled beam systems, so Pascal is now fully compatible with our Air- and Waterborne solutions. Just as before, Pascal offers demand and presence-controlled ventilation that in combination with intelligent fan control provides an optimal and sustainable indoor climate with minimal energy consumption.

Contribution of CEN/TC247 Building Automation and Control (BAC) for EPB standards

JEAN DANIEL NAPAR
Convenor CEN/TC247/WG6
Chief Technology Officer
SIEMENS Building Technology France
dan.napar@siemens.com

ROLAND ULLMANN
President CEN/TC247
Innovation and Industry Affairs
SIEMENS Building Technology Switzerland
roland.ullmann@siemens.com

KLAUS WAECHTER
Global Standardisation Manager, SIEMENS Building Technology Switzerland
waechter.klaus@siemens.com

This article describes the contribution of CEN/TC247 Building Automation and Control to the EPB standards set. The intentions of EU for this M/480, in accordance with the statement from the mandate are: "make the CEN standards more usable as direct reference in national legislation and give a high transparency of national choices". A second intention is to close the gaps between REGULATIONS (National) who could use the standards when implementing the Directive EPBD recast, for: a better transparency (what are the national choices for EPB?), to support a Voluntary Certification Scheme through EU, go to NZEB and last but not list to try to converge the Primary Energy Factors. In this context, CEN/TC247 has done his work for more visibility of BAC within the EPB standards Set, and for the usability of BAC technique as Technical Building System.

Keywords: Building Automation and Control (BAC), energy performance of buildings, EPB, EPB regulations, Control Accuracy, Control Functions, Control Strategies.

Introduction

On bases of M/480, CEN/TC247 has three work areas:

1) Revision of the existing BAC standards, related to the EPBD recast.

2) Developing two new standards:
   - Inspection for BAC (with link with eu.bac system): EN 16946-1
   - Contribution of TBM (Technical Building Management) for Energy Efficiency: N 16947-1

3) Work to be performed to support the relevant CEN/TC's (TC 89, TC 228, TC 156, TC 169) to contribute with the BAC topics in the deliverables of these TC's!

Insight the CEN/TC247/WG6 deliverables

Also, as a result of the EPBD recast, about 52 EN and EN/ISO standards were updated, merged or developed to harmonize the energy calculation methods concerning buildings. To increase the transparency and coherence of the calculation methodology used today and tomorrow within the European countries and where possible globally. BAC (via CEN/TC247) contributes with 7 standards and 7 Technical reports. The main standard is EN 15232. This standard which contains a comprehensive and structured (for calculation methodology) list of BAC functions that are intended to be used in the whole EPB standards set as contribution of BAC in all modules of the new MODULAR STRUCTURE of EPB standards, where applicable. BAC is identified as Module M10 and covers the modules M10-1, M10-5, M10-6, M10-7, M10-8, M10-9 and M10-10 vertically, but consistently will be present in ALL Modules Mx-5, Mx-6, Mx-7 and Mx-8.

Improved energy efficiency in buildings is a high priority among European decision makers, as well as building owners. Presently there is one CEN standard assisting building owners to ensure that a newly constructed building or an existing building being refurbished, will have the best available BACS technology to save energy – i.e. the EN 15232 "Energy performance of buildings – Impact of Building Automation, Controls and Building Management standard". Two standards (EN 15500 and EN 12098-x) complete the set of functions of EN 15232 and give the CONTROL INPUT DATA for other modules. For BAC standards, the set is completed by new subjects: Contribution of Building Management System (or Technical Building Management TBM) to optimize the energy use of technical building systems and the Inspection for Building Automation and Control. BAC performance has a tendency to decline over time if not actively checked, maintained and adapted to the actual use of the building (independent of the building type). These subjects will be in another article of BAC Consortia Team in charge for M/480.

> However, there are no standards available that address the difficult challenge of building owners to ensure that their buildings keep good performing over time, or better, than when they were first commissioned.

The scope of BAC and TBM covers in accordance with their role from one side all installed and involved Technical Building Systems (where the effect of the BAC is used in the calculation procedures) and from another side the global overall optimization energy performance of a building.

There are two ways of calculation of the contribution of BAC for energy performance of buildings:

- One is using the factor methodology described in the EN 15232-1; this methodology is used for Inspection of Building Automation, Controls and Technical Building Management EN 16946-1 (Module M10-11 in the Modular Structure of EPB Standards set).
- Second is in the underling standards of the other Technical Building Systems (M3, 4, 5, 6, 7, 9) as DATA INPUT where the CONTROL IDENTIFIERS are used in the calculation methodology of the entire EPB standards set.

To explain the second way, several practical examples of visibility and usability are given below:

- HEATING (M3-5), COOLING (M4-5) and VENTILATION (M5-5) as the EMMISION AND CONTROL modules are influenced by EN 15500-1 – Control Accuracy; This is used also in the European Voluntary Certification Scheme eubacCERT; EN 15316-2 will take this reference into account and will required certified products values for the EMMISION (HEATING and COOLING); the energy carrier can be water and/or air.
- The DISTRIBUTION/GENERATION standards on HEATING & COOLING will take into account the EN 12098 series.
- The VENTILATION standards introduce «DEMAND CONTROL VENTILATION»; see also the article "The impact of control on the energy use of fans in building ventilation systems" issued in REHVA JOURNAL October 2015. The author, dr. Jürg Tödtli described and developed this concept in the mathematical formulas to be used in this case.
- EN 15232 as EN 16496 and EN 16497 will be the standardized references for the eu.bac- system and basis for the tool for INSPECTION.

Also, these references and BAC techniques will be used for the EU-VCS (Voluntary Certification Scheme).

Implementation of the BAC standards by BAC industry

BAC manufacturers are heavily influenced by the developed BAC (EPB) standards. Their own R&D programs and production to implement the CEN/TC247 standards across Europe and worldwide, is supporting the dissemination activities of the NSB's (National Standard Body's) on national level. The successful rollout to the market place of BAC standards by the industry are supports the transparency and visibility of the whole building construction chain starting with specifications for design, commissioning and use. Taking into account

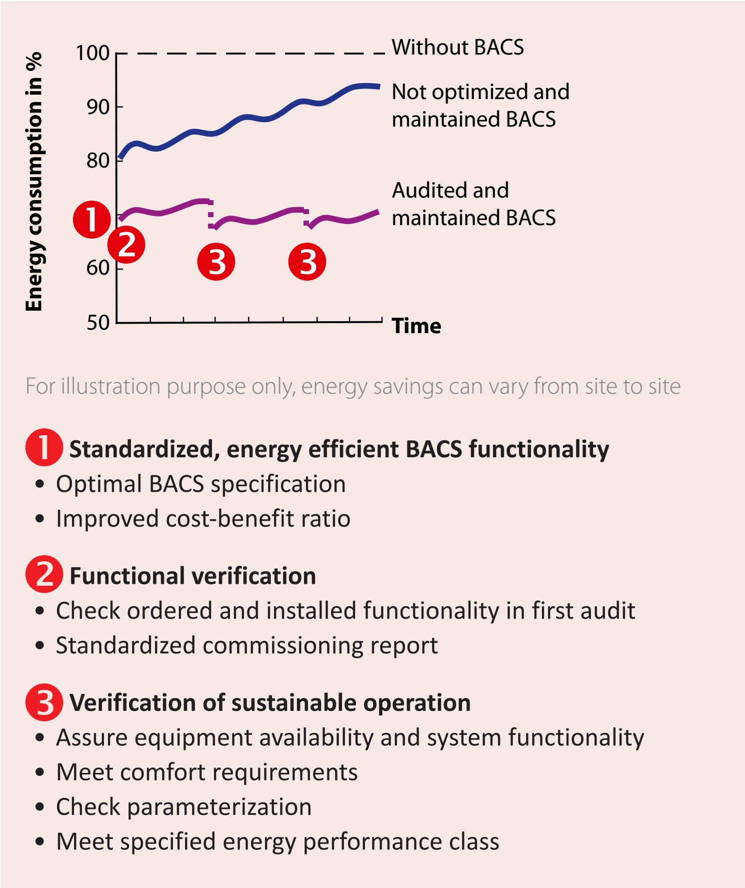


Figure 1. Description of the goals of eu.bac system and the relation between EPB and BAC systems.

Table 1. The global overview of the whole work of CEN/TC247.

Reference	Title	Related TR
EN 12098-1	Controls for heating systems - Part 1: Control equipment for hot water heating systems - Modules M3-5,6,7,8	CEN TR 12098-6
EN 12098-3	Controls for heating systems - Part 3: Control equipment for electrical heating systems - Modules M3-5,6,7,8	CEN TR 12098-7
EN 12098-5	Controls for heating systems - Part 5: Start-stop schedulers for heating systems - Modules M3-5,6,7,8	CEN TR 12098-8
EN 15500-1	Control for heating, ventilating and air-conditioning applications - Part 1: Electronic individual zone control equipment - Modules M3-5, M4-5, M5-5	CEN TR 15500-2
EN 15232-1	Energy performance of buildings - Part 1: Impact of Building Automation, Controls and Building Management - Modules M10-4,5,6,7,8,9,10	CEN TR 15232-2
EN 16946-1	Inspection of Building Automation, Controls and Technical Building Management - Module M10-11	CEN TR 16946-2
EN 16947-1	Building Management System – Module M10-12	CEN TR 16947-2

the full buildings live cycle starting with new constructions and existing buildings, using upgrading, evolution, and retrofit techniques for the BAC systems.

Industry associations such as Syndicat ACR in France or eu.bac (European Building Automation and Control Association) in Europe support this action. They provide lunch programs to support the implementation for the usage of the standards to fulfill the requirements of the EPBD recast and national regulation. This also means that there is a strong wish of the BAC Industry that the activities such as REGULATION, STANDARDIZATION, CERTIFICATION and LABELING use the same REFERENCES to describe BAC Systems. This means in practice that the BAC standards could be used and referenced in national regulation and also used as basis for EU Voluntary Certification Scheme and EU Labeling Schemes.

There two important initiatives of eu.bac on EU level: the eu.bac Certification and Labeling Scheme (already in place from 2005 with more than 200 public domain certificates based on EN 15500) and eu.bac system based on EN 15232.

A small description of the goals of eu.bac system and the relation between EPB and BAC systems are shown in **Figure 1**.

Conclusion

With the activity of CEN/TC247/WG6 on basis of the EU-mandate M/480, the BAC visibility and usability has definitely made a huge step ahead in Europe. It is clear that the proposal to make BAC specifications VISIBLE and USABLE at EN and also ISO level will allow a better support for the BAC industry worldwide! ■

Literature

[1] CENTC247 EN standards: see **Table 1.**

[2] www.eubac.org

[3] www.eubaccert.eu

[4] www.acr-regulation.com

About the contribution of BAC and BMS to energy performance of buildings

CLEMENS FELSMANN
Chair of Building Energy Systems and Heat Supply at Technische Universität Dresden, Germany
CEN TC247/TC371 Technical Expert for BAC
clemens.felsmann@tu-dresden.de

The key-role of Building Automation and Control and Technical Building Management is to minimize building energy use and related greenhouse gas emissions required to operate any building tending at the same time to ensure both human comfort and the occupant's satisfaction with room climate conditions. It is obvious that organisation and management of HVAC systems is at least as much important as the installation of energy efficient and well-designed energy related products. Finally, the question raises: how to quantify and visualize this outstanding importance of building management systems to interested parties as designers, investors, building operators, and building owners, respectively? Within the EPBD calculation framework EN 15232 is well known, for years, as European standard describing, classifying and evaluating different BAC functions having an impact on the energy performance of buildings. These system specific control functions realized are dedicated to the physical chain of transformation of the energy, from Generation, to Storage, Distribution and Emission. Controllers are communicating along the chain and across different disciplines (e.g. heating, cooling, ventilation) via a standardized open bus, such as BACnet, KNX or LON. This multidiscipline and complex control (heating, cooling, ventilation, DHW, lighting…) can be used for optimization. For example, INTERLOCK, is a control function that avoids heating and cooling in same time.

Usually the functions implemented in the controllers can be programmed or adjusted by choosing certain parameters. The CONTROL FUNCTIONS present in a BAC system or TBM, are organized in EN 15232 according to the matrix given by Modular Structure of EPB standards. The Table starts with Heating Emission, Distribution, Storage and Generation followed by Domestic Hot Water, Cooling, Ventilation and Lighting. Each function is described in detail, in accordance with the type (level) of the function: from the lower type (NO AUTOMATIC CONTROL Type=0) to most advanced types. For practical reasons, four different BAC efficiency classes (A, B, C, D) of functions are defined both for non-residential and residential buildings. This is the fastest way to specify a BAC or a TBM.

- Class D corresponds to non-energy efficient BAC. Building with such systems shall be retrofitted. New buildings shall not be built with such systems. One is in class D: If the minimum functions to be in class C are not implemented.

- Class C corresponds to standard or commonly accepted BAC. To be in class C minimum building automation and control functions that could be defined on a national level shall be implemented.

- Class B corresponds to advanced BAC and some specific TBM functions. To be in class B it is required that room controllers shall be able to communicate with a building automation system.

- Class A corresponds to high-energy performance BAC and TBM. To be in class A, room controllers shall be able for demand controlled HVAC (e.g. adaptive set point based on sensing of occupancy, air quality, etc.) including additional integrated functions for multi-discipline interrelationships between HVAC and various building services (e.g. electricity, lighting, solar shading, etc.).

A reference list of BAC functions defining minimum requirements of BAC functions according to BACS efficiency class C is given in EN 15232. Unless differently specified this list shall be used:

- to specify the minimum functions to be implemented for a project;
- to define the BAC function to take into account for the calculation of energy consumption of a building when the BAC functions are not defined in detail;
- to calculate the energy use for the reference case in the BAC efficiency factor method.

Both energy consumption of the building as well as indoor conditions are depending on CONTROL ACCURACY which is the degree of correspondence between the ultimately controlled variable and the ideal value in a feedback control system. The controlled variable could be any physical variable such as a temperature, humidity, pressure, etc. The ideal value is in fact the SET POINT established by the user (occupant) when he determines his level of comfort. It is clear that the entire control loop is concerned with all the elements constituent, such as sensors, valves and actuators. The impact of BAC functions on the annual energy use of a building can be calculated within the EPBD simulation environment by either a detailed method or a so-called BAC factor method. The detailed method models physical effects in the HVAC control loops in very detail thus requiring lot of technical information about the system configuration and its control algorithms while the BAC-factor method is simplifying this approach for practical estimation taking into account typical building and HVAC configurations.

At this time one has to keep in mind that EPBD calculation approach is based on DEMAND ORIENTED CONTROL. Usually these strategies implement the direction of the energy flow (from GENERATION to EMISSION) with flow of calculation (from building needs to delivered energy). Usually for this complex CONTROL STRATEGY, a TBM is necessary with a distributed specific control for each Technical Building System who communicates in system architecture. More clear, this Demand Oriented Control works as follows: When the comfort is reached in the Emission area, the controller from the Emission sent the message to the controller in charge of Distribution to stop to distribute energy, who sent the message to the controller in charge of Storage either to store the energy and if the Storage cannot store more energy sent the message to the controller in charge with the Generation to stop to generate more energy.

In addition to that a Technical Building Management System may be installed in reality (depending on the size of the building and complexity of the management task) if several Technical Building Systems are used in the building. Specific global functions are implemented here, necessary to reach the key-role mentioned above. Usually, in this case, an interrelation with the Building as such will occur, mainly to take in consideration the building needs; for example, due to outside temperature, taken into account the inertia of the building when the control will reach the set point in a room. BAC orchestrated by TBM will allow for the global optimization of the Building Energy Performance. Therefore, a CONTROL STRATEGY is applied to reach a goal. Optimal control strategies deliver a desired level of control at a minimum cost. A CONTROL STRATEGY could consist by a CONTROL FUNCTION or a group of CONTROL FUNCTIONS.

A new standard EN 16947 has been established under the M480 to address the TBM/BMS functions. This new standard covers several functions of the application of the Building management system. Each function is represented by at least one calculation method. The functions are as follows:

- "Function 1 – set points", is meant for set point definition and set back. An example of a CONTROL STRATEGY consist by a CONTROL FUNCTION is OPTIMUM START, OPTIMUM STOP, Night SET BACK described in the standard EN 12098.
- "Function 2 – run time" is intended for estimating run times. An example of a CONTROL STRATEGY who is realized by a group of CONTROL FUNCTIONS is the CONTROL STRATEGY used by INTERMITENCE. This function uses several CONTROL FUNCTIONS, OPERATION MODES, OPTIMUM START-STOP and TIMER in same time. All elements together are called either Building Profile or User Pattern. Usually, to implement such Building profile, a TBM is a prerequisite.
- "Function 3 – sequencing of generators" is intended for estimating the sequential arrangement of different

generators. Generators are either from same type (e.g. several boilers) or different types (e.g. a boiler and heat pump) including also the Renewable Energy Sources. The strategy could be based as follow:

- Priorities only based on running time;
- Fixed sequencing based on loads only: e.g. depending on the generators characteristics, e.g. hot water boiler vs. heat pump;
- Priorities based on generator efficiency and characteristics: The generator operational control is set individually to available generators so that they operate with an overall high degree of efficiency (e.g. solar, geothermic heat, cogeneration plant, fossil fuels);
- Load prediction based sequencing: The sequence is based on e.g. efficiency & available power of a device and the predicted required power.

- "Function 4 – local energy production and renewable energies" is intended for managing local renewable energy sources and other local energy productions as CHP.
- "Function 5 – heat recovery and heat shifting" is intended for shifting thermal energy inside the building.
- "Function 6 – smart grid" is meant for interactions between building and any smart grid.

In general functions could be used independent from each other depending on the BMS features installed in the building. Nevertheless, in some cases methods do represent different levels of similar function and will reference each other. It is worth to mention that impact of both BAC functions by detailed method described in EN 15232 and BMS functions described in EN 16947 on the energy performance of a building can be quantified only in case detailed information about the building, the HVAC system and especially the type of automation, control and management functions is available that can be applied in a holistic EPB calculation method. The method should be used only when a sufficient knowledge about automation, control and management functions used for the building and the energy systems is available. The application of the calculation procedures implies that all automation, control and management functions that have to be account for the operation of a building and its energy systems are known.

In at least any other cases the BAC factor method is a valuable alternative. ■

References

EN 15232-1 Energy performance of buildings - Part 1: Impact of Building Automation, Controls and Building Management - Modules M10-4,5,6,7,8,9,10.

EN 16947-1 Building Management System - Module M10-12 and the connected TR's: CEN/TR 15232-2 and CEN/TR 16947-2.

Industry perspective on the holistic approach to buildings

The holistic approach to buildings developed by the ISO TC 163/205 Joint Working Group (JWG) and as a result of the EU mandate has opened new opportunities and challenges to the built-environment industry.

DRAKE H. ERBE
Chair, ISO TC 86
Member ISO TC 205
Member ISO TC 163/205 JWG
Vice President, Market Development
Airxchange, Inc.
781-421-2806
drakeerbe@airxchange.com

While much of the detailed development has been done within CEN and for the EU, the intent has always been to extend the results through the Vienna Agreement to ISO. **Figure 1** shows the ISO related perspective of the pyramid that illustrates the holistic approach to buildings in a slightly altered and emphasized manner. One will note that the emphasis is on the very bottom and therefore "base" of the structure namely the product information required to support everything needed to move up the pyramid to the ultimate goal of building performance characterization. This article will focus on and explore this

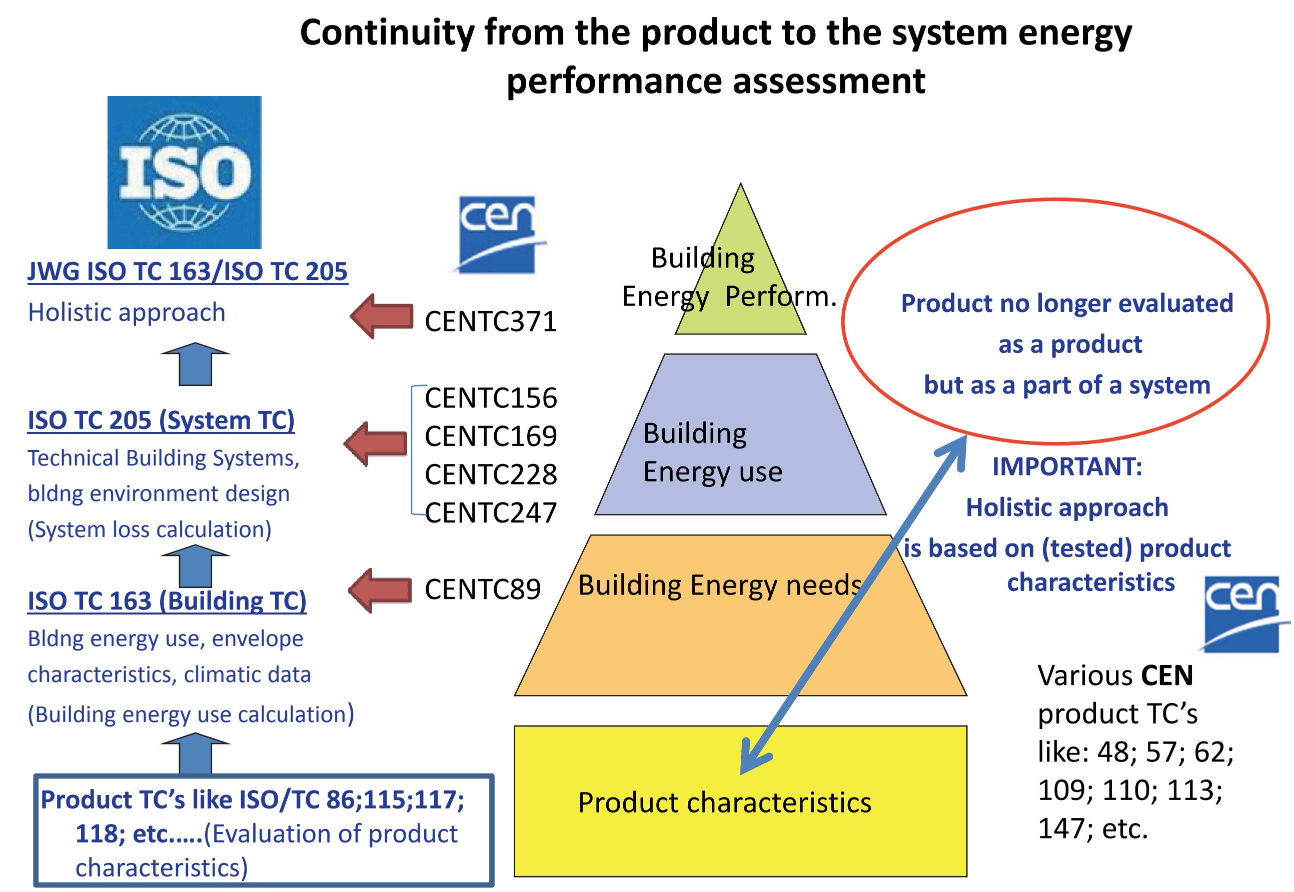


Figure 1. Holistic approach to buildings with ISO related perspective.

bottom rung primarily as it relates to mechanical equipment, sub-systems and systems. One will note in the figure the intent is evaluate products not individually but as part of the system. This is not done lightly and will require a different paradigm from the companies and organizations involved.

The manufacturers of building products and sub-systems have provided information and data about their products in various ways. Some use catalog with tables, suppliers of components to manufacturers that build systems such as air handlers most often use a focused program that can be inserted into the prime movers' program to provide the product data, and some limited products can provide an entire map of their performance throughout the entire application range. All of this information is used in the design of buildings through modeling and other means to arrive at the expected performance of the building. In today's environment, the building's performance has usually been in terms of energy use. What is not always clear is that many products do not have accepted or required energy performance metrics and those that do have limited testing to arrive at the required performance. The Energy Performance of Buildings Directive (EPBD), which is the genesis of the holistic approach to buildings has changed this dynamic. What is now required is a complete characterization of the performance of the building in many different ways. Emissions, source energy focus, and full annual energy use to name a few. Product manufacturers are now being asked to characterize the performance of their product not at design conditions, rather, at any condition the building my see during an average year. The EU has also asked manufacturers to provide information for its ECO-DESIGN mandate which results in a product label for its products and much activity and focus is on this in the manufacturers' companies within the EU. This may or may not be sufficient for the full EPBD.

What is the concern?

As the process has moved along it has always been a concern that since this process developed under the EU mandate and intended for ISO and therefore globalization has done so assuming the product manufacturers know and understand what is going to be required of them now and in the foreseeable future. While it may be true in some cases within the EU, it is not the case in other regions of the world. Product information, technical terms related to inputs and outputs, energy metrics and coverage of the application of performance is not universal nor is it currently designed to be provided in the way necessary to support the EPBD.

The JWG has recognized this and I am the Task Leader of a team that will be providing communication on this need to the built-environment industry at large so as to insure that companies that will be required to provide information, data, and other support will understand the need and move to organize their resources to do so. This is not a trivial task; it will require business leaders to fully understand the complexities of the EPBD and to insure they are fully aware of where their products and services "fit" in this scheme.

As chair of ISO TC 86 Refrigeration and Air Conditioning, I am also keenly aware of the need to insure all products and technologies have coverage in the standards community of the built environment. In addition to ISO and CEN, there are also ASHRAE, Eurovent, AHRI (The Air Conditioning, Heating, Refrigeration Institute) standards, just to name a few, whose efforts should also be incorporated into the Global Community. These organizations need also to be kept informed and fully understand the requirements as the effort moves forward. Today, it is safe to say that there are few product standards or certification programs that provide information and performance characterization of the products to support the holistic approach to buildings. In addition, within ISO, there is not full coverage of all the technologies and products needed to insure all buildings can comply with the EPBD if it is incorporated into the ISO organization. While setting the standards and initial compliance with standards is one part of the effort, sustaining and maintaining the standards on an on-going basis is quite another. It will require another critical look at the ISO organization to fully support the built environment.

Effect on the built-environment industry

Another aspect of the EPBD is the output of all the analysis, calculation, modeling etc. is expected to be the building label as previously mentioned. Building labeling is being used in the EU today and volunteer programs and jurisdictional requirements elsewhere are in play as well. However, at present this is all based on the information that the manufacturers, engineers etc. can provide which, in many cases, is extrapolated from a small set of test points, or empirical data from curves or calculations which in the past have been "good enough" based on the requirements of the project. However, if this building label becomes more important due to type of information it identifies and becomes tied to the asset value of the building i.e. "one has to prove that their building is an A building label to get the financial backing for the project", the level and accuracy of the information provided will increase in importance. Accordingly, the base of the pyramid information providers, the product manufacturers, will be asked to increase the accuracy of the information of their products in order to move up the ladder to sub-systems and full systems for full characterization of performance. This includes understanding the impact of fuel and the energy transfer of their products. Imagine if you will that a project is designed as an A building and the financial pro forma was based on this outcome and the measurement and verification of the commissioning process resulted in a B building. What happens to the value of the building and what is the impact of the financial evaluation and expected return to the investors/owners if this occurs? I submit that due to that sort of scenario, the level of expectation of the accuracy of the information provided from the EPBD will increase significantly.

Of course, all this is a view of what might happen in the future. At this point, is important for all levels of the pyramid structure to be very aware of the impact of the information and data provided and insure that attention is paid to its accuracy and adherence to the requirements. While this article primarily focuses on manufacturers of equipment in the mechanical portion of the building I would submit that all of the entities involved in the built-environment could benefit from becoming more involved in understanding the details as it relates to their particular interests.

This article has outlined a very real opportunity and some cautions as we move forward through the EPBD. CEN has developed a matrix which supports the standard development process which must be understood by all members of the community, but especially the product and system providers. It has been the intent of this article to prompt all members of the built environment to get involved, understand, evaluate and organize the resources needed to support the impending CEN-ISO effort so as to not find themselves in an uncompetitive position in the future. ■

The Ecodesign Preparatory Study on Smart Appliances

In the Autumn of 2014, DG Energy launched a 2-year Ecodesign Preparatory Study on Smart Appliances (Lot 33) which will provide an analysis of technical, economic, environmental, market and societal aspects that are relevant for a broad market introduction of smart appliances. This article summarizes the scope and status of this preparatory study.

Keywords: Ecodesign smart appliance

KOEN VANTHOURNOUT
Senior researcher
VITO and EnergyVille
Boeretang 200
2400 Mol
Belgium
Koen.vanthournout@vito.be

SARAH BOGAERT
Project manager
VITO and EnergyVille
Boeretang 200
2400 Mol
Belgium
Sarah.Bogaert@vito.be

One of the basic laws to maintain the stability of the electricity system is that the electricity production must equal the electricity consumption at all times. For this purpose, a wide range of control and planning systems are deployed, operating in different time ranges from milliseconds up to years. Traditionally, it is the production side that adapts to the consumption side. More specifically, it is dominantly the fossil fuel plants that produce less or more in function of the changes in the electricity demand.

This arrangement is increasingly under stress, as the share of renewable and typically intermittent and non-controllable generation is growing. At the same time, environmental and other concerns lead to a decrease in fossil fuel generation. And while the electrification of transport – electrical vehicles – and of heating – heat pumps – allows for a reduced primary energy consumption, the total electricity consumption is further increased as a side-effect. Summarized, the share of flexible electricity production relative to the total electricity demand is decreasing, and therefore new sources of flexibility are required to further ensure the stability of the electricity system.

Those new sources of flexibility can be subdivided into two clusters. A first cluster contains everything energy storage related: batteries, pumped hydro, etc. A second cluster is demand response, which can be considered as the inversion of the traditional control paradigm, i.e., not only adapt the production side, but also adapt the electricity consumption in function of the (renewable) electricity production and/or to avoid grid congestion.

Although there are large differences between the European Member States, in general demand response and demand side flexibility are well-developing in the industrial sector where the large energy consumption of a single installation justifies a customized approach and technical solutions. Most countries have programs that allow automatic adaptation of the electricity consumption of such large energy intensive industrial installations. However, and despite the significant potential, residential demand response is only slowly developing. The cause is what can be described as a "chicken and egg problem": there are virtually no residential demand response programs, because there is not enough capacity available in terms of installed base of appliances with the required functionality. On the other hand, development of appliances with demand side flexibility features is low because there are so little residential demand response products which justify the investment in this extra functionality. Without price signals, capacity fees and/or other rewards, there is no incentive for consumers to buy demand response ready appliances.

To overcome this chicken and egg problem, the European Commission launched several initiatives to stimulate the introduction of residential demand response. One of these is the Ecodesign Preparatory Study on Smart Appliances (lot 33 - http://www.eco-smartappliances.eu). With this preparatory study, the European Commission wants to investigate the technical, economic, environmental, market and societal aspects that are relevant for a broad market introduction of smart appliances in residential and commercial sectors and the policy instruments that can stimulate a wide roll-out of smart appliances in Europe. The study is being executed by an expert consortium composed of VITO, Viegand Maagøe, Rheinische Friedrich-Wilhelms-Universität Bonn, MINES Paris-Tech and Wuppertal Institute. The effective start was in the autumn of 2014 and the study is expected to be finished in September 2016.

Smart appliances?

From the start of the study, it became clear that 'smart appliances' is a term with many domain dependent meanings. In its broadest interpretation, it is any appliance that is internet connected and for which a cloud application exists (see **Figure 1**). The preparatory study, however, approaches smart appliances from the very specific angle of the electricity domain. Hence, for the purpose of the lot 33 preparatory study **a smart appliance is defined as an appliance that provides Demand Side Flexibility**:

- It is an appliance that is able to **automatically** respond to external stimuli e.g. price information, direct control signals, and/or local measurements (mainly voltage and frequency);
- The response is a **change** of the appliance's **electricity consumption pattern**. These changes to the consumption pattern is what is called the 'flexibility' of the smart appliance.

The study focusses on the smart appliances and the potential flexibility generated, independent of how this flexibility is used in a specific energy market structure. The range of demand response business cases and energy markets that can be supported should be as wide as possible, but market design self, i.e. what market structure or business cases are to be preferred, is out of scope.

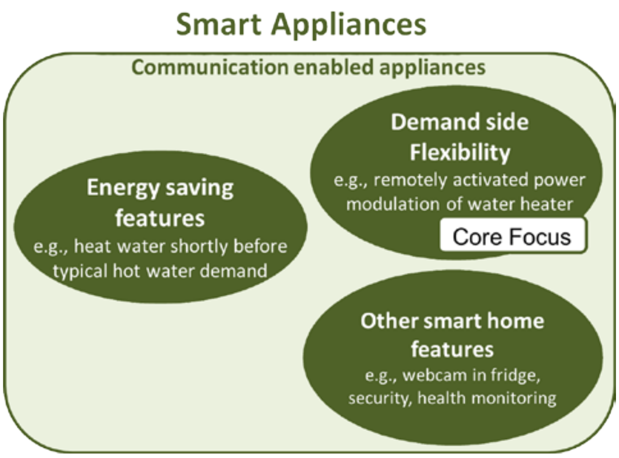


Figure 1. Various functionality classes associated with smart appliances, with the functionality class highlighted that the preparatory study is focusing on, i.e., demand side flexibility.

Lot 33: a horizontal Ecodesign study

The Ecodesign Directive [1] establishes a framework to set mandatory ecological requirements for energy-using and energy-related products sold in all 28 Member States, with the purpose of reducing the energy consumption and other negative environmental impacts. These Ecodesign requirements may be complemented with mandatory labelling requirements [2].

Typical Ecodesign preparatory studies focus on the energy efficiency of a single product group, and do so according to the Methodology for the Ecodesign of Energy-related Products ("MEErP") [3]. However, the Preparatory Study on Smart Appliances is atypical and deviates from this default approach. It focuses on demand response flexibility, which indirectly supports energy efficiency, as it provides functionality that allows the electricity grid to support a larger share of renewable production and more electrified energy-efficient appliances. Hence, environmental and economic impacts are calculated at the level of the overall energy system, not (only) the product itself. Secondly, it also adopts a horizontal approach, meaning that it takes a broad range of product groups into consideration, rather than a single one. The MEErP has been designed mainly for specific and homogenous product groups. Despite this, the study follows it where possible.

Appliances in scope of the study

The focus of the preparatory study on smart appliances is the demand side flexibility of residential end devices. 'End device' means the appliance that is controlled and that alters its electricity consumption, as opposed to the equipment higher up in the control chain (devices that control other appliances or end devices).

The end devices within the scope of the study are listed in **Table 1**. These product groups have been categorized based on their potential, which was analyzed based on the product-specific end-use parameters and user requirements, daily and seasonal use patterns, comfort constraints and expected flexibility.

Out of these categories, following product groups were selected for further in depth study:

- Washing machines
- Tumble dryers
- Dishwashers
- Refrigerators and freezers

- Commercial refrigeration products
- Water heaters (continuous)
- HVAC heating in residential and tertiary buildings (electric heating)
- HVAC cooling in residential and tertiary buildings (air conditioning)
- Residential energy storage systems

The study will further focus on the functionality that is required to achieve **demand response readiness** of the appliances. An example of such functionality is, for instance, the ability to remotely switch air conditioners on or off within the boundaries of the user's comfort settings.

A second focus is the **interoperability** of smart appliance, i.e., what is required to ensure that smart appliances can be used 'plug and play' throughout the E.U., without risk of customer lock-in.

Table 1. The appliances within scope of the preparatory study, divided into three categories;'high potential': high flexibility potential with few comfort and/or performance impacts, 'medium potential': smaller flexibility potential and/or larger comfort/hetalth impacts, and 'low/no potential': only emergency flexibility potential.

High potential	Medium potential	Low/no potential
Washing machines	Refrigerators/freezers	Electric water heater (instantaneous)
Dishwasher	Battery operated rechargeable appliances (smart phone and tablets)	Battery operated rechargeable appliances (others)
Washer-dryer	Tumble dryer	Vacuum cleaners
HVAC (radiators, boilers, heat pumps, circulators, residential and non-residential air conditioners)	HVAC (extraction fans, heat recovery ventilation and air handlings units)	Range hoods
Buffered electric water heater		Lighting
Battery storage systems		Electrical hobs
		Ovens

Current status and next steps

A stakeholder consultation process has been set up and all deliverables are available via the website http://www.eco-smartappliances.eu. The site also provides information on the procedure and timeframe for written comments. A first stakeholder meeting, held on 10 March 2015 in Brussels, was dedicated to introducing the scope, objectives and structure of the Preparatory Study, and included discussions on the products' scope, and the standardization and interoperability issues. The final MEErP Task 1 report of the study, which defines the scope, has been published in December 2015.

During a second stakeholder meeting on 19 November 2015, the draft reports of MEErP Tasks 2-4 were discussed, containing respectively an economic and market analysis for smart appliances, the impact study of smart appliances on the user and a technical analysis of the existing products and the state of the art.

Currently, model calculations are being executed to assess the economic and environmental value of the flexibility provided by smart appliances for the electrical energy system. Draft results are expected to be published in the next months. The next stakeholder meeting to discuss these results is expected to take place before Summer. The study is expected to finish by the end of September 2016. ■

References

[1] Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products. http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32009L0125.

[2] Directive 2010/30/EU of the European Parliament and of the Council of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0030.

[3] Methodology for the Ecodesign of Energy-related Products (MEErP). http://ec.europa.eu/growth/industry/sustainability/ecodesign/

Articles

NZEB 2.0: interactive players in an evolving energy system

Buildings are more than just stand-alone units using energy from the grid. They are becoming micro energy hubs consuming, producing, storing and supplying energy more flexible than before. Buildings can even help balance the grid with demand management and could play a leading role in transforming the EU energy market, shifting from centralised, fossil-fuel based, national systems towards a decentralised, renewable, interconnected and variable system.

Keywords: Smart Buildings, Energy Efficiency, Electricity Market, nZEB, Energy System, Renovation, Demand Response, Energy Storage and Innovation..

ROBERTA D'ANGIOLELLA
BPIE - Buildings Performance Institute Europe

MAARTEN DE GROOTE
BPIE - Buildings Performance Institute Europe

MARIANGIOLA FABBRI
BPIE - Buildings Performance Institute Europe

Buildings are becoming "all-in-one" entities that could facilitate a shift in the energy system, create "benefit-for-all" conditions and bring multiple positive outcomes, including an increased uptake of renewables and the resultant decarbonisation, energy and cost savings, as well as increased control and comfort for its occupants.

Building control companies will soon be able to extend demand response services to the residential market and new market actors, such as ICT companies like Google or Apple, and Energy-utilities are starting to capture value by entering the building market with new products and services. The shift would also create an opportunity for providers of HVAC, monitoring systems, appliances and even construction materials to adapt their products to this new technological environment.

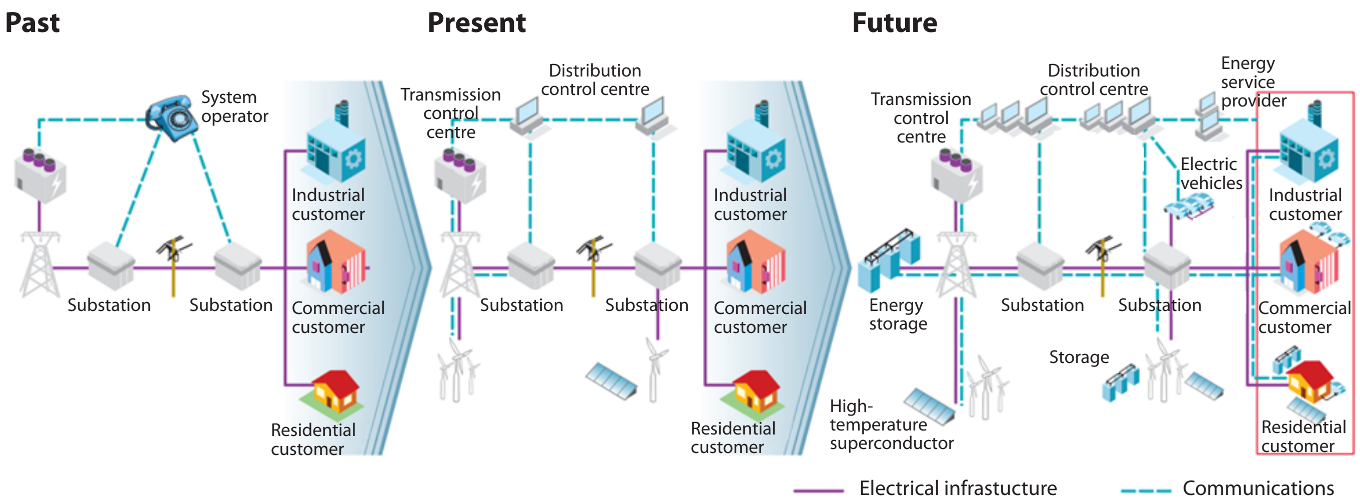


Figure 1. The smartening of the electricity system is an evolutionary process, not a one-time event (Source: IEA, 2011)

Buildings as micro energy hubs

Buildings will increasingly interact with the energy system and have the potential to take up an important role in the power-supply-system stability by acting as micro energy hubs, providing renewable energy production, storage and demand response.

Demand response (DR) is a reduction in power demand designed to reduce peak demand or avoid system emergencies. It can be more cost-effective than increasing infrastructure to meet demand: instead of steering the supply side with power generation to balance the grid, demand response steers the power demand of energy consumers by using price signals to modify their consumption. All categories of consumers (industrial, commercial and residential) can engage in demand response by employing different technologies and strategies to achieve shifts in demand.

As a result, buildings have the potential to become a source of flexible energy demand and storage, providing distribution and transmission system operators with the services they need to balance available supply and manage power quality at all times. Demand response could be enabled by adopting energy management systems (EMS) and new technologies such as smart meters, smart thermostats, lighting controls and other load-control technologies with smart end-use devices. Steps in this direction are already being made with the development of new apps allowing consumers to check on the status of their home appliances and thermostats and take control, enabling energy savings with a simple touch on their smart phones.

A lot is happening on the decentralised power storage front as well. More and more international companies (i.e. Tesla, Panasonic, and Johnson Control) are starting to enter the building market with home battery storage, creating a revolution towards more consumer driven power storage. This is a signal that should wake up European policymakers. Battery storage is developing fast and companies and innovators around the world are in fierce competition. The burning question is whether EU policies will trail the trend and leave it to North American, Japanese or Chinese entrepreneurs to occupy this new market, or whether upcoming policy decisions will give Europe an innovation and implementation lead on the topic. The regulatory framework should encourage innovation in the field and should facilitate the market uptake of these new technologies, with the ultimate goal of having a highly efficient and smart building stock.

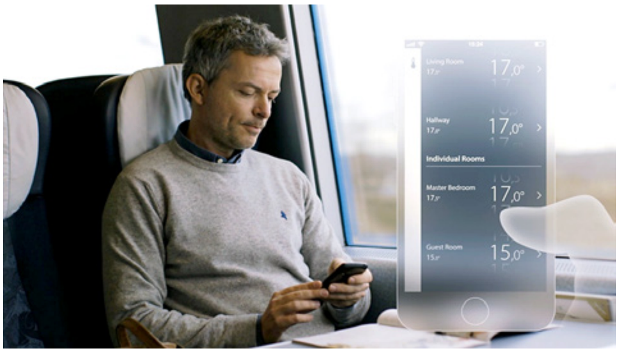


Figure 2. Smart appliances initiating smart control and automatic demand response (Source: Danfoss, 2016)

It is too early to predict how the market will evolve in practice, but this is a clear indicator that it is shifting from innovation to a growth phase. Storage possibilities will facilitate change in consumption over time, through load shifting and peak savings. Battery-based projects are likely to account for a large part of future building-related storage investments, but other storage technologies options, such as thermal and hydro storage, could be considered as well.

According to the STRATEGO project, thermal storage is much cheaper than electricity storage. Domestic hot water storage is a well-known technology, often combined with solar thermal panels. The storage of heat or cold in the building mass – i.e. walls and ceilings – is a less common technology with a practically untapped potential, despite very low costs and short returns on investment. Another more innovative technique would be to apply construction materials with integrated 'phase change materials', which can store heat or cold 'latently' by using a process that occurs at a defined temperature level.

By using heat storage, buildings connected to district heating could even support cutting the heat-load peak, allowing the district-heating supplier to avoid running the peak-load boilers, often fuelled by conventional energy sources. District heating could as well integrate heat from heat pumps driven by photovoltaic solar panels, geothermal and solar thermal energy, waste heat and municipal waste.

Flexible technologies should have a primary role in the market: in an energy environment of increased complexity, technologies that can rapidly adapt to operating loads, that absorb or release energy when needed, or convert a specific final energy into another form of energy, become highly valued.

Decarbonising heating in buildings and the role of energy efficiency

From an economic perspective, energy efficiency measures and demand response technologies may be perceived as competing options. However, switching focus from energy efficiency to energy flexibility is not desirable, unless the energy efficiency potential is fully exploited first.

Energy system analyses show that in relation to costs, fuel consumption, and CO_2 emissions, individual heat pumps together with district heating form the best heat supply solutions. At the same time, the real potential of demand response lies in thermal appliances, such as heat pumps which, however, achieve their most optimal performance (seasonal performance factor) in buildings with lower heating demand. A shift from boilers with conventional fuels to heat pumps will have the undesirable side-effect of significant contribution to peak electricity demand. Demand response could compensate this peak, but analysis demonstrate that peak shaving becomes less effective for heat pumps with higher capacity (mainly because less energy efficient buildings are not efficient for pre-heating). Considering this, it can be concluded that demand flexible services are more effective in buildings with high levels of energy efficiency.

Challenges to a near-future transition

Despite their potential, demand response and power storage technologies are not mature enough for market breakthrough. A number of issues are challenging the transition ahead, from the need to establish IT protocols and advance metering infrastructures (AMI), to data privacy and behavioural change.

The lack of an overall communication/IT protocol for all components of the demand response process to interact properly, the cost and maturity of storage units and a missing closer collaboration between the building and energy sectors are only some of the challenges.

Most important, consumers are concerned about a decrease in comfort and data privacy and are not likely to use demand response and power storage technologies if these do not prove to be user friendly. The absence of a broad societal acceptance and sense of urgency slows down the process towards the behavioural change needed for a speedily adoption of these new technologies.

Innovation as the key

Eandis, a Belgian distribution system operator, declared: "The old idea of fixing a capacity problem with extra cables is not sufficient anymore. […] IT solutions have become so widespread and cheap that this is a much better solution."

Introducing innovative solutions facilitating buildings' interactions with the energy system is therefore essential to this transition. In particular:

- Third-party business models (aggregators, agents or energy service companies – ESCO's) aggregating demand response, storage and on-site power production, as well as monitoring and controlling them, thus saving money for building owners or occupants;

- Smart controls and household appliances that enable building users to temporarily modulate their energy use according to a user's stated preferences, system, load or price signals at the condition of not compromising the quality of their process;

- A communication interface and steering programme easy to use for building occupants, limiting their effort to implement demand response themselves;

- Dynamic prices needed to enable the uptake of the above-mentioned smart controls.

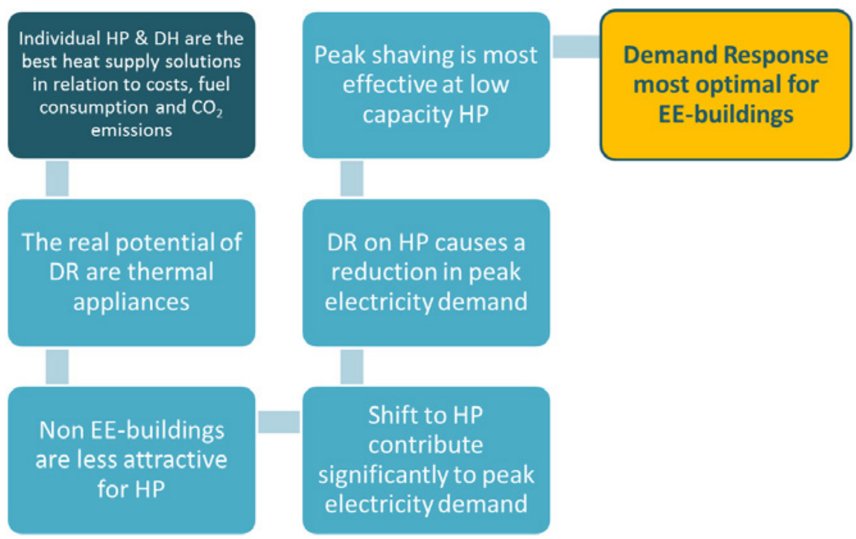


Figure 3. Decarbonising heating in buildings[1] (Source: BPIE, 2016).

1 HP= Heat Pumps; DH= District Heating; DR= Demand Response; EE= Energy Efficiency

Unlocking the transition and mitigating its side-effects

While innovation is instrumental to unlock this transition, it is also fundamental to be mindful of its consequences and to be ready to manage change to ensure that the involved actors are protected from potential side effects (i.e. extra costs of smart meters, the difficulties of adapting to new technologies, the limit to innovation in the absence of a strategic planning and more), and are properly equipped to contribute to this change.

All actors involved can actively contribute to this transition and be ready to manage its potential side-effects:

- Decision-makers should outline a comprehensive vision on the decarbonisation of heat (and transport), and more specifically on the integration of demand response, renewable energy production and storage in buildings, as well as an enabling regulatory framework encouraging buildings' interaction with the energy system;
- Transmission and distribution system operators, energy market actors and decision makers at all levels should strategically plan the grid at both transmission and distribution levels, in order to trigger innovation;
- Both private and public aggregators together with housing associations could extend their support to industrial, commercial and residential consumer groups;
- Electricity suppliers, power system operators, decision makers and energy regulators should make dynamic price signals available for industrial, commercial and residential consumers;
- Large players and sector federations in the smart metering and control industries together with standard bodies should adapt smart user metering and control systems to a universal communication protocol.

These measures are essential to allow buildings to fully take up an active role in the energy system, shaping their role as micro energy hubs and unlocking the opportunities to offer new and tailored services.

The political thinking is currently moving towards this transition, in particular with the legislation under the Energy Union framework. As stated in the Commission communication on the Energy Union, "*an ambitious legislative proposal to redesign the electricity market and linking wholesale and retail to increase security of supply and ensure that the electricity market will be better adapted to the energy transition is needed to bring in a multitude of new producers, in particular of renewable energy sources, as well as to enable full participation of consumers in the market notably through demand response*" (EU Commission, 2015).

The upcoming revisions of the Energy Performance of Building Directive (EPBD) and the Energy Efficiency Directive (EED), and the Energy Market Design consultation are a window of opportunity to mark a turning point to make smart buildings the main interactive players in the European evolving energy system and help them become the new nZEB 2.0. ■

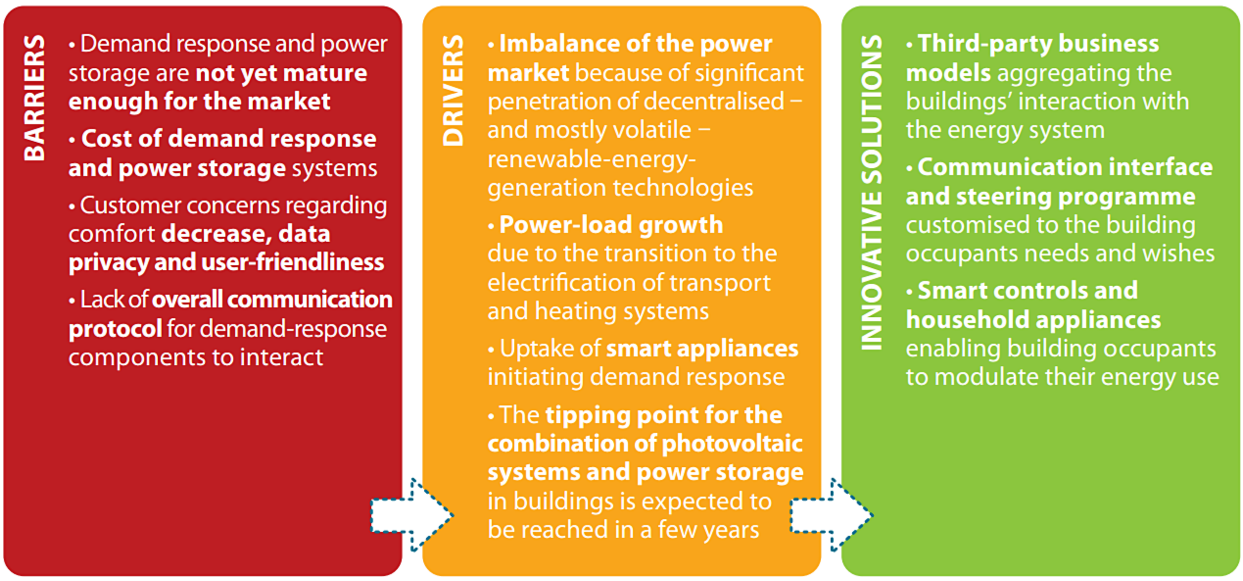


Figure 4. Outlining the innovation of 'the buildings' interaction with the energy system' (Source: BPIE, 2016).

Nearly Zero Energy Buildings in reality, not just theory

ROBERT COHEN
BSc (Hons), MSc, PhD
Technical Director
Verco
Overmoor, Neston,
Corsham, Wiltshire,
SN13 9TZ, UK
robert.cohen@vercoglobal.com

PAUL BANNISTER
BSc (Hons), PhD, FIEAust
Director
Energy Action (Australia)
Unit H, 58-69 Lathlain St
Belconnen, ACT 2617
Australia
Paul.Bannister@energyaction.com.au

BILL BORDASS
MA, PhD, Hon FCIBSE, Hon FRIBA
Research and Policy Adviser
Usable Buildings Trust (UBT)
c/o10 Princess Road,
London
NW1 8JJ,UK
bilbordass@aol.com

The EU requires new buildings to be 'nearly zero energy' by 2020. A citizen might expect this to mean what is says. However, the current requirement is for predicted energy, not actual performance in use. The difference is often a factor of 2 or 3. How can the performance gaps be eliminated?

Keywords: Design for performance, Base building, Commitment agreement, Nearly Zero Energy.

What should NZE mean

All new buildings in Europe must be nearly zero energy (NZE) by the end of 2020, if Member States are complying with Article 9.1(a) of the EPBD recast (1). This paper reflects on the expectations that European citizens might have of this 'nearly zero' concept, particularly those in the real estate industry, when they need to report to internal and external stakeholders.

At first sight, the NZE ambition might be expected to apply to all the energy used in a building. This would be laudable, but the EPBD recast is focused on the energy needed for heating, ventilation and cooling (HVAC) to provide a comfortable working environment, together with domestic hot water[1]. Of course, the energy needs for lighting, lifts and the business energy uses of the occupiers, e.g. small power and ICT, can and should be subject to a complementary NZE protocol to arrive eventually at NZE whole buildings. Stakeholders have to recognise for now that the EPBD's NZE remit for 2020 is to concentrate on reducing to nearly zero the energy used for HVAC and hot water.

1 See the first paragraph of Annex 1 of the EPBD recast which defines how the energy performance of a building is to be determined for a building energy certificate

Government officials charged with transposing Article 9.1(a) appear to believe compliance with the NZE requirement can be fulfilled by theoretical calculations at the design stage of new buildings. We think most stakeholders would disagree, given the performance gaps between design and reality, and assuming the EPBD intends new buildings to play their proper part in achieving the EU's energy security and climate goals - by reducing their energy use in practice, not just in theory. We, therefore, suggest that the NZE requirement should be verified by measurements over a year of operation with normal occupancy. This is not a fantasy: the scope of the EPBD's NZE ambition is similar to what is called **base building** energy use in Australia, where large new commercial offices have been designed for better in-use performance with increasing success since, at least, 2002. The EU needs to adopt a similar approach.

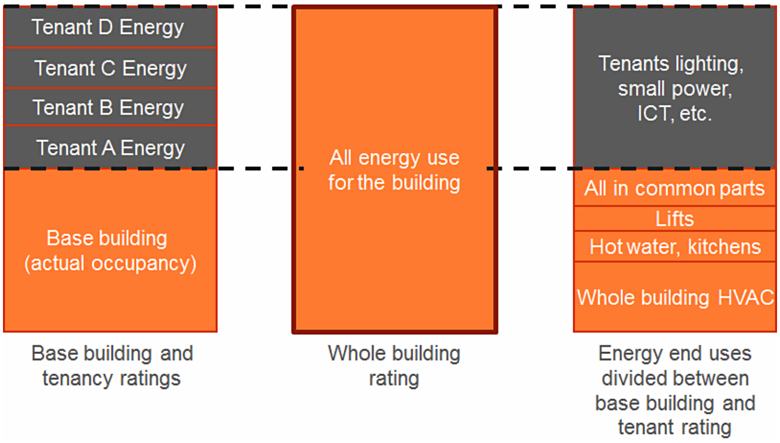


Figure 1. Alignment of energy metering and ratings with landlord and tenant responsibilities.

The other uncertainty in the 2020 NZE ambition is: how 'nearly' close to zero means. Stakeholders might expect NZE buildings to be approaching zero energy use on a scale that covers the full range of performance for the applicable building type. Again Australia offers a template: the NABERS[2] scale for rating office energy performance has eleven points from 1 to 6 stars, with 1/2 stars between the whole stars. The scale was calibrated in 1999, when 15% of buildings performed poorer than 1 star, average base building performance was 2.5 stars and 4 stars was best practice. Today, the stock average rating is 4.2 stars, while nearly all new offices achieve at least 4.5 stars, most reach 5 stars or better, and a few are beginning to achieve 5.5 or 6 stars. 6 stars is a credible contender for the NZE target, being half-way from 5 stars to net zero energy.

Market transformation

Australia has focused its energy efficiency efforts on base building energy performance in use because this metric gained the most traction in the market. Measured base building energy ratings and their disclosure in sale or let transactions are now fundamental to the way commercial offices are managed in Australia: they influence investment decisions for existing and new buildings and impact the management of major investment property portfolios, including sales and purchases (2). Research indicates that better base building ratings enhance property values, reduce vacancy rates and increase yields (3).

One reason why base building ratings have worked so well in Australia is the routine provision of landlord's utility meters, facilitating measurement and benchmarking of base building energy use (see **Figure 1**). Separate utility meters measure energy used by each tenant, giving each party the energy data they need to support management of the energy use they can control.

Commitment Agreements

The impact of the base building in-use rating on asset value and a reluctance of some tenants to occupy space unless they knew its rating created a need for developers and investors to be able to promise how well a new building would perform once occupied. This triggered the concept of the NABERS "Commitment Agreement" in which a developer could enter into a firm commitment to deliver a specified level of in-use performance. This was considered feasible because base building performance is determined by the building's design, its construction, HVAC services, controls, commissioning and management - all things for which the developers, designers, procurement and delivery teams and operations and maintenance people can be responsible. It has been demonstrated that, provided occupancy hours are taken into account, other aspects

[2] NABERS (the National Australian Built Environment Rating System) covers energy, water, indoor environment and waste. The NABERS Energy rating scheme has enjoyed particular success in driving improvement in energy performance of larger prime office base buildings in Australia, for which it is now mandated (on sale or let) by the Building Energy Efficiency Disclosure Act 2010. NABERS is also available, but less widely used, for office tenant ratings, whole office buildings, and for shopping centres, hotels and data centres. NABERS Energy is based on measuring and benchmarking the CO_2 emissions arising from the energy use of buildings. (www.nabers.gov.au/public/WebPages/Home.aspx).

of tenant activity have a relatively small effect on measured base building performance.

Since its inception in 2002, experience of 'design for performance' has accumulated to the point that Australian teams are now capable of designing, building, commissioning, fine-tuning and operating office buildings that routinely achieve measured performance in line with predictions made at the design stage. Overall, there have been a total of 147 Commitment Agreements for base buildings. **Figure 2** shows that 30% have been achieved, 40% are pending, 25% are overdue and just 5% have failed. It also shows nearly all have targeted 4.5 or 5 stars, whilst one has achieved 5.5 stars. This is significant in that 5.5 star performance represents almost four times less energy than 2.5 stars, the average performance of Australian office buildings in 1998. In other words, a 5.5 star building is now achieving the "Factor 4" efficiency improvement hypothesised by Lovins et al in 1998 (4).

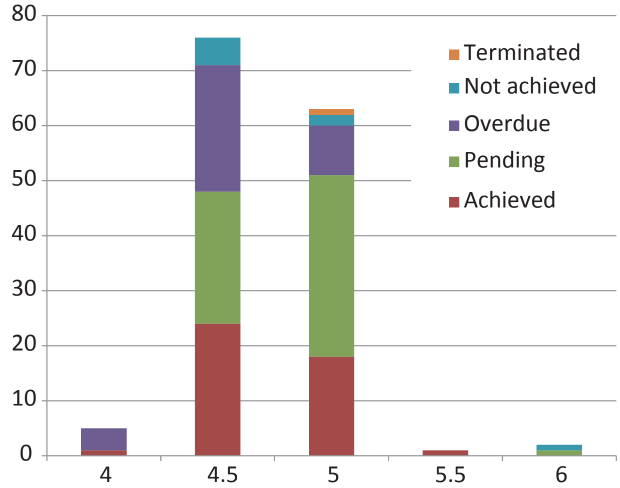


Figure 2. Number of office base building Commitment Agreements by target.

Offices in London and Melbourne compared

There are no intrinsic physical reasons why the base building energy performance of new European offices cannot be as good as it is in Australia. However, the absence of both a disclosure culture and feedback from real-world measurements into new office design and management has contributed to Europe falling behind (5).

In **Figure 3** we compare the base building energy performance of offices in London and Melbourne. London is typically cooler, both in summer and winter, so buildings require more heating and less cooling. The line in **Figure 3** shows the relationship between base building energy intensity in kWhe/m²NLA/yr and the NABERS star level for the State of Victoria (for such international

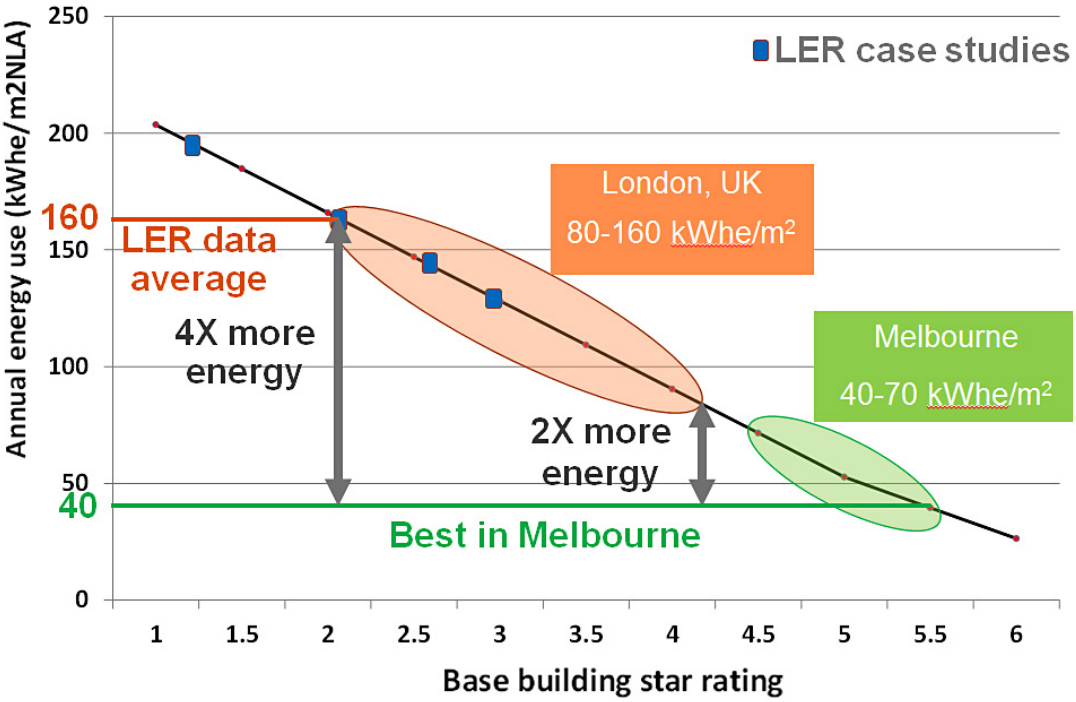


Figure 3. Base building energy use for new prime offices in London and Melbourne.

comparisons of energy efficiency we favour the kWhe energy metric[3]). Most new offices in Melbourne achieve 4.5 stars (70 kWhe/m²/yr) or better, with the best at 5.5 stars (40 kWhe/m²/yr).

Where do new London prime offices sit on **Figure 3**? We cannot say precisely, because UK base building operational performance is rarely measured. However, a set of base building energy use data collected in 2013 averaged 160 kWhe/m²/yr, close to the average performance of buildings in Melbourne in 1999, but four times the best in Melbourne today. From other confidential data sources, London's best performing offices currently seem to be at 80 kWhe/m²/yr, twice the best in Melbourne.

Conclusions

The requirement for new buildings to be 'nearly zero energy' from the end of 2020 creates a unique opportunity for Europe. Let's grasp the nettle and make the claim credible to stakeholders by targeting in-use performance outcomes, verified by measuring and benchmarking. The NABERS 6 star base building performance level is a tried and tested precedent for an achievable 'nearly zero energy' target. ■

[3] kWhe is the "electricity equivalent" of total energy use: kWh of electricity are added to kWh of any fuel multiplied by 0.4 and kWh of hot or chilled water multiplied by 0.5. NLA is net lettable floor area.

References

(1) Directive 2010/31/EU of 19 May 2010 on the Energy Performance of Buildings (recast).

(2) New South Wales Government, How is NABERS being used? Fact Sheet 2, OEH2014/0742, 2014.

(3) Australian Property Institute (2011). Building Better Returns: a Study of the Financial Performance of Green Office Buildings in Australia. Can be downloaded at: http://www.api.org.au/folder/news/building-better-returns-research-report.

(4) von Weizsacker, E., Lovins A.B., Lovins, L.H. Factor Four: Doubling Wealth, Halving Resource Use - Report to the Club of Rome, December 1998

(5) Cohen RR and Bordass WT, "Mandating transparency about building energy performance in use", Building Research & Information Volume 43, Issue 4, 2015 special issue: Closing the policy gaps: from formulation to outcomes, pages 534-552. Can be downloaded at BR&I online: http://www.tandfonline.com/doi/full/10.1080/09613218.2015.1017416

The Energy Performance of new buildings before they come into use is necessarily expressed as an "asset rating" (see EN ISO 52003-1), in most EU countries based on the building "as built" data (or data collected on basis of as built information and additional information collected when the building is inspected in its current existing situation). For existing buildings, it is possible to base an EP on the "operational rating" (using measured energy) or an "asset rating" (based on calculations). The EPBD requires that the Energy Performance rating includes the assessed (in most cases calculated but possibly measured) energy use for HVAC, DHW and (to some extent) lighting under typical conditions (standard outdoor climate, specific indoor climate conditions and standard -well-defined- user behaviour).

A tailored calculation could adapt the typical conditions deployed in the standard EP calculation methodology to the actual running conditions of a building. It would then be technically applicable to compare (and verify) the predictions of a tailored calculation with measured energy values during a year of actual use of the building e.g. per service (heating, DHW). During the construction of the building, users of this approach would need to ensure sub-meters were located where needed to measure the parameters of interest. The managers of the building could use the calculated values for each parameter to set the targets for metered performance. This because measurement data must separate between EPB use and non-EPB use, correcting for effects on the internal heat load due to this not-standardized non-EPB use and correcting for the real user pattern and real weather. Only when the tailored calculation is done properly, does it make sense to verify a tailored asset rating with a measured operational rating for the same parameter (see article on EN ISO 52003-1).

Articles

The road to energy efficient buildings through the eyes of environmental NGOs

FRIEDEMANN STELZER
Environmental Citizens' Organisation for Standardisation (ECOS) - Energiebuendel – Independent Engineering Consultant, Reutlingen, GERMANY
info@energiebuendel.com

CHRISTOFOROS SPILIOTOPOULOS
Environmental Citizens' Organisation for Standardisation (ECOS) - Policy Officer
chris.spiliotopoulos@ecostandard.org

ECOS, a pan-European association of environmental NGOs, and a partner of CEN, is the only organisation representing the environmental interest in standardisation processes at European level. One of their many work areas includes the energy performance of buildings (EPB) set of standards under M/480, which will be published in 2017. Two ECOS representatives share their experiences from the process.

Keywords: EPB, standards, environmental interest, energy efficiency, partial performance indicator, NZEB.

For the past three years, ECOS has participated in a project to renew a set of CEN standards to support the EPBD recast, requested by the European Commission. In an area of wide national divergence in terms of approach, ECOS maintained a strong and ambitious objective: to contribute towards more energy efficient buildings in Europe by putting forth the environmental perspective, technical field expertise, and a call for harmonisation of European approaches. The project's wide scope and ambitious timeline demanded understanding of the main structure, systematic participation, coordination and cohesion between multiple Committees and experts.

Towards a right pathway

This new set of EPB standards under M/480 will be a valuable set of tools for technical experts, professionals and other stakeholders, offering more detailed possibilities for calculation. Considering the challenges, the size of the task, the timing constraints, and the mobilisation of a great number of experts and committees, the results of this project are truly creditable and valuable. At the same time, the challenges were amplified by the lack of sufficient willingness to harmonise the methodologies and reach a common agreement for parts where there was opportunity to do so. This signifies the need to revisit these standards in the future, in order to ensure their continuous improvement and a higher level of harmonisation.

Resistance to a common approach

The road to a harmonised and realistic methodology that would allow comparing the performance of buildings across Europe requires compromises amongst national representations. That is because the building regulation (mainly applicable for new buildings and building permits) in EU member states is subject of national legislation (the subsidiarity principle according the EU treaty). This means that EU-MS's are free to use the developed EPB standards. Different approaches are traditionally embedded in the methods of Member States without necessarily constituting realistic solutions for all climates. One example comes from prEN 16798-1 (former EN 15251), where four different possibilities to determine necessary air flow rates in residential buildings are accepted, based on air change per hour for each room or entity, outdoor air supply per person, required exhaust rates (bathroom, toilets, and kitchens) or on minimum opening areas. The M/480 requirements of having a common template for declaring national or regional options, boundary conditions and input data, do indeed offer flexibility and a level of transparency, but at the same time, prove insufficient for real and fair comparisons across Member States. The tables with default values offered by the CEN EPB standards provide a limited level of harmonisation being only voluntary.

Nearly zero energy buildings need revised thinking

Standards are living documents in the sense that they reflect state of the art and technological progress in terms of methodologies. That means making the methodology adaptable to taking into account a wider variety of possible use scenarios, different types of buildings and available technologies. The current methodologies still do not address those parameters sufficiently. For example, Nearly Zero Energy Buildings (NZEBs) would require calculation methods closer to the experiences gained from research and monitoring of such existing buildings. Some of these possibilities could now be incorporated in the new standards, such as the option to consider internal gains for the calculation of the heat load. This is necessary, as otherwise due to the big time constant of NZEBs the calculations result in oversized heating systems.

At the same time, if the standards are to offer a useful and applicable tool for the assessment of real buildings and the implementation of legislation (e.g. certificates), they should be able to produce results that reflect the reality of the contemporary building stock and allow for a fair comparison of building performance across Europe. Therefore, whilst the **methodologies** in the standards should be adaptable and future-proof, the **data and values used as input** to those methodologies ought to be realistic and, as much as possible, harmonised. Otherwise, divergence in fundamental parameters would only portray a theoretical performance, and would not facilitate any comparison via the means of a certificate or other form.

The value of the partial performance indicators

Another issue of major importance in the new set of standards relates to the connection and interlinkages among them, and the detailed analysis of the different building entities of different usages and different mechanical systems. Therefore, partial performance indicators are introduced, which shows the characteristic values for each of these processes and building parts. This is a huge improvement for designers and auditors to identify problems for each part of an examined building, to facilitate the identification of areas of concern (e.g. energy waste), and to encourage long-term, energy-saving measures and investments. Providing a good analysis tool for professionals will also increase the acceptance for this complex calculation methodology. ■

REHVA position paper on the European Commission review of the energy performance of buildings directive

General remarks

REHVA supports and acknowledges the main principles of EPBD which have been the improvement of energy performance in new buildings with cost optimal minimum energy performance requirements and improvement of energy performance in existing buildings with incentives. Based on technology neutral and performance based approach, all MS have conducted cost optimal calculations with the same (regulated) methodology providing comparable results and many MS have had to set stringent requirements – leading to real and cost effective improvement of energy performance in new buildings which can be seen as the biggest successes of EPBD. As the cost optimal calculation is required in every 5 years, this mechanism as such is a major driver for development and energy performance improvements. So far there is only limited evidence that nZEB requirements will go beyond cost optimal, hopefully the situation will improve. If having been applied properly, the incentives led to deep and integrated renovation with better results than minimum requirements for major renovation. More ambitious targets of EPBD, such as nZEB, are still in progress in most of the MS will need evidently further attention and guidance for successful implementation.

Indoor environment quality (IEQ) problems generated by energy efficiency measures

The EPBD includes the statement that indoor climate cannot be compromised when improving energy performance. However, in practice the EPBD was implemented in most MS without paying attention to indoor environmental quality which has led to serious IAQ and mould problems especially in renovations. It is well known that insulation and air tightness improvements stop natural air change and lead to poor IAQ as well as to significant mould and health problems if controlled ventilation is not arranged when implementing energy efficiency measures. There is also evidence that if properly applied heat recovery ventilation serves also as energy efficiency measure, improving IEQ and efficiency at the same time.

To achieve a win-win situation, the EPBD shall handle ventilation as a separate area besides heating and cooling, streamlined through the whole directive as described below:

1. The revised EPBD shall set a clear mandate for Member States to define minimum ventilation and Indoor Environmental Quality (IEQ) requirements that are monitored and reported in a harmonised way in building regulations across Europe. EPBD shall require the MS to:
    - Define minimum ventilation airflow rates which take into account the intended use of the building and the pollutant generation in rooms;
    - Address the issue of the quality of the installed ventilation system and its regular maintenance.

2. REHVA together with EVIA recommends to develop a common methodology for an indoor environmental quality indicator to be used together with primary energy indicator. This IEQ indicator shall be reported in a transparent way in the energy performance certificates: it shall provide information about indoor air quality (ventilation rate) and about the indoor thermal environment (summer and winter). This shall be implemented based on the EN 15251 (new number prEN 16798-1) standard which define I-IV indoor climate categories. The indoor climate category shall be added to energy performance certificates. In a more detailed description the indoor climate category could be provided separately for air quality (ventilation rate), temperature in summer and temperature in winter.

3. EPBD shall include the requirement of regular inspection and maintenance of ventilation systems in addition to existing requirement of inspection of air conditioning system.
   The inspection shall include:
    - Assessment of the system efficiency;
    - Assessment of the size in relation to the indoor air quality requirements of the building. This assessment shall be repeated when the ventilation system, the defined IEQ requirements or the use of the building have been changed.
    - In building with continuous monitoring and control systems in place, Member States may reduce the frequency of such inspections as appropriate.

4. The general framework for the calculation (Annex I of the EPBD) of energy shall consider ventilation and IEQ appropriate by taking into account at least the following aspects:
    - (c) air-conditioning installations;
    - **(c1) ventilation systems including mechanical, hybrid and natural ventilation;**
    - (d) **air-tightness of the building envelope and ventilation system**;
    - (h) indoor environmental conditions and indoor environmental quality

5. Minimum ventilation requirements shall be especially addressed in the articles dealing with major renovation because the integrated renovation is more complicated compared to new buildings and the risk that renovation measures will not include controlled ventilation is evident if minimum ventilation requirements are not set as prerequi-

sites of incentives. Therefore, minimum ventilation requirements, together with energy performance requirements, shall be included in every grant and financial support schemes for energy refurbishment. There are already some existing good practices, for instance KredEx renovation grant scheme in Estonia that contains mandatory installation of mechanical ventilation in apartment buildings.

All issues listed in the previous 5 points are well addressed in the European EPB standards. Therefore, it is important that the EPBD shall refer explicitly to European standards stating that national requirements and methodologies should be in line with European standards. This is the way to strengthen the role of European standards and to foster harmonisation.

Knowledge gap related issues

The different development level of energy calculation methodologies in the MS as well as inexact definition of major energy uses to be accounted in EPBD has led to the situation where MS use extremely different calculation methodologies and have set nZEB requirements varying from 20 to 270 kWh/m2/y primary energy. REHVA draws attention to the fact that in the case of higher national nZEB values the requirements represent the real energy use of buildings, i.e. calculated and measured energy performance is expected to provide similar results. In the case of very low values they are likely to represent only a small fraction of real, measured energy use. REHVA energy experts are concerned that the credibility of the entire energy performance certificate system is in danger if EPC values report only a small fraction of real energy use, so do not match with reality from the consumers' point of view. REHVA recommend the recent situation with EPCs and nZEB requirements (which should represent EPC class A) shall be evaluated and the necessary corrective actions shall be taken in the review process in order to restore the credibility of the EPC system. To improve this situation, the following is recommended:

1. REHVA has concluded that remarkable differences of nZEB values are caused mostly by the different energy uses included, however the calculation methodologies (input data) have also a large effect on the outcomes. In order to achieve measurable and transparent targets, REHVA suggest that the EPBD energy performance definition shall define major energy uses explicitly to be accounted. The definition shall not include "inter alia" formulation. REHVA energy experts recommend that all major energy uses according to the energy demand associated with a typical use of the building is accounted - including appliances, plug loads and lighting (but no processes as stated in REHVA Report No 4, 2013, as well as in the US DOE common definition for zero energy buildings, indicating international scientific consensus in this issue). This is a key issue to ensure that calculated energy use will match measured energy use.

2. To help the development of national calculation methodologies the EPBD and its Annexes should define common grounds making sure that all MS require and measure similar and comparable values. In order to boost harmonisation REHVA recommends including an EC mandate in the EPBD to issue a delegated regulation on energy accounting similarly as was done to prepare the regulation on the cost optimal calculation.

3. Linked to nZEB requirements REHVA wants to stress a small but highly significant problem with building categories. EPBD Annex I provides relevant list of major building categories but many MS have set nZEB requirements for residential and non-residential building categories only. From engineering point of view, these countries can't tackle the eight building categories specified in EPBD Annex I. Building category specific nZEB requirements are important, because usages, intensities and operation times vary a lot between different building types and optimal EE and RES measures differ accordingly. Therefore, in order to achieve that EP requirements steer to cost effective design solutions, appropriate nZEB requirements and standard use input data has to be defined for each building category.

4. Metering systems are essential both for new buildings and major renovations as already addressed in EPBD Article 8. However, in the review, it would be important to coordinate metering issues in between EED and EPBD so that transparent principles could be set in EPBD for buildings. The iSERVcmb project has shown that it is both feasible and very cost-effective in terms of measured energy savings achieved, to collect operational data at the level of individual sub-meters from new and existing buildings. The best impact was achieved when meters served very clear end uses, such as lighting, small power, chillers/cooling system, ventilation system, space heating and domestic hot water systems. This allowed to locate the problems and to determine actions to reduce the non-intended energy use in straightforward manner. There is also well known solid evidence on individual domestic hot water metering savings. The requirement of major end use and technical systems based metering would be needed to make the implementation common, by following the available best practice for electrical system design. Therefore, an end use and technical systems based metering could be seen more important than dwelling, room or heat emitter based space heating measurement, and could be highly encouraged to be set as the requirement with the aim to achieve operationally nZEB buildings by 2020. •

Light + Building 2016 set new records

light+building

Light + Building, the world's leading trade fair for lightning and building services technology was held in Frankfurt am Main from March 13th to 18th, 2016.

The world's biggest event for lighting, electrical technology and home and building automation set new records such as the number of visitors, the number of exhibitors and the area occupied.

2,589 exhibitors from 55 countries launched their new products onto the world market on around 248.500 square meters of exhibition space. A total of 216,000 trade visitors from 160 countries attended the fair to discover innovations, solutions and new products. In 2016 the organizers noticed a growth of 2.3% of attendees, both national and international. The level of internationality also rose in comparison with the previous events: 67% of exhibitors compared to 63% in 2014 and 49% of visitors compared to 47% in 2014 came from outside Germany. The best-represented visitor nations after Germany were Italy, The Netherlands, France, United Kingdom and China. Considerable growth was also noted in the number of visitors from Spain and East European countries, such as Poland, the Czech Republic, Hungary and Romania, as well as from Turkey, India, Morocco and Iran.

The two main themes at this year's Light + Building were safety, security technology and digitalization. Safety and security technology was the subject of the first Intersec Forum held concurrently with the fair, which had around 150 participants from the fields of planning, installation and operation of buildings and safety and security equipment, as well as from the electrical industry.

200.000 visitors had been attracted by Luminale, an initiative developed by Light + Building and the Biennale of Lightning Culture, that presented over 200 unique lighting installations in the Rhine = Main region. •

40th Mostra Convegno Expocomfort – world leadership in diverse industry sectors

mce mostra convegno expocomfort

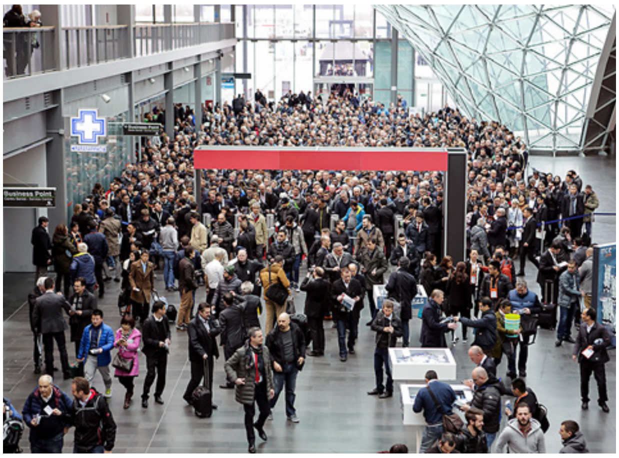
Mostra Convegno Expocomfort took place in Fiera Milano between March 15th and 18th, 2016.

More than 2 100 exhibitors, of whom 40% from abroad, and over 155 000 attendees who made their way to the show from all over the world with a 5.5% increase in foreign attendance figures, confirm that all the world's languages are now spoken at MCE.

A large audience of industry professionals from the four corners of the world who filled the aisles of the show – from more than 134 countries – from Antarctica to New Zealand, including French Guiana, Swaziland and Zimbabwe. In this year's edition the number of both international visitors and exhibitors increased considerably, even the number of Italian attendees increased.

Innovation, efficiency, sector integration and convergence, competencies: the 40th MCE – Mostra Convegno Expocomfort in a nutshell. Different industry sectors had been discussed during the event, mainly residential and industrial installations, air-conditioning, renewable energies and sanitary and HVAC&R.

The success of Mostra Convegno was also achieved thanks to the partnership with the leading trade associations in the industry, including Aicarr, Angaisa, Anima, and Assistal.



Mostra Covegno pleased its attendees with a busy agenda, including also training courses to improve professional competence. Furthermore, this year's main news was the first Mostra Convegno Expocomfort Master just launched: a physical and online meeting place aimed at HVAC&R companies and installers interested in upgrading their technical and professional skills to provide a high level of service to the end-user and at the same time, developing their business. •

ACREX India 2016 – The spirit of the Indian HVAC&R industry

RAKESH KUMAR, Technical Editor, Air Conditioning and Refrigeration Journal, ISHRAE

ACREX India brings together, every year for three days, the who's who of the industry from India and abroad. It showcases the innovations, technical expertise and manufacturing prowess of the industry, and provides a networking platform for professionals. Recognized as the largest exhibition of air conditioning, ventilation, refrigeration and building services in South Asia and the sixth largest in the world, it is more than an exhibition. ACREX 2016 welcomed more than 450 exhibitors of which 116 exhibitors from 18 countries, it hosted almost 35 000 visitors and 19 country pavilions.

From its humble but ambitious beginning at Bengaluru in 1990, ACREX has become the flagship event of ISHRAE that rotates annually between Mumbai, Delhi and Bengaluru. The 17th edition of ACREX India was held from February 25th to 27th at Bombay Convention and Exhibition Centre, Mumbai. The theme, quite appropriately, was *Make in India – Infinite Opportunities for HVAC&R Industry*.

David Underwood, ASHRAE President, lighting the lamp of knowledge at the inauguration as (L to R): K. Ramachandran (ISHRAE National President), PankajDharkar (National Chair, ACREX India 2016) and others look on.

The event saw all the major companies in the industry participating, reflecting their optimism in its future also presenting brand new products. Overseas companies also participated in large numbers, in recognition of India as the fastest growing major economy in the world.

There were several concurrent events like workshops and interactive panel discussions. The evenings saw glittering events, such as:

- Curtain Raiser, opening events of ACREX 2016 based on the theme: 'Sustainabiz: Sustainability Makes Business Sense', dealt with carbon neutrality and sustainable buildings;
- ACREX Awards Night in which the best exhibits in the expo had been honored with an award according to four different categories: Energy Saving; Green and Sustainable; Indoor Air Quality: Innovation and Special Jury Award.
- Danfoss Hall of Fame Night, a new industry benchmark to recognize the excellence achieved in conservation energy by commercial buildings. The Hall of Fame was introduced at ACREX INDIA 2016 for the first time. Among about 100 nominations, 10 projects were nominated. The parameters included energy efficiency, healthy environment, architecture and art, and conducive environment for employees and visitors. One-year operational data was scrutinized.

There were also student events like aQuest and National Student Design Competition. Furthermore, ISHRAE presented its position paper on Indoor Environment Quality to the government of India. •

World Sustainable Energy Days 2016 - REHVA highlights

Report by ANITA DERJANECZ, REHVA Policy and Project Officer

The 15th World Sustainable Energy Days (WSED) was held from 24 - 26 February 2016 in Wels/Austria. It offered a unique combination of events on sustainable energy attracting around 700 participants from 57 countries.

REHVA was represented at the event as VIP guest exhibitor, while **Jaap Hogeling** and **Jarek Kurnitski** were invited as speakers at the different conference sessions.

The 3-days event was a composition of several conferences, an "Energy saving" trade show, interactive sessions and many side events.

6 conferences:

- European Pellet Conference
- European Nearly Zero Energy Buildings Conference
- European Energy Efficiency Watch Conference
- Energy Efficiency Services Conference
- Smart Facade Materials Conference
- Young Researchers Conference: Energy Efficiency & Biomass

3 hands-on events:

- Tradeshow "Energiesparmesse"
- Cooperation platforms on pellets and energy efficiency in buildings
- Site visits on "pellets & wood chips" and on "nearly zero energy buildings"

REHVA had a well visited booth at the event as VIP guest distributing REHVA Journals and promoting EU projects, REHVA guidebooks and other knowledge related services. Below a short summary about the conferences that are the most relevant for REHVA.

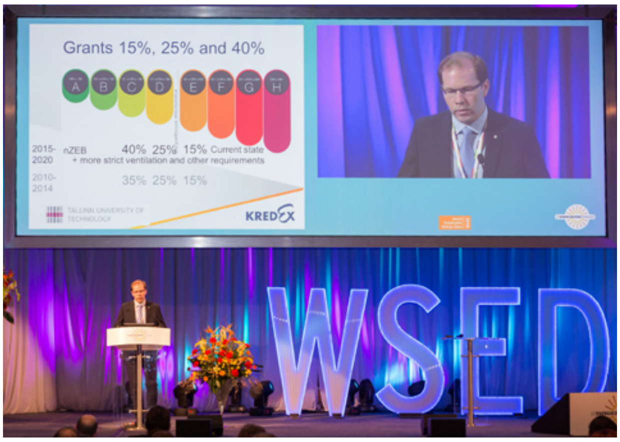
European Nearly Zero Energy Buildings Conference

The conference started with news on NZEBs presented by Gordon Sutherland from the European Commission. The following session "Smart NZEBs in a decentralised energy market" highlighted the role of buildings in transforming the energy market and dealt with the user as the central point of building automation and energy efficiency. Smart buildings as well as smart cities and smart grids were covered. Afterwards international experts, including Jaap Hogeling representing REHVA, discussed about which measures would work best to accelerate building renovation. Jaap Hogeling highlighted among the successful measures the PROF/TRAC project of REHVA that is about developing a European Qualification and Training platform for professionals involved in nZEB design and construction. More information about the project: www.proftrac.eu

Energy Efficiency Services Conference

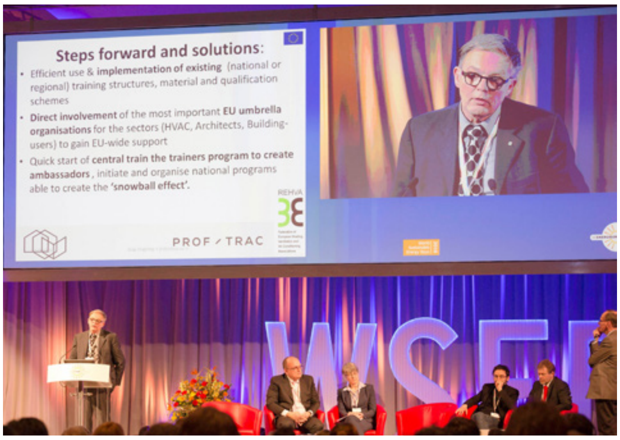
Energy efficiency services are a key for the transition of the building sector. New financing approaches and operation models support not only sustainable buildings and technology innovation but also create jobs throughout Europe. The Energy Efficiency Services Conference, held on 25 - 26 February 2016, focused on business models for sustainable buildings and on examples for successful energy efficiency services in the building sector. Annette Jann from the European Commission presented existing and upcoming policies and initiatives on financing energy efficiency investments, a new platform called Sustainable Energy Forum will be set up supporting MS to exchange experience and successful tools for energy efficiency financing.

Jarek Kurnitski, REHVA Vice-president presented the Estonian good practice of a successful grant scheme for the energy refurbishment of apartment buildings with well-defined and monitored energy performance, technical and indoor environment quality related specifications, including the compulsory installation of mechanical ventilation systems and the promotion of heat recovery. The plenary conference was followed by a workshop about the topic "How to dynamise energy performance contracting (EPC) markets?".



European Energy Efficiency Watch Conference

The European Energy Efficiency Watch Conference offered an update on EU energy efficiency policies and discussed how they can drive innovation and employment. The current status of the implementation of the Energy Efficiency Directive, European experiences with energy efficiency obligations and good practice examples for national energy efficiency policies and implementation were presented. The conference was organised by the European project Energy Efficiency Watch and presented interesting outcomes of an EU wide survey about energy efficiency related policies. An important finding of the survey was for example that policy instruments on the inspection on AC and heating systems is seen very ineffective in terms of energy efficiency improvement in most of the EU member states.



The 15th edition of the World Sustainable Energy Days was again a success bringing together international experts, scientists, students, policy makers, public sector intermediaries and industry stakeholders from 57 countries to discuss about sustainability and energy efficiency. More information about the other conference sessions, as well as earlier WSED events can be found on the website **www.wsed.at**. •

ASHRAE Grant-in-Aid Funds Human Thermal Comfort Database Project

JODI SCOTT, Public Relations, jscott@ashrae.org

ASHRAE Grant-in-Aid Funds Human Thermal Comfort Database Project aim is the creation of a database to help better understand human thermal comfort in residential and commercial buildings.

Veronika Foldvary, a visiting Ph.D. student at the Center for the Built Environment (CBE), University of California, Berkeley, is one of 18 students who will receive a grant through the ASHRAE Graduate Student Grant-In-Aid Award Program, which is designed to encourage students to continue their education in preparation for service in the HVAC&R industry. The grants, totalling $180 000, are awarded to full-time graduate students of ASHRAE-related technologies.

The project would identify previous thermal comfort and occupant responses in residential and commercial buildings worldwide. Foldvary would collect that data to construct an international database, which would include measurements of all the physical conditions affecting thermal comfort (air temperature, humidity, air movement, radiant temperature and occupant clothing and metabolic rate) plus subjective surveys (thermal sensation, comfort, perceived air quality and wherever possible, adaptive behaviour and interaction with building controls).

"The database would be used to analyse trends in thermal comfort and behaviour patterns and evaluate current comfort prediction tools, as well as their relevance to different building types, climates, cultures and demographics," Foldvary said. "We would convene discussion groups to address issues of data analysis and representation to ensure its usefulness to the global research community. The analysis will provide the evidence base for developing improved international standards."

From the other 15 Grants 13 have been rewarded to US university students and two to students outside the USA (National University Singapore and University of Toronto). •

More information: https://www.ashrae.org/news/2016/ashrae-grant-in-aid-funds-human-thermal-comfort-database-project

LG Electronics – a new REHVA supporter!

LG Electronics had its innovative start in 1958, since then it strives to provide its customers with sustainable solutions for every necessity by quickly responding to up-to-date industry trends while creating upselling opportunities. A leader in total HVAC and Energy Solutions, LG's ultimate goal is to lead the industry through innovative technology, creating heating and cooling systems with world-class energy efficiency and smart network capabilities that efficiently control these systems.

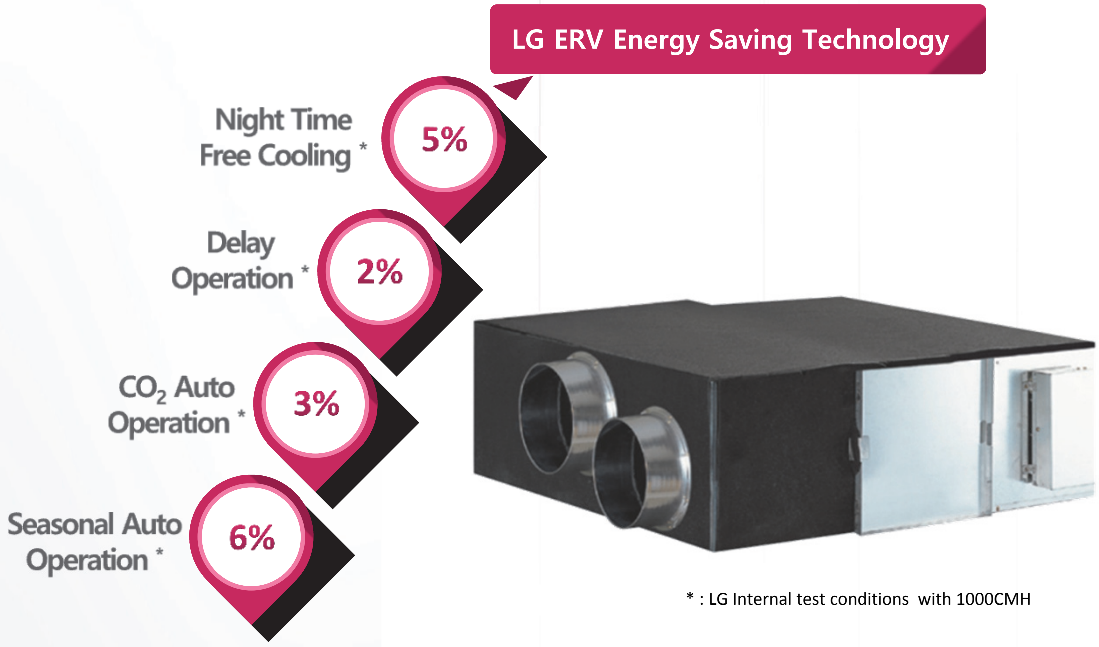
LG achieves its energy efficient and cost-saving solutions by precisely controlling building facilities with differentiated technology. LG offers optimum HVAC solutions to fit customer's needs in various environments and realizes future value through the innovation of eco-friendly technologies. LG provides HVAC solutions for a range of small to mid/large buildings and industrial facilities through: VRF systems including the industry-leading MULTI V IV, the side-discharge VRF MULTI V S, and the MULTI V Water IV which uses Variable Water Flow technology. LG also provides single and multi-split air conditioners ideal for various small-medium sized spaces and air to water heat pumps such as the THERMA V for hot water and floor heating.

Considering LG Electronics' background, it was natural to go forward with committing to be a REHVA supporter. With the European market being the most demanding in terms of building regulations and efficiency, this made LG go forward with a REHVA stable partnership. LG Electronics is committed to cooperating further with REHVA for better consciousness and transparency in the European market. •

LG
Life's Good

LG ERV

Save energy! Enjoy fresh air!



* : LG Internal test conditions with 1000CMH

Ventilation is a process that allows users to exchange indoor air with outdoor air in order to improve the air quality and to maintain environmental temperature conditions, with this intent LG has developed a standalone product called ERV. The Energy Recovery Ventilation (ERV) system reduces the temperature and humidity of incoming fresh air. A balance is achieved between indoor and outdoor ambient which enables the cooling or heating load placed on the air conditioning system to be reduced. It can be controlled individually or as an integral part of the air conditioning system. The ERV system provides efficiency, cost savings, superior performance, compact and light design, linear E.S.P control and easy maintenance. The indoor air is passed through the heat exchanger to pre-warm or pre-cool the incoming outside air that saves energy and money. Acoustically engineered and tested for quiet operation, the new ERV offers easy filter replacement and heat exchanger cleaning.
The new ERV was conceived to achieve ErP target and to illustrate compliance to EU 1253/2014 and 327/2011.

www.lgeaircon.com

Management changes within SWEDVAC as from 1st of March, 2016

The board of SWEDVAC has appointed Mr Stefan Jakab as the new Secretary General, hence succeeding the former SG, Mrs Veronica Eade.

Mr Stefan Jakab is 51 years old and holds a Master of Science degree in Mechanical Engineering / Industrial Economics from KTH Royal Institute of Technology, in Stockholm.

The last 20 years he has held various management positions in the telecoms industry, focusing on sales and strategy issues, most notably with TeliaSonera where he was responsible for all B2B sales through partners and resellers in Sweden.

"I am glad to take the next step in my career in a whole new industry, and I am eager to learn as much as possible about the SWEDVAC sphere. In return, I hope that my previous experience will be to the benefit of SWEDVAC on our everlasting and continuing journey for energy efficient building and sound indoor environment."

His personal interests range from vintage wooden yachts, preservation of old buildings and Swedish history 1520-1809 to champagne and French composers during the years of post impressionism; 1880-1930.

"That music is just as modern and relevant today as it was some 100 years ago!"

The interest for France and for French culture came to life, says Mr Stefan Jakab, when he in his early twenties represented Sweden in a World Cup Tournament in rapier fencing in Paris. As a consequence, and after having completed his university studies, it felt quite logical to return to France for an international career. And what better place to realize those ambitions than at the Paris office of Business Sweden, thus promoting the presence of Swedish companies in France.

"I look forward to meet all our members, to continue the important work of SWEDVAC with my fellow colleagues and of course to interact with REHVA".

Even though he holds everything French in high esteem, he admits, a bit embarrassed, that the Italian cuisine is something extraordinary. •

National Register of ABOK Engineers now online

At the end of 2015, the official website of the ABOK Chamber of Engineers had been created (http://palataabok.ru/) with the aim to establish a national register of ABOK Engineers in order to organize all available information about engineering community.

The new website has already registered more than 4.200 specialists and through that, the ABOK Chamber of Engineers is planning to launch an extensive training program, involving the most authoritative industrial experts.

The ABOK Chamber of Engineers or "Chamber of engineers in automation, ventilation, heating, air conditioning, heating, electricity, water supply and sanitation, gas supply of buildings and building thermal physics" was established by the Ministry of Justice in September 2014.

The main objectives of the ABOK Chamber of Engineers are:

- To informing Russian specialists about the need to create a new system of certifying engineers that is compatible with similar foreign systems;
- To provide qualification certificates for engineers;
- To publish studies and synthetized information about the construction sector market, as well as about the state of the art project and construction works and services within the Russian Federation and beyond.

On behalf of all the REHVA Members, we would like to congratulate Prof. Tabunschikov, President of ABOK for the ABOK Chamber of Engineers and the new website. •

Summarized by ANITA DERJANECZ and JAREK KURNITSKI

REHVA - AiCARR seminar at Mostra Covegno Expocomfort

REHVA and AiCARR organized a joint seminar at the 40th Mostra Convegno Expocomfort in Milan on 17 March 2016. The topic this year was "Principles, expected effects and national implementations of the EPBD and EED directives". Speakers from REHVA, AiCARR and the Joint Research Center (JRC) of the European Commission presented the recent status, challenges of the implementation, the first outcomes of the EPBD review, as well as case studies and good practices from the Netherlands and Italy. The REHVA-AiCARR seminar was opened by Livio de Santoli, AiCARR President, Stefano P. Corgnati, REHVA President-elect and David Underwood, ASHRAE President.

Anita Derjanecz, REHVA Policy and Project Officer presented the "**Open Training and Qualification Platform on nZEB for building professionals**" called PROF/TRAC, which is an initiative supported by the European Commission. It will define and analyse the new skills needed for the successful design and construction of nearly zero energy buildings, offer training materials and free methodologies for training providers and an EU level that can be adapted in national level courses for professionals. PROF/TRAC will develop a harmonised qualification scheme, web based tools for self-assessment referring to relevant courses for professionals working in the sector. The platform involves 13 REHVA Member Association so far, that will roll-out the PROF/TRAC training scheme - including AiCARR.

Jarek Kurnitski, REHVA Vice-president and TRC Co-chair presented the "**nZEB implementation progress and open issues in national applications".** He summarised the current status of the nZEB definition and criteria across Europe pointing out some key problems and discrepancies in the process, such as different, non-harmonised energy performance calculation methodologies (diverse energy frames, and accounted energy uses) in the EU member states that result in extremely diverse and incoherent numeric nZEB criteria across Europe. Open nZEb related issues are the energy uses accounted, the defined system boundaries, time steps of calculation, the period and type of balance when accounting RES export, numerical indicators of energy performance, and the application of nZEB definition to building categories.

Livio Mazzarella, TRC Co-Chair, AiCARR presented the "**Public consultation on the evaluation of the EPBD**" summarizing the results of the public consultation performed by the DG Energy with the aim to analyse whether and to what level the Directive has met its aims. He was highlighting the comments that were prepared by the REHVA Technical and Research Committee and submitted to the consultation. He highlighted the most important REHVA position in the commenting: EPBD was implemented in most MS without paying attention to indoor environmental quality (IEQ), so energy efficiency measures often lead to significant comfort and IEQ problems in buildings. REHVA recommends that EPBD shall create a mandatory link between energy efficiency and IEQ and mandate the MS to set minimum IEQ and ventilation requirements. Also regular inspection of ventilation systems shall be required.

Delia D'Agostino from the *Joint Research Centre, of the European Commission presented the results of an* **Assessment of the progress towards the establishment of definitions of efficient buildings in European Member States**. There are 5 similar terms related to zero and positive energy buildings used globally, so no surprise that defining high energy efficient buildings at MS level is complicated and very diverse definitions were implemented so far at national level. She stressed also the need for a *harmonised definition framework and a robust zero calculation methodology. So far only a few MS went beyond the nZEB, like France and Denmark, where the definition of positive energy buildings is in place. Member States must strengthen quantitative intermediary targets and set up the mechanisms to monitor the nZEB implementation at national level. Also there is a need to further strengthen and evaluate measures and policies to stimulate cost effective nZEb renovation.*

Wim Maassen, Senior Consultant at Royal Haskoning DHV, TVLL showcased good examples to achieve **nZEB Hospitals** in the Netherlands in line with the Dutch roadmap of nZEB refurbishment of the building stock. They prepared feasibility studies for both new hospitals and the refurbishment of existing hospital buildings in cooperation with the Eindhoven University of Technology following a 5-step user demand and behaviour based approach to reduce energy demand, applying sustainable energy sources, installing energy storage and exchange systems and finally ensuring the efficient use of fossil energy. Energy reduction in hospitals is not yet a priority within nZEB strategies, although they use a significant amount of energy and there is a huge saving potential in the sector. He suggested reconsidering the Dutch nZEB definition for the hospital building type and setting ambitious targets for the sector.

Stefano P. Corgnati, REHVA President-elect presented a joint study with Cristina Becchio rom the REHVA Task Force on "nZEB in MedClimate" on **Design strategies for EPBD implementation in the Mediterranean Region**. He presented the plan and resources used by the REHVA Task Force on nZEB in Mediterranean Climate, which was set up the aim to address the nZEB related issues in that specific climate zone taking into account its specificities, such as thermal inertia, minimising thermal loads during both heating and cooling periods, solar control, or the integration of natural and mechanical ventilation with heat recovery and dehumidification, etc. He also presented an excellent imitative of a harmonised database on nZEB buildings in the Mediterranean region collecting information on the technical building systems besides the general information and geometrical data. By presenting an existing case study building he stressed using himself as an example that designing and building an nZEB dwelling is economically viable thus acceptable if the owner takes into account the costs incurred during the whole life-cycle of the building. •

Download the presentations: http://www.rehva.eu/ Publications and resources

Motorised potable water valve
Maintenance-free enjoyment of water

BELIMO

Potable water is the basis of life. There is no substitute for it. So it is important that water is highly pure and free of pathogenic micro-organisms. Belimo's motorised potable water valve ensures this purity by combining a certified 2-way ball valve with a compact rotary actuator. This ensures high functionality and operational safety.

The 2-way ball valve has been certified by the DVGW, the German Technical and Scientific Association for Gas and Water. Through this certification, the DVGW ensures the safety and reliability of the country's gas and water supply. The open-close ball valve, with air bubble tight shut-off prevents contamination and deposits of dirt and limescale, making it not only safe, but durable and reliable.

Uncomplicated and versatile motorisation is provided by the tried and tested standard actuators from Belimo. The compact rotary actuator is powerful and reliable and can be ordered with or without emergency control function. The motorised potable water valve is supplied as a unit and can be installed with ease. Once installed, it is totally maintenance-free. Put your trust in the functionality of the new potable water valve and enjoy a glass of water with complete peace of mind.. •

More information: www.belimo.eu

Belimo's motorised potable water valve impresses customers with its compact design and certified 2-way ball valve. Along with the tried and tested rotary actuator, it ensures maintenance-free potable water installation.

Swegon ESBO – Early Stage Building Optimization

PER SAHLIN
Prof. PhD, IBPSA Fellow, CEO of EQUA Simulation AB, Sweden
per.sahlin@equa.se

MARKUS T. KALO
M.Sc. (Architecture), Swegon AB Sweden
markus.kalo@ipad.se

BÖRJE LEHRMAN
System specialist, Swegon AB, Sweden
borje.lehrman@swegon.se

Swegon

Swegon ESBO is a new easy-to-use and time-efficient simulation tool that is useful from the early stages of design to the optimisation of existing and newly constructed buildings. Swegon ESBO is based on a recognized state-of-the-art thermal model for reliable computation of installed power and energy use. The software enables users to be able to experiment with—and modify—a fully configured and controlled HVAC system in a modelled building.

Keywords: software, building optimization, system comparison, HVAC system, HVAC components, early design, power requirements, energy consumption.

Introduction

Throughout the entire lifecycle of every building or refurbishment project, there are numerous HVAC-related questions concerning comfort, energy consumption and installation costs. Due to rising environmental awareness and subsequent legal requirements, designers, engineers, consultants and contractors realise they have to work with integrated design methods where architecture, materials, use of space and technical systems come together from the very beginning of a project. New challenges are posed on the people involved as well as the tools they use.

For advanced climate and energy modelling, there are quite a few programs available. The bottleneck lies in the competence required to use them and time it takes to create such models. For large and prestigious projects this can often be managed, but nowadays, even medium and smaller projects have to deliver high performance buildings.

Swegon ESBO

Back in 2000, Swegon and EQUA Simulation AB developed an easy-to-use web based tool, ProClim, for cooling and heating load calculation [1]. ProClim (which relies on EQUA's specialist-level tool, IDA Indoor Climate and Energy (IDA ICE) [2] on the server side) has become popular with well over 10,000 registered users. However, the migration path from ProClim to the full IDA ICE program has proven overwhelming for most users, and for this reason, EQUA started a prototype project in 2011 with Aalto University in Helsinki. The aim of this project was to develop a new tool, ESBO [3], which needed to be equally easy-to-use; it also had to enable users to progress to full-year energy studies that included many zones and complex energy HVAC systems. An additional goal was that users should be able to experiment with realistic components based on genuine, fully configured and controlled, HVAC equipment. ESBO has a complete set of generic (no name) components, but supports also a plug-in system allowing the software to be customized (and co-branded) with specific components from individual manufacturers. Swegon ESBO is the first such co-branded tool to be released.

Figure 1. Portal window of Swegon ESBO – Early Stage Building Optimisation.

Another ESBO edition, SSF ESBO, is offered by the Swedish Solar Shading Association (SSF). Like Swegon's ProClim, SSF has previously offered an equally widely appreciated tool, ParaSol [4], to its members. The key functionality of ParaSol around window and shading devices is now included in Swegon ESBO.

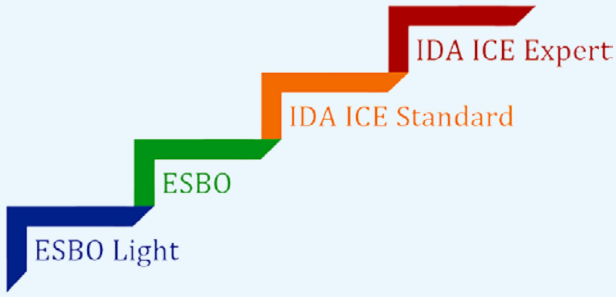


Figure 2. ESBO Light and ESBO are seamlessly integrated with EQUA´s specialist-level tools, enabling projects to be smoothly handed over for deeper analysis in more advanced software.

Swegon ESBO is available in two editions: ESBO Light, a free tool with some limitations, and ESBO, a paid software with extra options, such as: multiple rooms with complex shapes; system comparisons; and simulations of complete buildings in one single calculation. ESBO Light can be operated as a cloud solution or locally installed. Both editions are available in eight languages: English, German, French, Spanish, Polish, Russian, Swedish and Finnish. The functions described throughout the article that only are available in the paid version are marked with an asterisk ("*").

Swegon ESBO relies on IDA ICE models, which have been extensively validated (ASHRAE 140, BESTEST, EN 15255, EN 15265, EN 13971, CIBSE TM33, IEA Task 58, IEA Task 34, IEA Task 22.) Swegon ESBO has not been designed to suit the code compliance requirements for any particular region. However, it follows the relevant European standards for categorization of delivered energy and system losses. For IDA ICE, a number of localisations and add-ins enable studies according to standards and certification systems such as LEED, BREEAM, Swedish Miljöbyggnad, the code compliance requirements of several countries etc.

A feature (which is now available in the whole suite) is a direct link with Swegon's product selection tool, ProSelect. This feature allows the user to insert any fully configured CAV, VAV and DCV indoor climate components (like diffusers, dampers, comfort modules, etc.) into the simulation. This makes parameters like sound data, throw length and physical sizes available also in early stage of a building design process.

ESBO models are all upward compatible: ESBO Light – ESBO – IDA ICE Standard – IDA ICE Expert. This means an ESBO simulation can be opened in the IDA ICE environment and completed with special functions.

* Available in the paid version.

Getting started with Swegon ESBO – Create a Simple Room

The user always starts at the Swegon ESBO portal page (**Figure 1**). From the portal page, the user can change the language, access the user forum and get information on ESBO news, training, support and manuals.

From the portal page, the user can start with Create a *Simple Room*, Create a *New Project* or use a template room that already has several commonly used settings that are adjusted to specific building types (e.g. hotel room, classroom, conference room, office, etc.).

In the Simple Room view (**Figure 3**), the user can simulate a single room with a single window in order to design for summer or winter situations, with or without local cooling. The user can choose climate data for over 3,700 locations in 155 countries. Throughout Swegon ESBO, the user can quickly select objects from drop-down menus, inspect and edit the details of each object and access a vast database of real product data, e.g., shading materials and glazing options.

Next step - Create a Project

In the next stage of the project, the user is able to get more specific, i.e. choose an HVAC system, optimise the annual energy consumption and possibly compare different types of HVAC solutions. This is done in the *Create a Project* level. Here, the user can choose to simulate a single room or a range of rooms* for cooling and heating loads, annual energy use, temperatures, heat balances and more (**Figure 4**).

As a next step when working with a building model, the user can add more windows and exterior surfaces, describe doors and parts below the ground and edit the shape to any prismatic form*. In full Swegon ESBO, users can also import complex room shapes from SketchUp and other 3D CAD drawings*.

The performance of different HVAC solutions can easily be evaluated. Most projects start with generic and fixed-efficiency components for heating, ventilation and cooling, but an extensive range of more complex options may also be tested. To compute annual energy consumption, the user can also get more specific in terms of VAV air volumes and the occurrence of thermal loads and occupancy over time.

With Swegon ESBO, the user can work with a model quickly and simply, or get into as much detail as needed. The work is quite intuitive. The user can use the palette on the left to drag and drop room features and HVAC components into the room. Opening, e.g., a generic climate beam, fan-coil or AC, the user can then set performance parameters according to any manufacturers' data sheets.

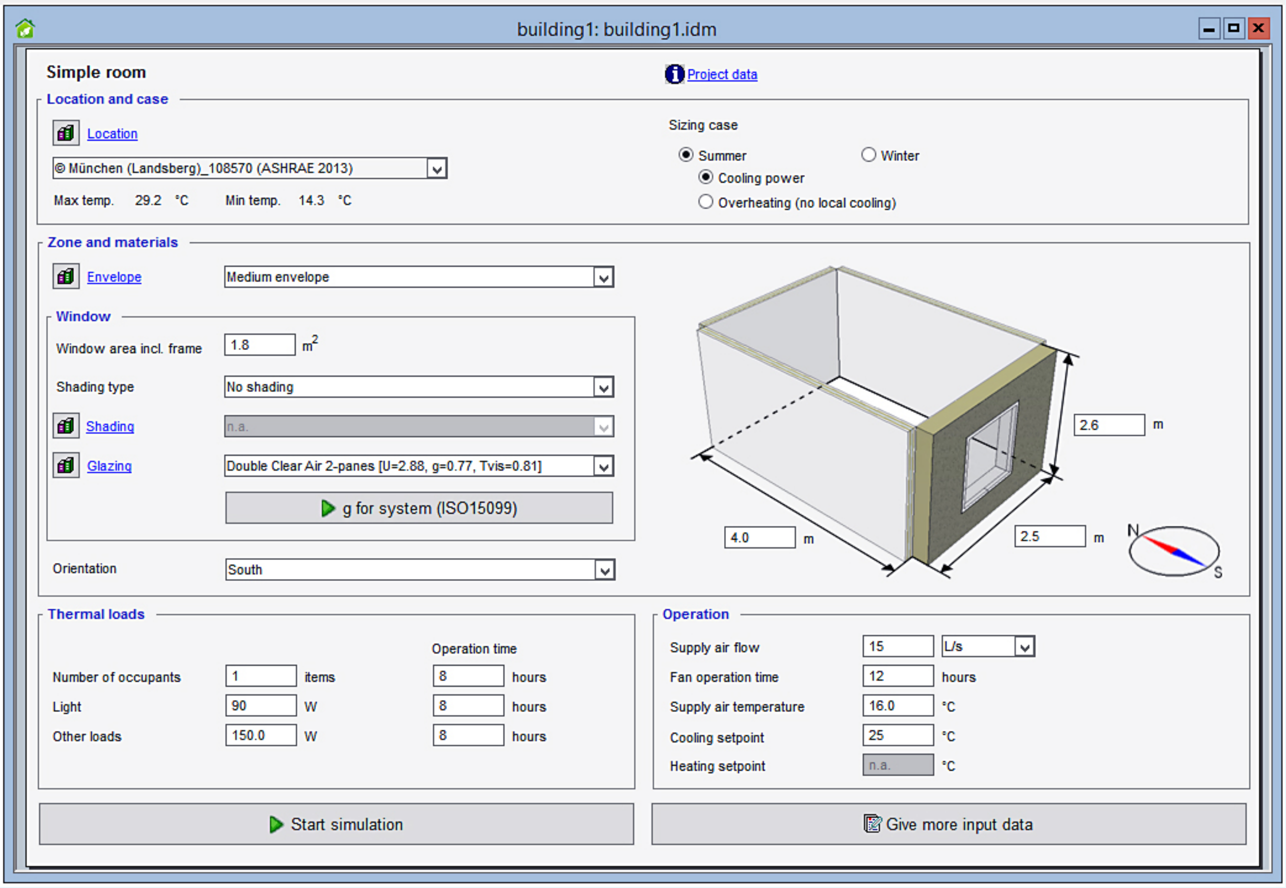


Figure 3. Swegon ESBO interface – Simple room view.

* Available in the paid version.

In the building tab (**Figure 5**), the user sets the conditions for the supply air, central heating, cooling and tap water as well as energy tariffs. The user can set the level of infiltration, define thermal bridges and other losses*, create a 3D model of the building* (where it is also possible to add external shadings from surrounding buildings*).

The user can define the type and running schedule of the air handling unit and also create different configurations for the central plant with storage tanks, heat pumps, CHP units, etc.

In the full Swegon ESBO edition, even more choices are available, including renewable sources like wind, solar and boreholes*. The user can also work with multiple rooms* in the same model in order to compute whole building performance.

Results from Swegon ESBO

The result of the simulation is shown in a report that can also be exported or saved as a PDF. The report contains a summary of key input data and includes results for the design day simu-

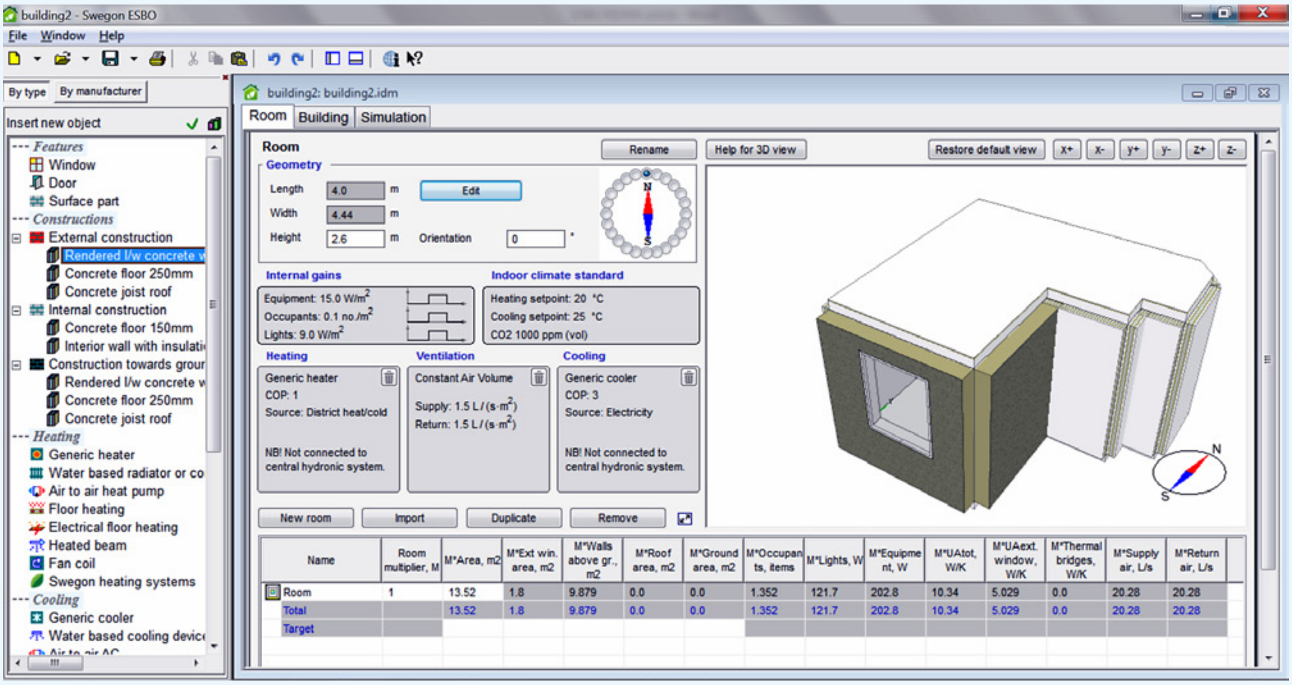


Figure 4. Swegon ESBO interface - modifying a building and HVAC system.

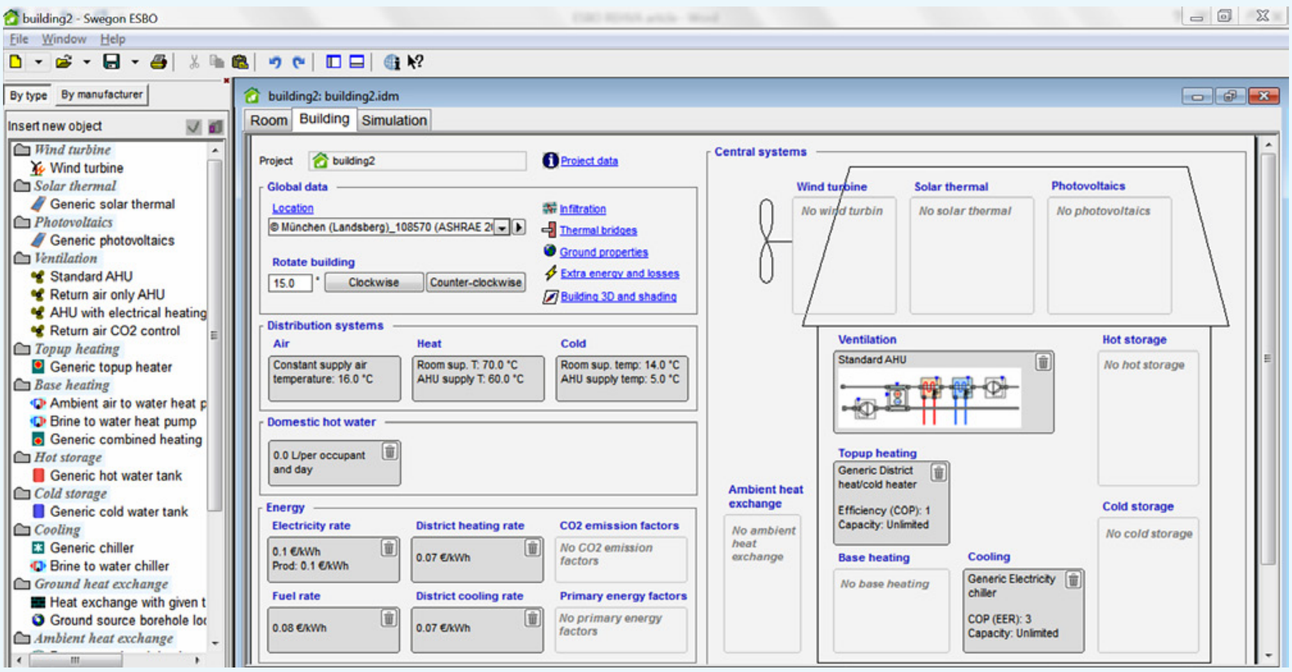


Figure 5. Swegon ESBO interface - working with HVAC system and components.

* Available in the paid version.

lations that show installed power requirements, temperatures throughout the day and a heat balance diagram (**Figure 6**). The cooling design day simulation automatically finds the worst day of the year based on ASHRAE design day climate statistics. For annual simulations, delivered energy, costs, CO_2 emissions as well as primary energy use are reported.

If the user has described several cases, he can compare key results in the same report*. In the full ESBO edition, the user can also access other results such as indoor air quality, daylight levels, operative temperature, comfort indices, detailed plant time series, etc.*

Opening a Swegon ESBO model in IDA ICE

Users that have access to a Standard or Expert IDA ICE license can move on to study further effects in the more detailed user interface. Here, room-to-room heat transmission and pressure dependent air flow are automatically computed based on whole building detailed geometry. Every detail of a model down to the mathematical equations can be investigated, and any variable can be logged so the user can understand detailed behavior.

Realistic component connections and control loops are automatically generated based on the components that have been selected in Swegon ESBO. In the Expert edition, users may reconnect modules and tailor plant models to represent actual systems.

Present state and conclusions

The basic ESBO user interface and model generation mechanisms have been included as beta versions in IDA ICE since 2013 and have thereby been thoroughly tested. The Swegon ESBO version was officially launched in the fall of 2015 and more than a thousand users have already registered.

Swegon has conducted a series of ESBO two- to four-hour seminars and training sessions, and after this introduction, nearly all of the participants have continued to work with the tool independently.

The experience with Swegon ESBO shows that detailed dynamic building simulation methods can be made useful to non-experts as well as experts. The ability for larger groups to evaluate different technologies and control strategies quickly is likely to lead to more optimal system choices and building designs.

Swegon ESBO has been nominated for the Swedish Grand Indoor Climate Prize 2016 (www.slussen.biz), one of the most prestigious prizes of the HVAC industry in the Nordic countries. •

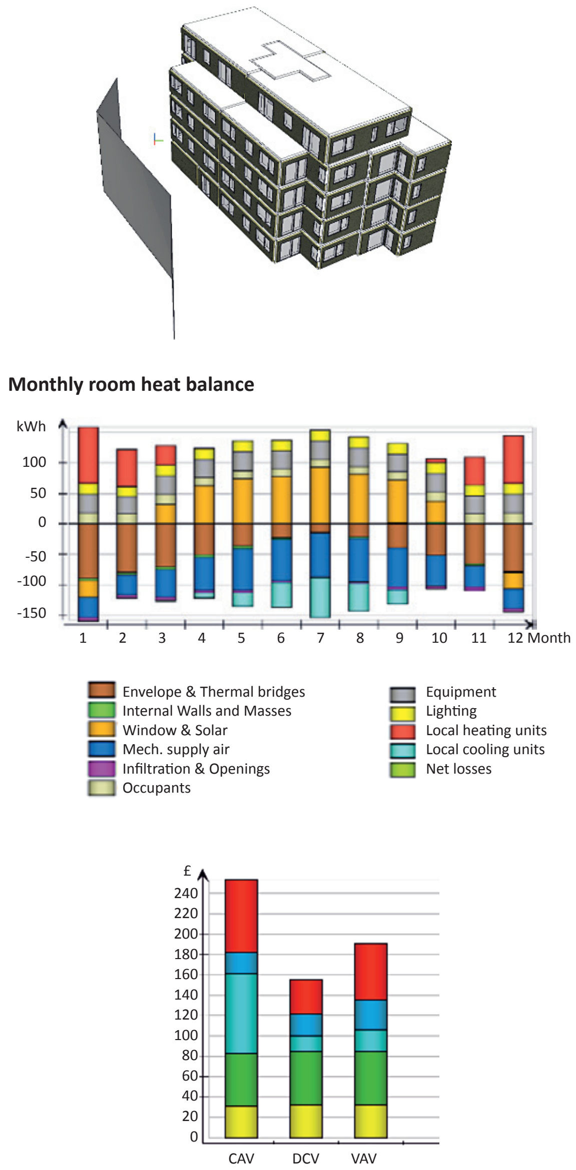


Figure 6. Swegon ESBO interface – working with results.

How to access Swegon ESBO

To access ESBO: www.swegon.com/en/Resources/Software/ESBO.

References

[1] ProClim, Swegon AB, 2001, http://www.swegon.com/en/Resources/Software/ProClim-Web/

[2] IDA ICE, EQUA Simulation AB, http://www.equa.se/en/ida-ice

[3] Swegon ESBO, EQUA Simulation AB and Swegon AB, 2016, www.swegon.com/en/Resources/Software/ESBO

[4] Hellström, B., Kvist, H., Håkansson, H., & Bülow-Hübe, H. (2007). *Description of ParaSol v3. 0 and comparison with measurements.* Energy and Buildings, 39(3), 279-283.

* Available in the paid version.

VDI- Standards published in March-April-May 2016

D VDI 3805 part 22 *(Draft)* (2016-03)
Product data exchange in the building services; Heat pumps

Based on VDI 3805 Part 1, the standard describes a manufacturer and IT system independent and unified data format for the exchange of product data for heat pumps used in building services. Only in German available.

D VDI 3810 part 7 *(Draft)* (2016-03)
Operation and maintenance of buildings and building services; Exploitation; Demolition, removal, dismantling, disassembly

Based on VDI 3805 Part 1, the standard describes a manufacturer and IT system independent and unified data format for the exchange of product data for heat pumps used in building services. Only in German available.

VDI 6202 part 1 (2016-03)
Contaminated buildings and technical installations; Demolition, refurbishing and maintenance

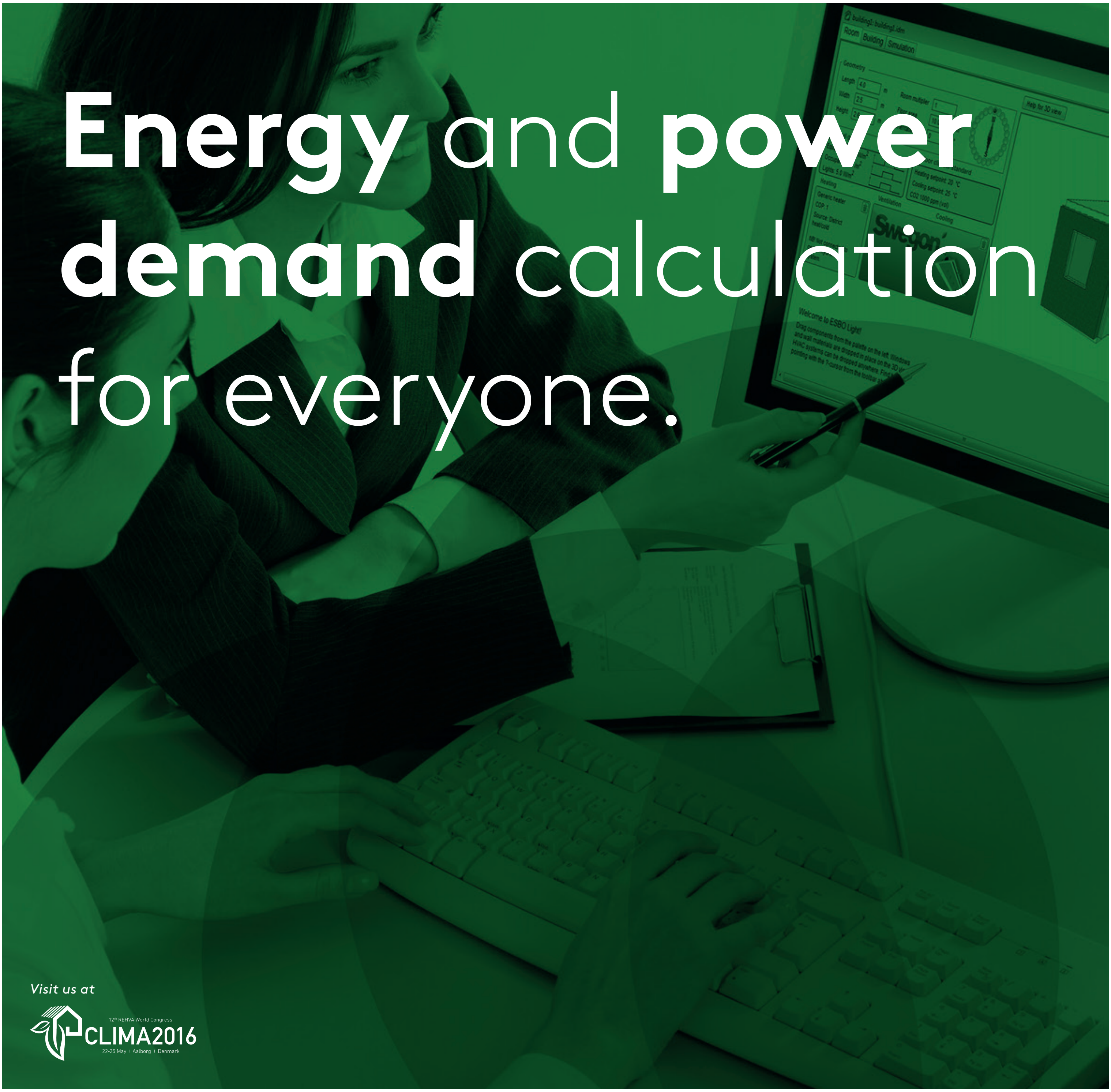
The standard applies to activities of demolition, refurbishing, maintenance and servicing of building structures and building services, where contaminants are involved. It applies to the removal, coating and separation of contaminants and the consignment and handover of the waste generated to disposal. The guideline describes the essential aspects of the decontamination procedure from the census up to the disposal. Recommendations are given regarding required contractual agreements, which supplement those given in the VOB (Ordinance on Orders and Contracts in Civil Engineering). German/ English language.

D VDI 3564 part 1 *(Draft)* (2016-04)
Fire protection; Requirements for high-bay warehouses

This standard provides fire protection technical recommendations for the planning, construction and operation of high-bay warehouses. The further requirements for high-bay warehouses with storage heights above 9 metres mentioned in the model industrial building directive, can be taken from this standard. Only in German available.

D VDI 6018 *(Draft)* (2016-05)
Cooling in building services; Planning, erection and operation

This standard deals with techniques and installations in the building services, which mainly serve to cool spaces occupied by humans. It can be applied by way of analogy to comparable tasks such as the cooling of data centres or production processes if they are used at a temperature above 0°C. Typical installations on the demand side are: air coolers of ventilating and air-conditioning installations, space-cooling surfaces including systems for the thermal activation of building elements (chilled beams), other space-cooling installations such as induction devices, local ventilating and air-conditioning systems or fan convectors. All common heat transfer media which can be pumped are considered; examples are water, salt solutions or ice slush. Furthermore, direct evaporation systems are considered, where refrigerants are simultaneously used as energy carriers. Only such chillers and chilling systems are considered, in which a "closed" thermodynamic cycle occurs. Natural and synthetic chilling agents are used in such cases. Sorptive cooling is covered only in the form of an overview of techniques for supply for the sake of completeness; no details are given, because this technique is not classically a method for the supply of cooling. Only in German available. •



SwegonESBO

is the new system software that helps you from the early stage of the design process, all the way through your project. Within a few minutes the software calculates both the installed power demand and annual energy costs.

We make every breath count.

Swegon

Send information of your event to Ms Chiara Girardi cg@rehva.eu

Events in 2016

Conferences and seminars 2016

May 10	3rd QUALICHeCK Conference	Brussels, Belgium	http://goo.gl/NEynsx
May 22-25	12th REHVA World Conference - CLIMA 2016	Aalborg, Denmark	www.clima2016.org
May 30-June 3	CIB World Building Congress 2016 Intelligent built environment for life	Tampere, Finland	http://wbc16.com
June 14-16	Sustainable Energy Week 2016	Brussels, Belgium	http://eusew.eu
June 22-24	Central Europe towards Sustainable Building Prague 2016	Prague, Czech Republic	www.cesb.cz
June 25-29	2016 ASHRAE Annual Conference	St. Louis, MO, USA	http://ashraem.confex.com/ashraem/s16/cfp.cgi
July 3-8	Indoor Air 2016	Ghent, Belgium	www.indoorair2016.org
August 21-24	12th IIR Natural Working Fluids Conference	Edinburgh, United Kingdom	www.ior.org.uk
September 12-14	37th AIVC - ASHRAE- IAQ joint Conference	Alexandria, VA, USA	http://goo.gl/bDlinv
September 21-23	International Conference on Solar Technologies & Hybrid Mini Grids to improve energy access	Bad Hersfeld, Metropolitan area Frankfurt, Germany	www.energy-access.eu
September 27-30	Eurovent Summit	Krakow, Poland	https://eurovent.eu/?q=events/eurovent_summit
October 23-26	IAQVEC 2016: international conference on indoor air quality, ventilation & energy conservation in buildings	Seoul, South Korea	www.iaqvec2016.org

Exhibitions 2016

May 4-7	ISK-SODEX 2016	Istanbul, Turkey	www.sodex.com.tr/
May 30 – June 1	ISH China & CIHE	Beijing, China	www.ishc-cihe.hk.messefrankfurt.com
August 31 - September 2	ISH Shanghai & CIHE	Shanghai, China	www.ishs-cihe.hk.messfrankfurt.com
October 11-13	Chillventa	Nuremberg, Germany	www.chillventa.de/en
October 12-14	FinnBuild	Helsinki, Finland	www.messukeskus.com/Sites1/FinnBuild/

Conferences and seminars 2017

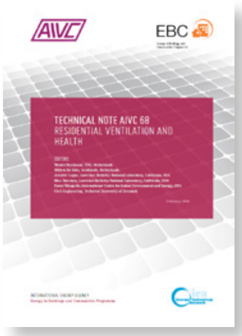
January 28 - February 1	ASHRAE Winter Conference	Las Vegas, NV, USA	http://ashraem.confex.com/ashraem/w17/cfp.cgi
March 1-3	World Sustainable Energy Days 2017	Wels, Austria	http://www.wsed.at/en/world-sustainable-energy-days
May 15-18	12th IEA International Heat Pump Conference	Rotterdam, The Netherlands	http://hpc2017.org/

Exhibitions 2017

January 30 - February 1	2017 AHR Expo	Las Vegas, NV, USA	www.ahrexpo.com

Technical note AIVC 68 residential ventilation and health

Executive Summary



Exposures in homes constitute the major part of exposures to airborne pollutants experienced through the human lifetime. They can constitute from 60 to 95% of our total lifetime exposures, of which 30% occurs when we sleep. The airborne pollutants constituting these exposures have sources outdoors and indoors. Pollutants having sources outdoors penetrate building envelope through cracks, gaps, slots and leakages, as well as through open windows and ventilation systems. Indoor pollutant sources include humans and their activities related with hygiene, house cleaning, food preparation, laundry, etc.; building construction materials, furnishing, and decoration materials; mould, bacteria, and fungi; tobacco smoking and combustion processes; as well as pets and pests. Studies have measured over 250 fifty pollutants in the indoor air in homes. Volatile organic compounds (VOCs) have the highest airborne concentrations in homes due to higher volatility however other pollutants impact occupant health as well. Indoor concentrations vary from home to home as well as over time in a given home.

Exposure controls should be designed to minimize health hazards and avoid unwanted odours. To do this, we must identify the pollutants driving the health risks and identify the best control strategies for those pollutants. High concentrations are not necessarily indicative of a health hazard. Pollutant concentration data alone cannot be used to identify pollutants driving health hazards. Toxicity varies widely from pollutant to pollutant and extensive research has been undertaken to link exposures levels of specific pollutants to specific adverse health outcomes. Toxicology and epidemiology have traditionally been used to link concentrations/exposures to health outcomes. However, in-silico and in-vitro based assessments of toxicity are gaining prominence.

Several studies have attempted to prioritize pollutants for mitigation in the indoor environment based on the prevalence of disease in the community, occupant exposure estimates, and the research derived links between exposures and health outcomes. The key pollutants identified as driving chronic health impacts include: $PM_{2.5}$ (particulate matter with a diameter less than 2.5 microns), mould/moisture, radon, environmental tobacco smoke (ETS), formaldehyde and acrolein. To reduce the exposure of contaminants different control strategies can be applied. The most effective are (1) source control and reduction of pollutant sources and (2) enclosure and encapsulation of sources. Ventilation plays a key role in reducing exposures that cannot be controlled by these measures. Effective local ventilation, such as cooker/range hoods, are critical for removing pollutants from periodic high emission sources such as cooking. Other contaminants can be removed by making use of mixing ventilation or displacement ventilation. The correct amount of ventilation is still an area of debate.

The following top five research needs were identified in a pair of workshops held by the Air Infiltration and Ventilation Centre (AIVC) and its partners in 2012:

(1) Impact of user behaviour on the control of indoor environmental quality;

(2) Development, implementation and harmonization of new, advanced methods for monitoring indoor air quality and its effects on health and comfort in buildings;

(3) Development of ways to increase the accountability of building contractors, designers, producers, constructors and installers;

(4) Tools and methods for ensuring a robust and performance-based design, operation and maintenance of building systems while maintaining good indoor air quality; and

(5) Quantification of health and comfort outcomes in terms of public health and economic criteria.

Workshop participants recommend that these research needs be addressed quickly so that indoor air quality (IAQ) and health in highly energy efficient buildings are not compromised. It is also of utmost importance to benchmark systematically differences in exposure to pollution sources and their associated health risks in buildings having different occupancy and purpose, from traditional through energy-retrofitted buildings to highly energy-efficient buildings to create reference points for further development. The tighter building envelopes of energy-efficient buildings will reduce adventitious ventilation and increase the need for designed ventilation systems to provide good IAQ. New materials in homes may also introduce new pollutants of concern.

These topics can be used for a number of purposes: they can guide research directions and the priorities of public, private, national and international agencies supporting research, they can be used to develop innovative solutions and they can indicate policy needs. Policies should be aligned, integrated, and harmonized with regulations and standards for highly energy efficient buildings and indoor environmental quality, and consistent requirements should be developed for any of their crosscutting and overlapping criteria. •

Reference

TECHNICAL NOTE AIVC 68: RESIDENTIAL VENTILATION AND HEALTH February 2016, 107 pages. Published by Air Infiltration and Ventilation Centre, Operating Agent and Management. INIVE EEIG, Lozenberg 7, B-1932 Sint-Stevens-Woluwe, Belgium. ISBN: 2-930471-46-8; EAN: 9782930471464. www.aivc.org

This AIVC Technical Note has been endorsed by the IEQ-GA, the Indoor Environmental Quality Global Alliance (www.ieq-ga.net).

The full members of the IEQ-GA in February 2016:

- American Society for HVAC Engineers (ASHRAE)
- American Industrial Hygiene Association (AIHA)
- Air Infiltration and Ventilation Centre (AIVC)
- Air & Waste Management Association (A&WMA)
- Indoor Air Quality Association (IAQA)
- Federation of European Heating and Air-Conditioning Associations (REHVA)

The vision of the IEQ-GA is to be the world's primary source for information, guidelines and knowledge on the indoor environmental quality in buildings and places of work around the world.

REHVA SUPPORTERS

A REHVA supporter is a company or an organization that shares the same objectives as REHVA. Our REHVA supporters use the latest European technologies to make their products. The REHVA Supporters are also members of reHVAClub. For more information about REHVA supporters' program, please contact info@rehva.eu or call +32 2 5141171.

Founded in 2009, SBA is the world's premier organisation for the sustainable building certification industry.

We bring together operators of rating and certification tools for sustainable buildings, standard setting organizations, national building research centres as well as key property industry stakeholders and manufacturers of construction products.

Our purpose is to advance quality certification and promote its role for the development of sustainable buildings.

Our latest publication *

Sustainability Thresholds generating Value

The aim of the research project was to understand how the sustainability features of buildings can "translate" into economic value and to make suggestions to improve the integration of sustainability-related characteristics into investment decision-making process and asset valuations. "

* (December 2015)

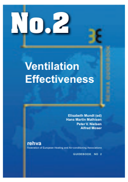
www.sballiance.org

REHVA

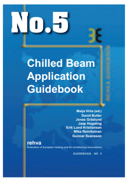
Federation of European Heating, Ventilation and Air Conditioning Associations

REHVA GUIDEBOOKS

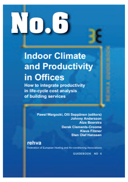
REHVA Guidebooks are written by teams of European experts



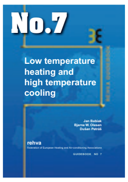
Ventilation Effectiveness. Improving the ventilation effectiveness allows the indoor air quality to be significantly enhanced without the need for higher air changes in the building, thereby avoiding the higher costs and energy consumption associated with increasing the ventilation rates. This Guidebook provides easy-to-understand descriptions of the indices used to measure the performance of a ventilation system and which indices to use in different cases.



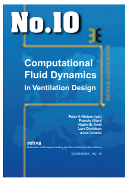
Chilled Beam Cooling. Chilled beam systems are primarily used for cooling and ventilation in spaces, which appreciate good indoor environmental quality and individual space control. Active chilled beams are connected to the ventilation ductwork, high temperature cold water, and when desired, low temperature hot water system. Primary air supply induces room air to be recirculated through the heat exchanger of the chilled beam. In order to cool or heat the room either cold or warm water is cycled through the heat exchanger.



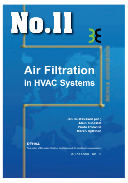
Indoor Climate and Productivity in Offices. This Guidebook shows how to quantify the effects of indoor environment on office work and also how to include these effects in the calculation of building costs. Such calculations have not been performed previously, because very little data has been available. The quantitative relationships presented in this Guidebook can be used to calculate the costs and benefits of running and operating the building.



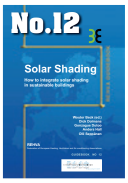
Low Temperature Heating And High Temperature Cooling. This Guidebook describes the systems that use water as heat-carrier and when the heat exchange within the conditioned space is more than 50% radiant. Embedded systems insulated from the main building structure (floor, wall and ceiling) are used in all types of buildings and work with heat carriers at low temperatures for heating and relatively high temperature for cooling.



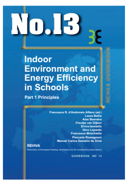
Computational Fluid Dynamics in Ventilation Design. CFD-calculations have been rapidly developed to a powerful tool for the analysis of air pollution distribution in various spaces. However, the user of CFD-calculation should be aware of the basic principles of calculations and specifically the boundary conditions. Computational Fluid Dynamics (CFD) – in Ventilation Design models is written by a working group of highly qualified international experts representing research, consulting and design.



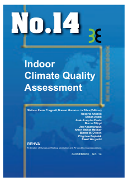
Air Filtration in HVAC Systems. This Guidebook will help the designer and user to understand the background and criteria for air filtration, how to select air filters and avoid problems associated with hygienic and other conditions at operation of air filters. The selection of air filters is based on external conditions such as levels of existing pollutants, indoor air quality and energy efficiency requirements.



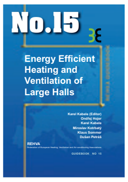
Solar Shading – ***How to integrate solar shading in sustainable buildings.*** Solar Shading Guidebook gives a solid background on the physics of solar radiation and its behaviour in window with solar shading systems. Major focus of the Guidebook is on the effect of solar shading in the use of energy for cooling, heating and lighting. The book gives also practical guidance for selection, installation and operation of solar shading as well as future trends in integration of HVAC-systems with solar control.



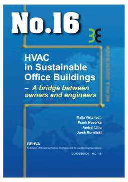
Indoor Environment and Energy Efficiency in Schools – *Part 1 Principles.* School buildings represent a significant part of the building stock and also a noteworthy part of the total energy use. Indoor and Energy Efficiency in Schools Guidebook describes the optimal design and operation of schools with respect to low energy cost and performance of the students. It focuses particularly on energy efficient systems for a healthy indoor environment.



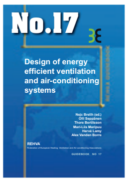
Indoor Climate Quality Assessment. This Guidebook gives building professionals a useful support in the practical measurements and monitoring of the indoor climate in buildings. Wireless technologies for measurement and monitoring have allowed enlarging significantly number of possible applications, especially in existing buildings. The Guidebook illustrates with several cases the instrumentation.



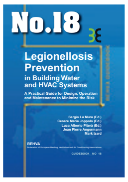
Energy Efficient Heating and Ventilation of Large Halls. This Guidebook is focused on modern methods for design, control and operation of energy efficient heating systems in large spaces and industrial halls. The book deals with thermal comfort, light and dark gas radiant heaters, panel radiant heating, floor heating and industrial air heating systems. Various heating systems are illustrated with case studies. Design principles, methods and modelling tools are presented for various systems.



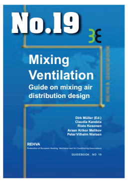
HVAC in Sustainable Office Buildings – ***A bridge between owners and engineers.*** This Guidebook discusses the interaction of sustainability and heating, ventilation and air–conditioning. HVAC technologies used in sustainable buildings are described. This book also provides a list of questions to be asked in various phrases of building's life time. Different case studies of sustainable office buildings are presented.



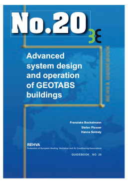
Design of energy efficient ventilation and air-conditioning systems. This Guidebook covers numerous system components of ventilation and air-conditioning systems and shows how they can be improved by applying the latest technology products. Special attention is paid to details, which are often overlooked in the daily design practice, resulting in poor performance of high quality products once they are installed in the building system.



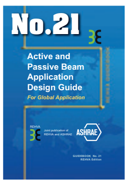
Legionellosis Prevention in Building Water and HVAC Systems. This Guidebook is a practical guide for design, operation and maintenance to minimize the risk of legionellosis in building water and HVAC systems. It is divided into several themes such as: Air conditioning of the air (by water – humidification), Production of hot water for washing (fundamentally but not only hot water for washing) and Evaporative cooling tower.



Mixing Ventilation. In this Guidebook most of the known and used in practice methods for achieving mixing air distribution are discussed. Mixing ventilation has been applied to many different spaces providing fresh air and thermal comfort to the occupants. Today, a design engineer can choose from large selection of air diffusers and exhaust openings.



Advanced system design and operation of GEOTABS buildings. This Guidebook provides comprehensive information on GEOTABS systems. It is intended to support building owners, architects and engineers in an early design stage showing how GEOTABS can be integrated into their building concepts. It also gives many helpful advices from experienced engineers that have designed, built and run GEOTABS systems.



Active and Passive Beam Application Design Guide is the result of collaboration by worldwide experts. It provides energy-efficient methods of cooling, heating, and ventilating indoor areas, especially spaces that require individual zone control and where internal moisture loads are moderate. The systems are simple to operate and maintain. This new guide provides up-to-date tools and advice for designing, commissioning, and operating chilled-beam systems to achieve a determined indoor climate and includes examples of active and passive beam calculations and selections.

REHVA – Rue Washington, 40 – 1050 Brussels – Belgium
Telephone: +32 2 514 11 71 • Fax + 32 2 512 9062 • E-mail: info@rehva.eu • website: www.rehva.eu