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REHVA OFFICE:
Washington Street 40
1050 Brussels, Belgium
Tel: +32-2-5141171
info@rehva.eu, www.rehva.eu

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CLIMA 2019 the venue where REHVA meets the global community

Every three year a REHVA member organisation is committed to organise the CLIMA HVAC World Congress. This year to be held 26-29 May in Bucharest, Romania. AIIR the Romanian Association of Building Services Engineers offered to organise this CLIMA 2019 after our last congress in 2016 in Aalborg Denmark. The theme "Built environment facing climate change" is right in the focus of the global challenges we encounter in our professional fields.

JAAP HOGELING
Editor-in-Chief
REHVA Journal

The four main topics pinpoint the mayor challenges we are confronted with:

- Advanced HVAC&R&S technology and Indoor Environmental Quality.
- High Energy Performance and Sustainable Buildings.
- Information and Communication technology for Intelligent Building Management.
- Sustainable Urbanisation and Energy System Integration.

The heading of the editorial in 2016 was addressing the outcome of the Paris 2015 COP 21 conference and reported on the harmonised assessment procedures for the Building Energy Performance declaration or certification which are essential to support our industry towards (Nearly) Zero Energy Performing Buildings by 2020. Addressing the set of EPB standards available since 2017 and currently in an implementation phase in European countries. Three years later we are many steps further.

The main topics of the CLIMA 2019 Congress reflect the commitments to developing a sustainable, competitive, secure and decarbonised energy use in our built environment by 2050. To meet that goal, Buildings can contribute significantly to GHG emission reductions, of around 90% compared to 1990 by 2050, all stakeholders need to take measures that aim to reach this long-term GHG emission goal. To remember: our building stock is currently responsible for approximately 36% of all CO_2 emissions (in the EU). We all need a clear vision to guide our policies, technical solutions and investment decisions to achieve these 2050 objectives. The 2015 Paris Agreement on climate change following the (COP 21 conference) boosts the EU efforts to decarbonise its building stock. Taking into account that almost 50% of EU final energy consumption is used for heating and cooling, of which 80% is used in buildings, makes it crystal clear that climate goals can only be reached if our buildings and building systems are renovated at a higher rate. Minimising the energy need of buildings and realise higher energy efficiency of HVAC systems in combination of deployment of renewable energy production. A challenge given the fact that 75% of our current building stock is energy inefficient, the low demolition rates (0.1–0.2% per year), the limited new construction activities (0.4–1.1% per year) and very low refurbishment rates (0.4–1.2% per year).

During CLIMA 2019 the keynote speeches, many paper presentations and workshops will offer opportunities for the professional community to share knowledge and experience supporting solutions to a more sustainable built environment. The four main topics of CLIMA 2019 cover all issues addressed in the European Energy Performance of Buildings (EPBD) and Energy Efficiency Directive (EED) and ongoing discussions related to these directives.

Participating at this CLIMA 2019 Congress is a unique chance to learn and communicate about solutions we have to deliver as professional community. Don't miss it! ■

Smart monitoring of building performance with IEQ sensor networks

ATZE BOERSTRA
bba binnenmilieu,
The Netherlands
ab-bba@binnenmilieu.nl

ARJEN RAUE
bba binnenmilieu,
The Netherlands
ar-bba@binnenmilieu.nl

LOUIE CHENG
PureLiving China,
China
louie@purelivingchina.com

The recent development of affordable Indoor Environmental Quality (IEQ) sensors has led to a growing interest in continuous indoor climate monitoring. Introduction of advanced IEQ sensor networks will allow us to better analyse building performance. This article addresses a couple of fundamental questions that need to be answered to assure the successful introduction of IEQ sensor networks at a larger scale.

Keywords: Indoor air quality, IAQ, thermal comfort, internet of things, monitoring, performance verification, monitors

To successfully deploy web-based IEQ sensor networks in buildings one needs more than just accurate sensors. It is important to develop an overall view on what to measure, why, where, when and how. A general methodology has to be developed that allows to analyse and present the enormous amount of IEQ data that will be gathered with indoor air quality and temperature sensors in a way that building users and decision makers can relate to. In this article we try to answer some rather essential questions, based upon literature review and the authors' experience with several kinds of IEQ sensor networks. The results presented in this paper can be used to further develop IEQ sensor networks both for academic and more practical purposes, e.g. the application of sensor networks in the context of PPP/DBFMO contracts (Public Private Partnerships / Design, Build, Finance and Maintain-contract).

This article is partly based on a paper that was presented by the first author at the 2018 AIVC conference that was held in Juan-les-Pins (France). It furthermore can be seen as a follow up article of a REHVA journal article on IAQ monitoring (5) that was written by the third author (published in 2017).

Backgrounds

In recent years, air quality sensor technology has improved considerably, resulting in smaller sensors that are more and more reliable, accurate and affordable. Multiple manufacturers for instance offer electronic PM2.5 fine particle sensors the size of a matchbox, or even smaller, of professional quality. Meanwhile, internet of things (IOT) technology has taken off. For IAQ practice this opens a whole new range of possibilities, as ad hoc sensor networks can be built from wireless IEQ monitor devices without much hassle. Today it is possible to monitor the indoor environmental quality of multiple rooms in multiple buildings in real time, from behind the desk, using online monitoring platform that

receive test data from the sensor devices, updated every second if you wish. For more background information see e.g. Guyot et al. (2017) [1].

The growing awareness of poor air quality, especially fine particles, as a health threat boosts the call for such monitoring networks. Mainstream electronics manufacturers offer consumer grade devices at rather affordable prices, apparently recognising a market for personal air monitoring. Which helps to boost the interest from building occupants in indoor climate monitoring.

On a professional level, building performance labelling programmes such as WELL require indoor air quality monitoring [2]. Initiated in China, RESET (see www.reset.build) offers a framework for IAQ monitoring that includes standardised practice, technical quality standards for the test equipment, as well as the RESET Accredited Professional training and accreditation programme. There are currently nearly ten types of RESET certified monitoring devices from diverse manufacturers mentioned on the RESET website and over 100 RESET accredited professionals worldwide [3].

Any practitioner who intends to set up an online sensor network will be confronted by a number of issues, each of which has to be solved. This article discusses a number of these considerations, especially the more generic ones. Some of them stem from our own experience (see **Figure 1**), others are the result of a workshop held at the NCEUB Windsor Conference 2018 [4].

Added value

The first question to discuss is: *How to explain to decision makers the added value of measuring with a sensor network compared to old school, short term, handheld measurements?*

Monitors are critical for developing recognition of an indoor air quality (IAQ) problem, which then drives improvement. Traditionally, facility managers or building owners had to commission long and in-depth audits with handheld particle counters to determine whether there is a problem. However, today, continuous monitoring of IEQ allows us to quickly, inexpensively, and meaningfully depict the health performance of a space.

There is a growing recognition that monitoring is critical to validate performance. In China, the phrase "PM2.5" was the fourth most searched term on the internet (per Baidu.com) in 2015. With the easy availability of inexpensive consumer grade monitors (as low as US$40), it is easy and natural for employees and tenants to test out their homes and offices. If they discover problems, they will usually share the information on social media or else challenge their managers, facility managers, or operations teams. This can either be a PR nightmare or a marketing, selling or recruitment opportunity.

Monitoring data enables self-auditing and green building certification, such as BREEAM, LEED and WELL. Most sophisticated clients want to show the Return on Investments (ROI) on projects to justify their investment in a healthy building. They may also want to keep their building or office space performing at a high level over time. The addition of furnishings, increase of headcount density, maintenance, outdoor air infiltration and occupant activity all are actors that impact air quality after commissioning. An unnoticed side effect of air quality monitoring is a mind shift in involving the facility manager and operations team in the "care and feeding" of their indoor environment, because they have a feedback loop now which allows them - and other stakeholders - to observe cause and effect.

Furthermore, monitoring enables climate system optimization and automation. Data informed operation of ventilation, heating and cooling devices can be a very effective way to improve overall building and building system performance.

Figure 1. Sensor network test site, pilot building The Hague (NL).

Parameters to monitor

The second question than is: *What IAQ and thermal parameters should be monitored with the sensor network and at what level of performance?*

For moderate environments (as in most European locations), we consider particulate matter (PM2.5), carbon dioxide CO_2) and temperature (plus possibly also relative humidity) the most important parameters to be monitored indoors. Some monitors include a Total Volatile Organic Compound (TVOC) sensor as well, however our experience is that indoor levels usually stay below detection levels of these sensors. They may be nice to have in specific situations where more significant levels are expected, such as in post-renovations or industrial environments.

Also, monitors with real-time formaldehyde sensors are starting to emerge, though common consensus is that these are not yet reliable enough. As far as nitrogen dioxide sensors are concerned (relevant e.g. at a location with above average outdoor air pollution) also these are not as affordable and reliable yet as e.g. fine particle and carbon dioxide sensors.

PM2.5 sensors should be able to provide particle count, not just mass concentration. Therefore, optical particle counter (OPC) sensors are required with a minimum measurement range of 0-300µg/m³. Critical considerations include: humidity compensation, stability, repeatability and accuracy over the ranges likely to be encountered.

CO_2 sensors should also be of the optical (NDIR) type, with a measuring range of at least 0-2000ppm. Select sensors that have auto-zeroing features and that can be field replaceable.

Temperature sensors can be thermocouples, Resistive Temperature Devices (RTD's) or silicon diodes, with a temperature range up to 50°C. Though measuring temperatures seem straightforward, we find many IEQ monitors to be inaccurate, with an offset up to 2K in off the shelf devices. This may be caused by heat production from other components within the devices, e.g. the driving fans of the air quality sensors.

For those users who may not be sensor professionals, another option for "pre-certified" monitors is to simply look for third-party certified monitors. E.g. RESET is a third-party system that establishes specific criteria for monitoring hardware to reach Grades A (professional), B (building-grade), and C (consumer).

Some manufacturers also have produced monitors that include noise and light sensors. This is something we do not further elaborate upon in this article as the main focus here is on indoor climate monitoring.

Sensor selection

Question nr. 3 is: *How to select the sensors? Taking into account aspects like measurement range, accuracy and self-calibration.*

Sensors must be fit for purpose. Most sensors need periodical calibration, e.g. once a year, whereas other sensors use disposable heads that are periodically replaced. There are numerous devices on the market and it may be hard to choose the right one (best value for money). Which one is the best in a specific situation of course also depends on the accuracy that is needed and e.g. the budget. RESET [3] has tested and approved a limited number of sensor devices that are considered accurate enough / of B-grade (professional, however not lab-grade) quality.

The measurement range is another important issue when selecting sensors. In **Table 1**, recommended measurement ranges are described for sensors meant for non-industrial, indoor use.

Threshold values and outcome visualisation

A further question is: *What threshold values should be applied and how to present measurement outcomes graphically so that e.g. building users understand how (un)healthy/(un)comfortable their indoor climate is?*

The World Health Organization and e.g. the European commission offer limit values for air quality [6, 7]. However, more appropriate values may apply for a specific country, trade or organisation. Furthermore, Occupational Health & Safety standards may have appropriate guidelines for work situations. RESET [3] also has defined specific threshold levels, especially for indoor air quality parameters, see **Table 2**.

RESET has both Regular and High Performance categories of certification. The latter has requirements that are even more stringent for PM2.5 than LEED v4 or e.g. WELL.

Also, some might argue that instead of absolute limit values (concentrations) as threshold values one should evaluate measurement results (esp. air quality) in terms of maximum allowable Indoor-Outdoor (I/O) ratios (measured indoor concentration divided by momentary outdoor concentration).

When presenting the monitoring results, serious health threats should be distinguished from results that may seem alarming at first sight, such as incidental exceedance of a threshold value that was meant as a limit for long term exposure. You want the building occupants to be alarmed only by real hazards.

Representation of (continuous) measurement outcomes (e.g. via a dedicated IEQ platform) normally benefits from intelligent colour coding. That e.g. uses the colour green to indicate non-harmful pollutant levels, red to indicate harmful pollutant levels and orange or yellow when exposure levels are in between the two.

Table 1. *Selection parameters. [5]*

IAQ parameter	Common sensor technology used	Recommended measurement range (Grade B)	Selection notes
Particulate Matter (PM)	Optical particle counters (OPC)	0–300 µg/m^3	Sensors should be able to provide particle count, not just mass concentration. Critical considerations: humidity compensation, stability, repeatability, long term accuracy. Measurement of PM 2.5 or PM 1 has preference over measurement of e.g. PM 10, as the smaller particles are more relevant from a health point of view.
Carbon Dioxide (CO_2)	NDIRs	0–2000 ppm	CO_2 is an indicator of the amount of bio-effluents in the air and allows one to assess the effectiveness of the ventilation system. This is usually the most determining parameter for IAQ related symptoms. Select sensors that have auto-zeroing features and that can be field-replaceable.
Total Volatile Organic Compounds (TVOC)	Metal Oxide Sensors (MOS); Photo-ionization Detectors (PID)	0.15–2.00 mg/m^3	Both MOS and PID sensors are indicative only and used mainly to show relative change. They will not usually match lab testing. High chemical levels will also require recalibration.
Temperature	Thermocouples; Resistive Temperature Devices (RTDs); Silicon diodes	0–50°C	Many IEQ monitors suffer from inaccuracy due to heat generated by nearby components on same PCB.
Relative Humidity	Capacitive	20–90%	Generally, field-replaceable. Important to measure due to impact of humidity on measurements of other parameters (e.g. PM).
Formaldehyde	Colormetric, electrochemical; chemical	0.03–0.3 mg/m^3	Currently, there are no real-time technologies known to the authors that reliably match lab analysis.

Table 2. *Suggested RESET threshold values. [3]*

IAQ parameter	Target level (24 h average)	
	Acceptable	High performance
Particulate Matter (PM 2.5)	< 35 µg/m^3	< 12 µg/m^3
Total Volatile Organic Compounds (TVOC)	< 500 µg/m^3	< 400 µg/m^3
Carbon Dioxide (CO_2)	< 1000 ppm	< 600 ppm
Carbon Monoxide (CO)	< 9 ppm	–
Formaldehyde (HCOH)	–*	–*

* no requirements defined yet

Indoor-outdoor relations

Another question that one has to answer before a sensor network can be deployed: *Is it only necessary to measure air quality and temperature at several locations indoors, or also the outdoor air quality and temperature?*

Some areas offer publicly accessible data from sophisticated outdoor measurement stations. This may be an excellent source of outdoor data, e.g. for local PM2.5 concentrations. Often however, outdoor stations don't measure what one needs (e.g. only PM 10 and not PM 2.5). Also, sometime outdoor stations are simply located too far away from the building that is under investigation (more than 10 KM or so). And when a building is located very close to e.g. a severely polluting source like a factory of a busy road local exposure is different anyhow from what the nearby outdoor station of the city or county is measuring.

Therefore, often it does make sense to include an outside air quality and outside temperature sensor when setting up an IEQ sensor network in a building. In that case one can decide to position the outdoor sensors on the roof or so (covered from rain and shielded from direct sunlight), or one places it in the HVAC air inlet.

One considerable advantage of also measuring outdoor levels with the same devices is that one can very accurately calculate the so called Indoor-Outdoor (I/O) ratio for all indoor air quality parameters involved. At the same time, it might make sense to also relate e.g. measured indoor temperatures with the momentary outdoor climate (e.g. daily maximum temperature).

Amount of sensors and location

Furthermore, one could ask: *How many sensors should one use? And where to place the sensors?*

It obviously does not make sense to install one sensor in a building that has e.g. 1000 building occupants. But how does one decide to how many sensors to use as part of an IEQ sensor network? Sensors and monitoring devices are becoming more and more affordable, therefore the deployment of a substantial number becomes more feasible over time. On the other hand: one can overdo it too. For example: applying a monitor / sensor box in all spaces of a building generally speaking is not (cost) effective.

As a general rule one sensor per 500 m² of occupied floor space seems to be adequate (this is in line with the RESET requirements [3]. Plus at least one sensor per representative room type (e.g. office room vs meeting room vs laboratory space).

Also, one has to decide about the location / position of the sensors. Ideally is a location as close to where people are sitting, standing or lying most of the time. In an office building for example this implies that sensors are placed on people's desks, if possible, at breathing zone height (1 to 1,20 m above floor level). If this is not possible, second best is a location on a nearby wall (e.g. next to a wall thermostat). Third best would be a position under the ceiling. Positions within (false) ceiling or e.g. placement inside ventilation ducts should be avoided as this will lead to inadequate estimates of building occupant exposure, unless the purpose is to measure performance of HVAC systems providing air within a building.

Sensor connectivity

An important question is further: *What connectivity solution to select?*

Generally speaking, sensor devices are available with Wi-Fi, ethernet or serial connections for data communication. These may be fine for permanent installations. However, in non-permanent situations where an external party sets up a temporary / ad hoc installation, the client is likely to forbid that the local ethernet or Wi-Fi network is used due to security reasons. In these cases, a dedicated Wi-Fi network is the most straightforward solution, with one internet access point that forwards the collected data from multiple Wi-Fi coupled monitors to the cloud, using the mobile phone network or LoRa. Another option is a decentralised network, where each monitor has its own sim card. However, this technology is not yet wide spread. Whichever connectivity solution is chosen, data is collected on a central server and can be accessed via an online portal where it is stored and can be accessed for analysis.

Other aspects

A last question is: *Are there any other important issues that should be addressed?*

One important aspect that often is forgotten is privacy. Sensor networks should be deployed in such a way that sensitive information is dealt with in accordance with e.g. European General Data Protection Regulation (GDPR). Apart from that, one should recognize that

'technical data' like e.g. measured CO_2 concentrations indoors in fact inform about whether people are present or not (e.g. in a dwelling). Persons with criminal intentions and hacking competences might be very interested in these kinds of data, which is why sensor networks should be designed and operated with not just privacy but also security in mind.

Another often forgotten aspect is interface quality. Data gathered with IEQ sensor networks often are presented via website, smartphones or wall devices in a non-optimal way. Using overcomplex graphs and infographics or even irrelevant ones. One should design the overall system in such a way that data is transformed into information. Explain (graphically) what it means e.g. when the CO_2 concentration is above a certain limit for a considerable amount of time. **Figure 2** provides an example on how to graphically display indoor and outdoor PM2.5 concentrations. In this example chart, the RESET threshold value is indicated, average and peak values are summarized and non-working hours are masked.

Make sure that end-users intuitively understand the information provided and test interfaces with non-technical people before they are launched officially. The last thing we need is high tech sensor networks that measure all kinds of relevant parameters but that produce data that nobody can translate / understand.

One last aspect that often is overseen is overall sensor network robustness. In this context think of questions like: How is the overall system functioning over time? Are all sensors still working after e.g. one year? Is it necessary to exchange components every month or every year or over 5-year period? Are there any alarm signals when there are sensor connectivity issues? Is somebody responsible for periodical maintenance and periodical quality checks?

Conclusions

There are many considerations related to the deployment of IEQ sensor networks. Especially adequate, continuous measurement of indoor air quality parameters is still quite a challenge.

Figure 2. example interface sensor data presentation.

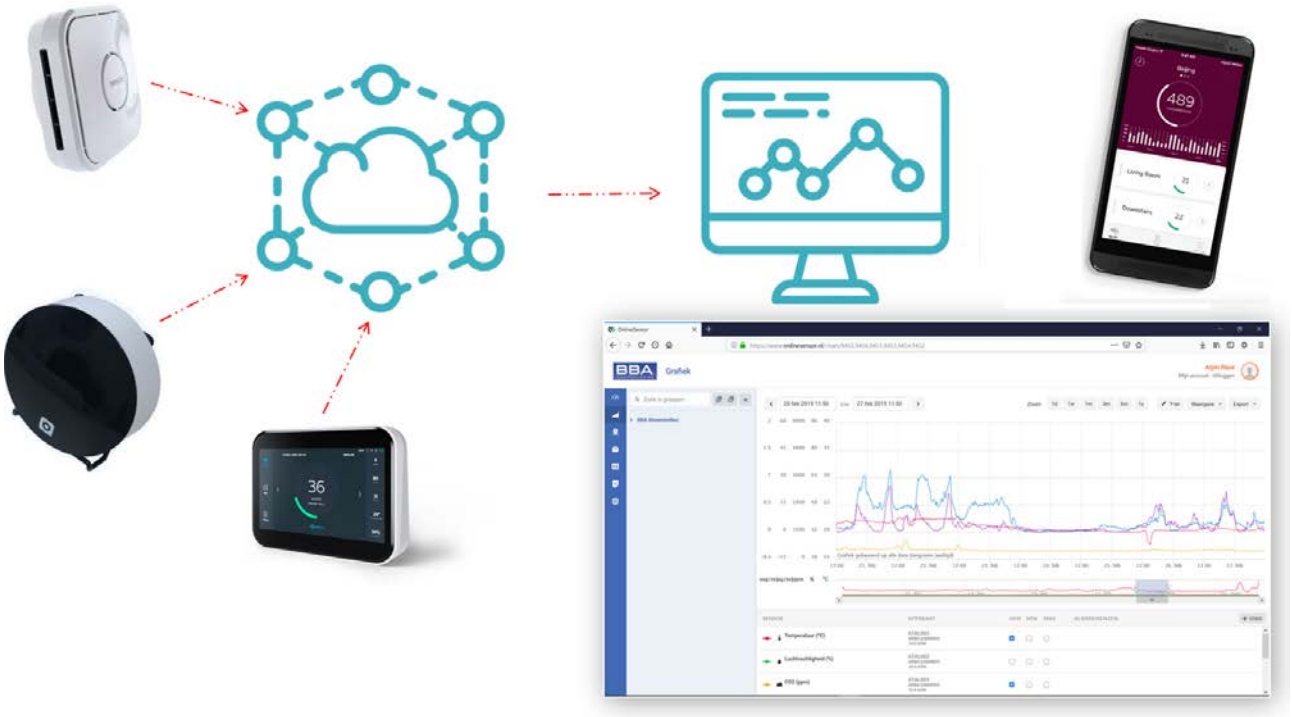

Figure 3. Core elements of an IEQ sensor network.

Several aspects should be considered when designing and operating these sensor networks:

- added value of the network to building occupants (and meaning of the data gathered);
- what parameters to measure (e.g. just CO_2 or also fine particles and volatile organic compounds);
- what threshold values to use and how to present measurement results in relation to these limits;
- simultaneous measurement of (local) outdoor parameters;
- accuracy, measurement range, self-calibration and robustness of sensor components;
- deployment strategy, amount of sensors per floor and location of sensor in rooms;
- connectivity (Wi-Fi vs ethernet etc).

The results presented in this paper can be used to successfully deploy IEQ sensor networks in the field. Which in turn will help to objectify building and building service system performance. ■

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Assessing and Communicating Indoor Environmental Quality

MANUEL GAMEIRO DA SILVA
ADAI, LAETA, Department of Mechanical Engineering
University of Coimbra, Portugal
e-mail: manuel.gameiro@dem.uc.pt

LEO VAN CAPPELLEN
Van Cappellen Advies bv,
The Netherlands
e-mail: vca@teleconsult.nl ;
leo@vancappellen.com

EDUARDO SANJUANELLO
Colswe Consulting AB,
Sweden
e-mail: eduardo@colswe.com

This paper describes how a developed multiprobe measuring system is used for the assessment of Indoor Environmental Quality (IEQ) in buildings. The objective of the work has been to develop an intuitive, coherent and user-friendly system for either short term or long term IEQ audits. Apart from the presentation of the measured values in tables and graphics, the main novelty of the system is the classification of the indoor environmental conditions in each sampling, according to the categories defined for thermal comfort, relative humidity and indoor air quality according EN-16798-1 [1]. The system introduces innovative graphical representations for reporting different phases of audits.

The concept of Indoor Environmental Quality (IEQ) is defined as the set of conditions associated with the thermal environment, the indoor air quality, the acoustic environment and the visual environment.

Assessing IEQ involves usually the measurement of various environmental variables and the subsequent calculation of composed indices that somehow take into account the human perception of the various types of stressors. The multiple evaluation of IEQ, considering simultaneously two or more aspects of IEQ (e.g. thermal comfort, indoor air quality and noise), is usually done with different measuring systems from different suppliers, resulting in a considerable investment both in monetary terms and in the time needed to get used to the different operation procedures.

The existence of miniaturized probes to measure various input environmental quantities, integrated to electronic digital circuits, gave the opportunity to develop new measuring systems. Having as a starting point the experience of implementing a detailed IEQ monitoring system in office buildings [2], the authors decided to develop a simpler system oriented to auditing activities. This paper presents the project of a multiprobe device for the assessment of IEQ and the related software tools to allow its interface and operation with a personal computer. A need for more detailed information about the IEQ aspects in buildings will certainly be induced by the launching of the Smart Readiness Indicator [3, 4] that is expected to include, in the evaluation criteria, besides others more energy related, comfort, health, convenience and communication with users.

Measuring System

The multiprobe device (**Figure 1**) is equipped with sensors to measure/display the variables below and it has the shape of a USB memory stick to be connected to the COM port of a personal computer.

- temperature;
- relative humidity;
- illuminance level;
- atmospheric pressure;
- concentration of CO_2;
- an Indoor Air Quality index based on volatile organic compounds concentration.

The initial main technical requirements defined for the system project were to:

- Develop a multiprobe system able to measure relevant IEQ variables;
- Present the instantaneous values of the measured quantities with an on-running adjustable sampling time step;
- Optimize the quality of measured data, providing to the users the possibility of an easy update of the multiprobe calibration file, according to their needs;
- Register the measured data in appending mode in a file created in the beginning of the data acquisition process and adding the data values after each sampling moment, minimizing this way the risk of data loss in case of any unexpected occurrence;
- Give to the user the possibility of having an adequate organization of measuring data files, including information about the multiprobe ID unit, the calibration data, the date, time and location of the sampling procedure, either in the name, either in the header of data files;
- Communicate the information, about IEQ, in its distinct dimensions, in a way easily understood by non-experts.

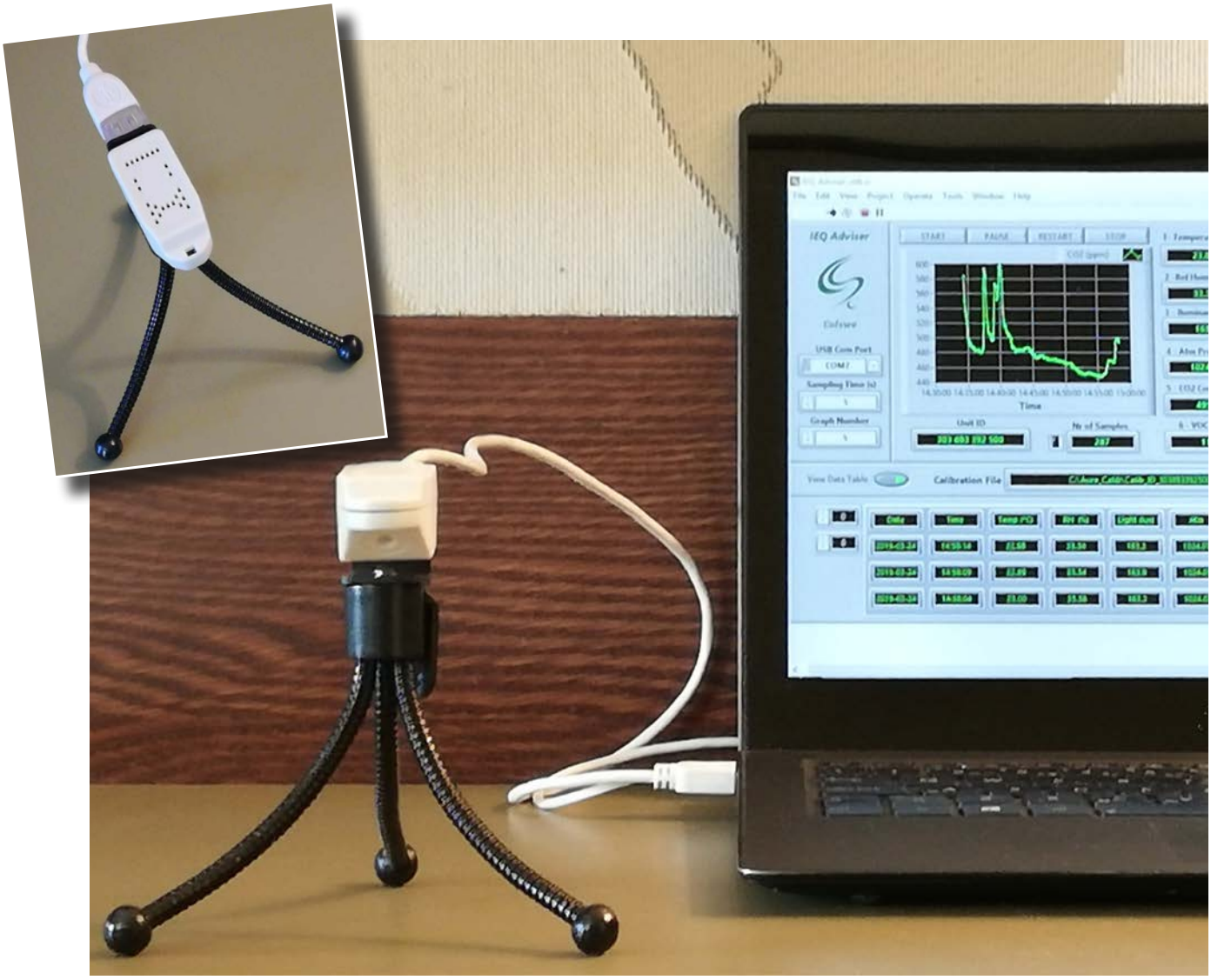

Figure 1. The developed IEQ multiprobe.

Software Tools

A set of software tools has been developed to support the use of the measurement system. The first one is called AURA IEQ DISCOVERER® to manage the operations below. The **Figure 2** shows the interface with the user during a sampling procedure where the multiprobe device was connected together with an operative temperature probe.

- Communication of the multiprobe device with the computer.
- Management of the sampling process.
- Presentation of the numerical values in displays, in a table and in graphical format.
- Categorization of the indoor conditions according to the standard EN 16798-1 [1] and the scale of an IAQ Index based on VOCs concentration.

The **Figure 2** shows the interface with the user during a sampling procedure where the multiprobe device was connected together with an operative temperature probe. Other software tools are developed to manage for example the calibration process of the multiprobe devices, to operate simultaneously with multiple devices or to operate the multiprobe device together with a low speed omnidirectional anemometer and a globe or an operative temperature probe. The latest allows the calculation and the display of complementary thermal comfort indices (e.g. PMV-PPD and WBGT).

As it has been previously mentioned, one of the main novelties of the developed system is the communication strategy based on the classification of the indoor environment aspects, using the categories, from I to IV, proposed by EN 16798-1 . The color scheme suggested in standard ISO 7730:2005 [5] to identify the thermal comfort categories has been adopted to fill the boxes used for the categorization of indoor environment. Three examples of the categorization section of the AURA IEQ DISCOVERER® interface are depicted in **Figure 3**. The first one refers to the same situation presented in the **Figure 2** where all the analyzed aspects are in the best possible category, i.e. on target, which is graphically indicated by the symbol (⊙) displayed in the small square box on the right side.

In case the HVAC Season is switched from Heating to Cooling, the situation changes to the second example in the middle of **Figure 3**. For the same operative values, the thermal comfort in summer changes to category 4. The box indicating the category changes the color from white to red and the graphical symbol (▼) in the small box on the right side indicates lower temperatures than the optimal target. It corresponds to a situation where people would feel cold.

The third example on the right of **Figure 3** represents a situation in which the user breathed on the multiprobe device, warming it a little and increasing the local CO_2

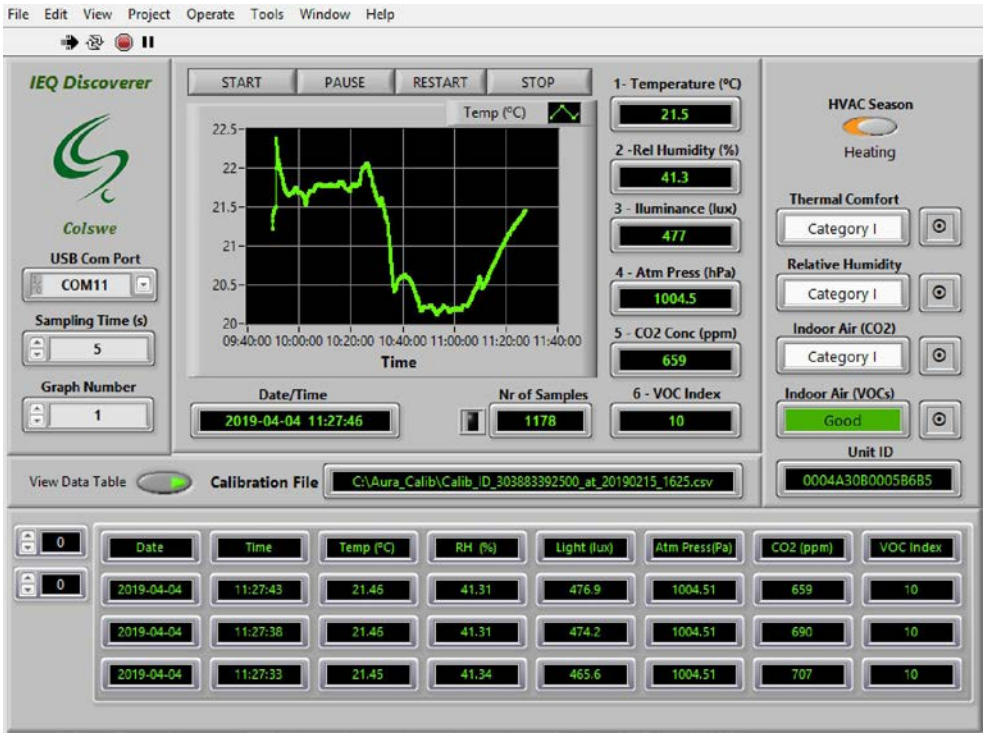

Figure 2. The interface window of IEQ Discoverer software tool during data acquisition.

concentration compared to example 2. The thermal comfort category improves from category IV to III and the color in the category box changes from red to yellow with values still lower than the optimal target. On the contrary, indoor air quality based on CO_2 concentration changes to category III and the graphical symbol (▲) in the small box on the right side indicates higher values than the optimal target.

The data files saved by AURA IEQ DISCOVERER® during the data acquisition process have a header with the following information: location of the sampling points (building, room and point reference), ID unit number of the multiprobe, name and date of the calibration file. Thirteen columns below the header display the date and time of the measurement, numerical values of all the measured variables, the status of the four categories, as well as the information on the HVAC season

Results

To facilitate the reporting of audits results, a data processing excel spreadsheet template has been created to display in graphs the evolution in time of the variables of the indoor environment. Similar graphs to those shown in **Figure 4** and **Figure 5** display the category intervals in colors according to EN 16798-1. Thus, a fast perception of the performance of the analyzed site, is facilitated.

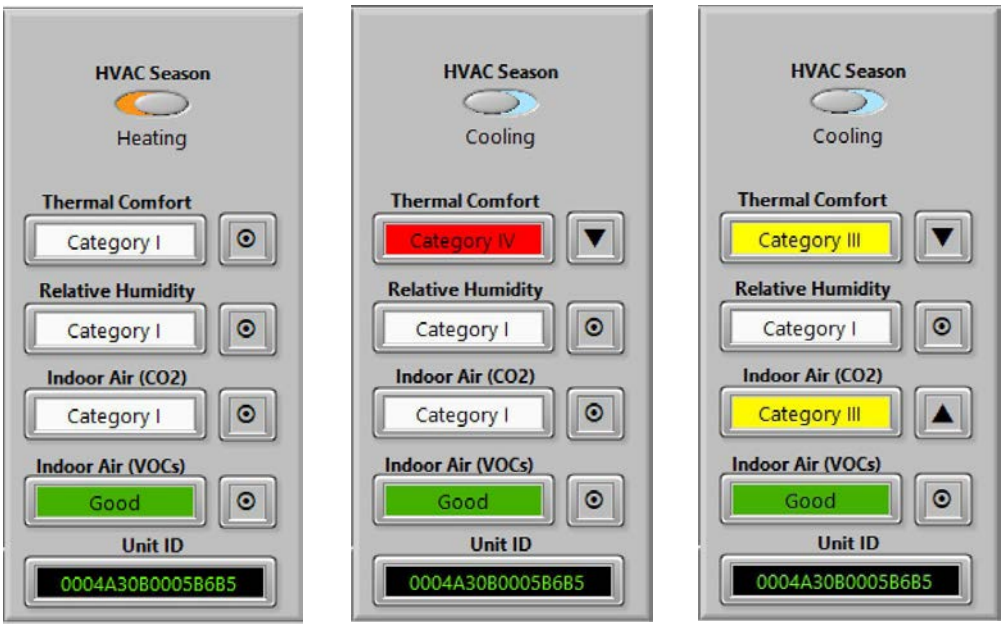

Figure 3. Different aspects of the categorization section of the IEQ Discoverer interface.

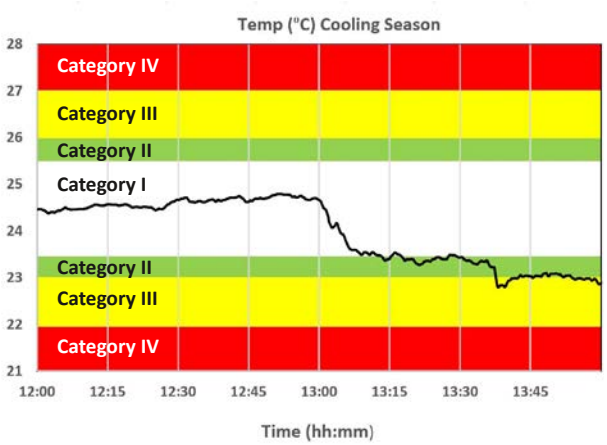

Figure 4. Evolution in time of Operative Temperature displayed with colored backgrounds for the categories defined in standard EN 16798-1.

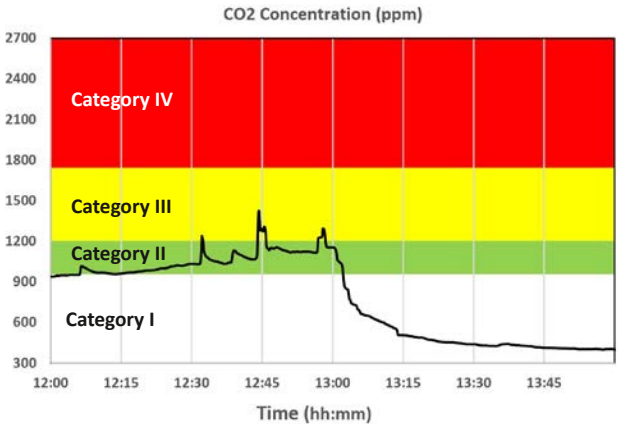

Figure 5. Evolution in time of CO_2 concentration displayed with colored backgrounds for the categories defined in standard EN 16798-1.

Conclusions

The concept initially defined for the IEQ monitoring system has been successfully implemented. The system is an attempt to allow a better spread of the use of IEQ assessments, due to the integration of different probes in only one measuring device and to the innovative communication strategy. It is expected that a larger number of users will have access and easily understand the different dimensions of the evaluation of IEQ, with positive impacts in terms of well-being, health, safety and productivity of people in buildings and other indoor environments. ■

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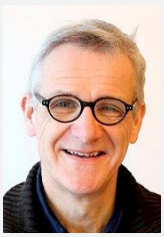
Ventilative cooling in a school building: evaluation of the measured performances

HILDE BREESCH
KU Leuven, Department of Civil Engineering, Construction Technology Cluster, Sustainable Building, Ghent Technology Campus, Belgium
Hilde.Breesch@kuleuven.be

BART MEREMA
KU Leuven, Department of Civil Engineering, Construction Technology Cluster, Sustainable Building, Ghent Technology Campus, Belgium



ALEXIS VERSELE
KU Leuven, Department of Civil Engineering, Construction Technology Cluster, Sustainable Building, Ghent Technology Campus, Belgium

The test lecture rooms of KU Leuven Ghent Technology Campus is a case study of IEA EBC Annex 62: Ventilative Cooling. The ventilative cooling system includes natural night ventilation and indirect evaporative cooling. This paper evaluates thermal comfort in this school building and the performances of its ventilative cooling.

Keywords: Ventilative cooling, nZEB, school building, measurements, thermal comfort, night ventilation, indirect evaporative cooling

One of the major new challenges in nearly Zero Energy Buildings (nZEB) is the increased need for cooling and risk on overheating not only during summer, but all year round (Heiselberg, 2018). Therefore, conceptual and building technical measures as well as energy efficient cooling systems are needed in these nZEB buildings to guarantee a good thermal comfort. Ventilative cooling is an example of an energy efficient cooling method and was extensively studied within IEA EBC Annex 62: Ventilative Cooling. The test lecture rooms of KU Leuven Ghent Technology Campus were one of the case studies of IEA EBC Annex 62 (see O'Sullivan and O'Donovan, 2018). This paper aims to evaluate thermal comfort in this nZEB school building and the performances of its ventilative cooling system.

This article is based on a paper presented at the 39th AIVC - 7th TightVent & 5th venticool Conference, 2018 "Smart ventilation for buildings" held on 18-19 September 2018 in Antibes Juan-Les-Pins, France.

Building description

Building and use

The nZEB school building is realized at the Technology campus Ghent of KU Leuven (Belgium) on top of an existing university building. The building contains two large lecture rooms with a floor area of 140 m² and a volume of 380 m³ each (see zone 1 and 2 on **Figure 1**). The first floor has a medium and the second floor a light thermal mass according to EN ISO 13790. The window-to-wall ratio is 26.5% on both façades. The building is constructed according to the Passive House standard. The windows are provided with automatically controlled moveable external screens on the southwest façade. Design of the building is described more in detail in Breesch et al. (2016).

The lecture rooms are in use from Monday to Friday between 8:15 and 18:00 with a maximum occupancy of 80 persons or 1.78 m²/pers. **Figure 2** shows details of one typical week of occupancy.

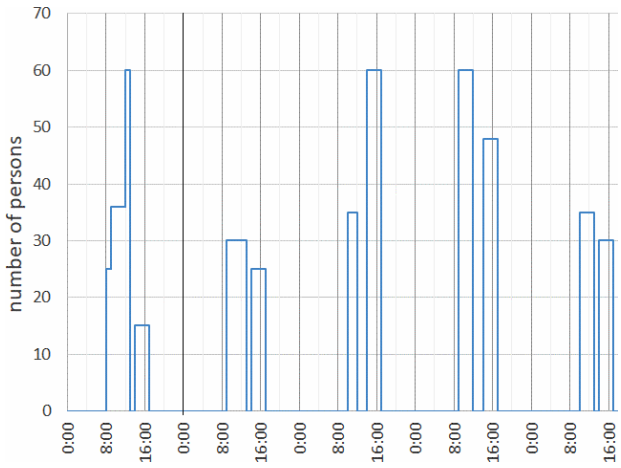


Figure 2. Typical occupancy profile in the lecture rooms during one course week (Monday to Friday).

Ventilative cooling

Two different principles of ventilative cooling are implemented in this building: (1) natural night ventilation (2) an air handling unit (AHU) that cools the supply air by controlling the modular bypass and by using indirect evaporative cooling (IEC). Night ventilation relies on cross ventilation through openable windows at both sides of the room (see **Figure 3**). The system includes 10 motorized bottom hung windows (1.29 x 1.38 m², maximum opening angle of 8.8°) with a chain actuator. There are 6 windows on the southwestern side and 4 on the northeaster side of the lecture room. The total effective opening area of these windows is 4.0% of the floor area. The modular bypass and IEC are part of the AHU. The maximum airflow rate is 4400 m³/h. The maximum capacity of IEC at maximum airflow is 13.1 kW.

Control strategy

Control strategy of the systems consists of two parts. First, the control strategy of the AHU (operation of bypass and IEC) during occupancy is based on internal and external temperatures (see **Figure 4** left). This strategy actuates the supply air temperature and the air flow rate. Second, control strategy that actuates the opening of the windows at night is based on internal temperature and relative humidity and external weather conditions (temperature, rain) measured on site (see **Figure 4** right).

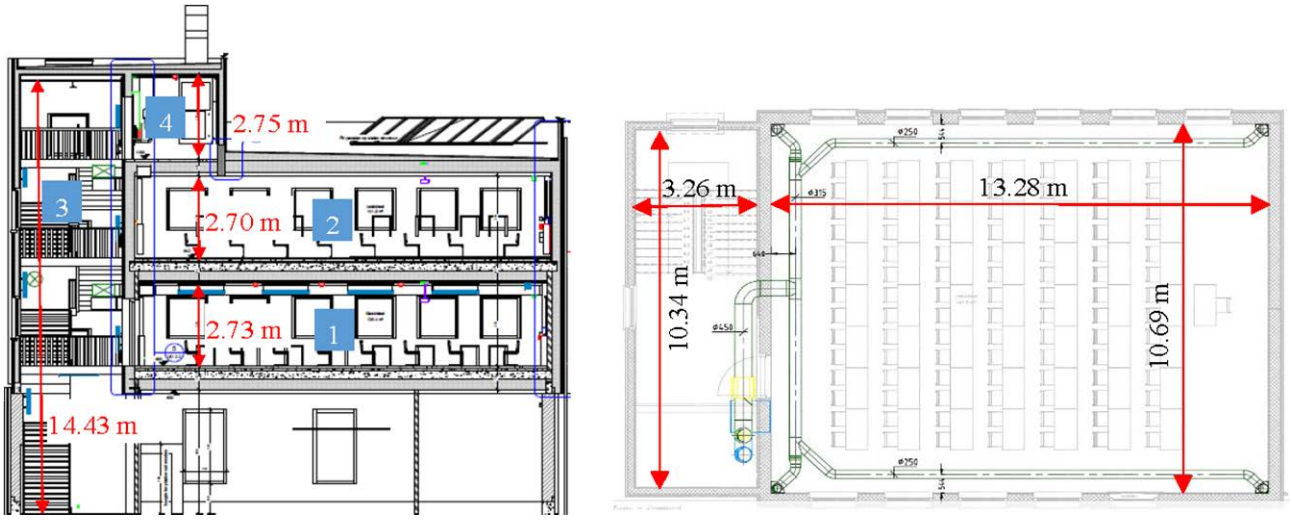


Figure 1. Section (left) and floor plan (right) of the test lecture rooms on KU Leuven Technology campus Ghent.

Measurement set up

Airflow rate

Air Changes Rates (ACR) as result of the opening of the windows were measured using a tracer gas concentration decay test method (EN 12569) in March and April 2017 by Decrock and Vanvalckenborgh (2017).

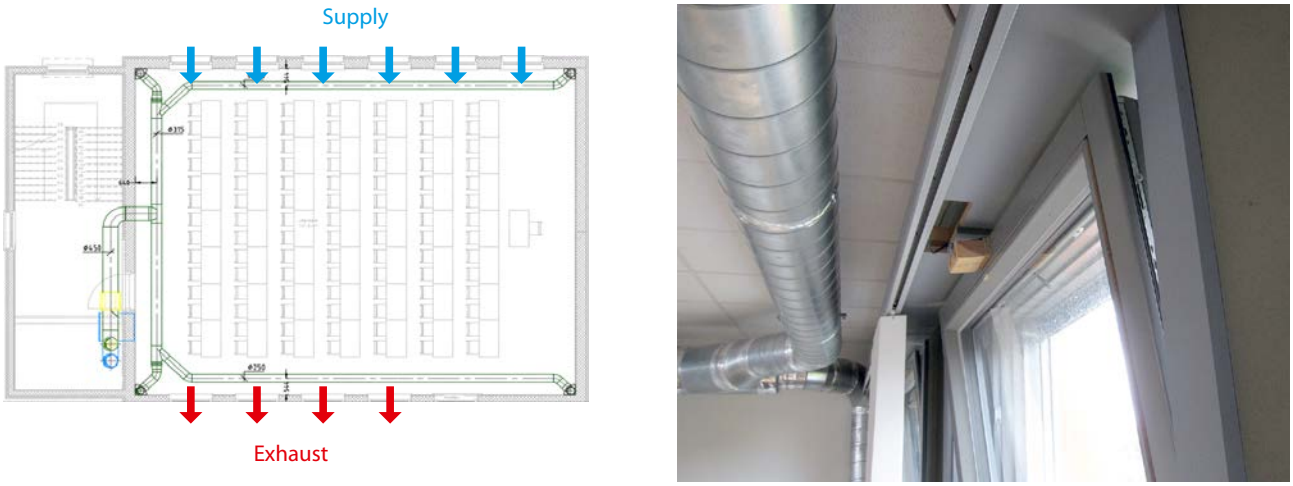


Figure 3. Principle of natural night ventilation (left) and detail of motorized window (right).

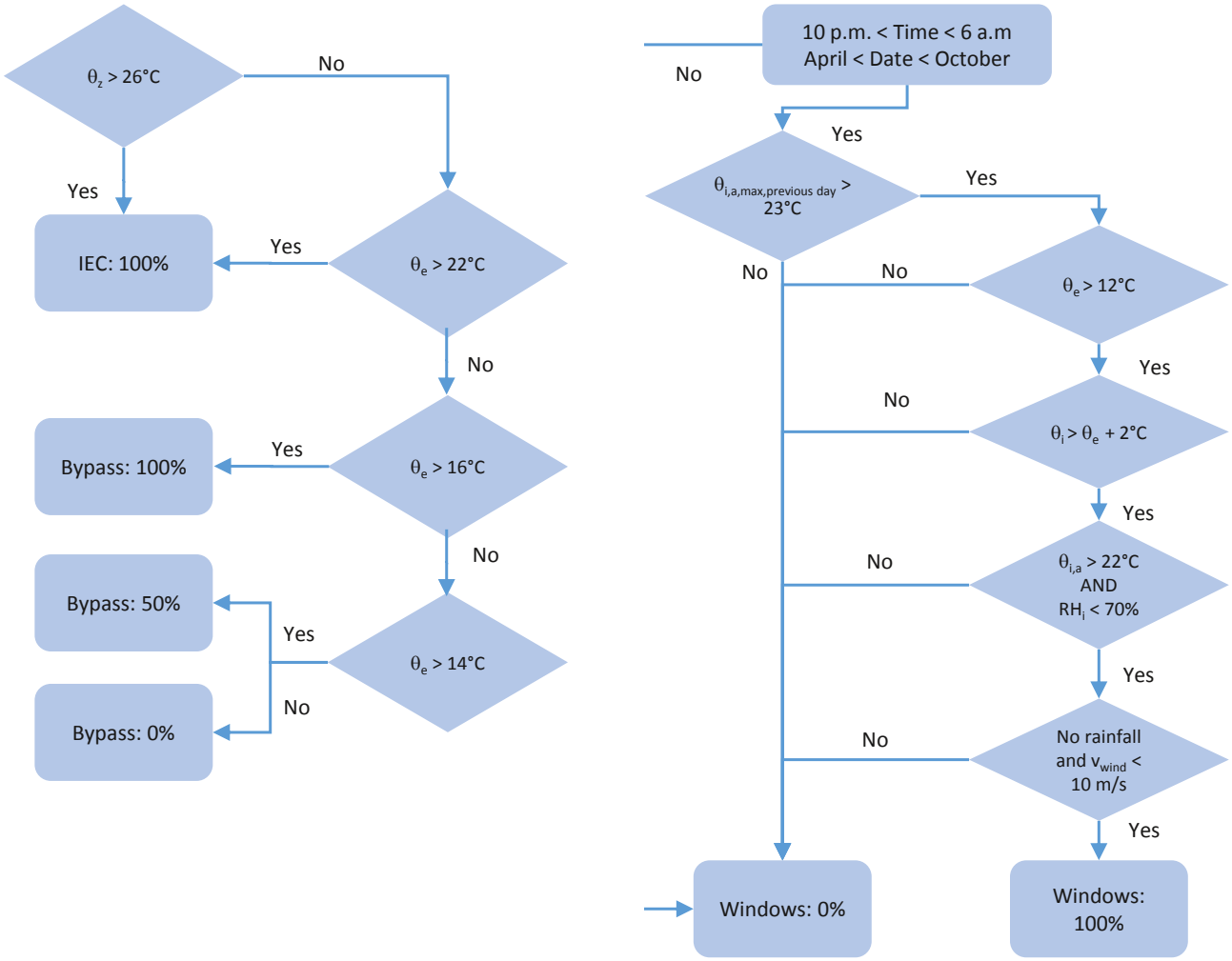


Figure 4. Control strategy flowchart of AHU during occupancy (left) and natural night ventilation (right).

The measurements were carried out in a representative zone with two opposing windows (see **Figure 5**). Tracer gas was injected and sampled in the middle of this small room and the concentration was increased to 200 ppm. Consequently, one or two opposing windows (depending on the test) were opened. The accuracy of the tracer gas equipment is 10% of the measured value.

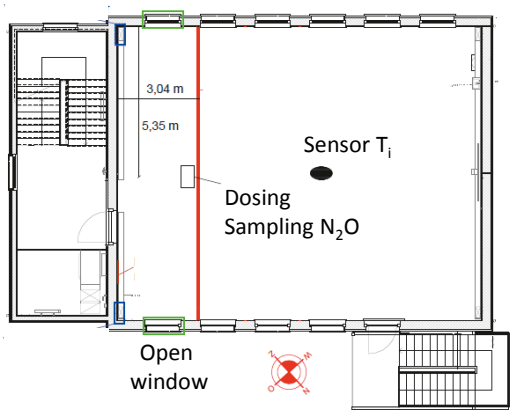


Figure 5. Test set up tracer gas measurement.

Indoor climate and operation ventilative cooling

A set of sensors has been installed to continuously monitor indoor conditions (temperature, CO_2-concentration, relative humidity, occupancy), operational data (of AHU, night ventilation, IEC, heating systems, etc.) and weather data (temperature, humidity, rain, global horizontal solar radiation, wind speed and direction) and is described in Andriamamonjy and Klein (2015). The time step is 1 minute. **Table 1** shows type and accuracy of the sensors used in this study.

Table 1. *Properties of the sensors.*

Parameter	Type sensor	Accuracy
Room temperature	SE CSTHR PT1000	± 0.1°C
Supply temperature	SE CSTHK HX	± 0.4°C
Occupancy	Acurity Crosscan Camera	± 5%
Outdoor temperature	Vaisala HMS82	± 0.3°C at 20°C
Wind velocity	Ultrasonic 2D Anemometer	± 0.1 m/s (0-5 m/s)
Wind direction	Ultrasonic 2D Anemometer	± 1°

In this paper, internal temperatures and operation of ventilative cooling are studied during the cooling season in 2017 in the lecture room on the first floor, i.e. from May 22th to September 30th, 2017. As there was no occupancy in July and only limited in August, these months are excluded from the analysis.

Results

Airflow rate

Table 2 presents the results of the tracer gas decay tests for single sided and cross ventilation including the local weather conditions (wind velocity and direction) and the average indoor-outdoor temperature difference during the test. For cross and single-sided ventilation, the 95% confidence interval for ACR is respectively 1.21 to 2.12 and 2.17 to 4.64 h-1.

Table 2. *Measured ACR with tracer gas decay during spring 2017.*

Ventilation mode	ACR (h^{-1})	Wind velocity (m/s)	Wind direction	ΔT (°C)
Cross ventilation	4,18 ± 0,42	1,9	WNW	4,3
Cross ventilation	3,76 ± 0,38	2,1	ESE	1,6
Cross ventilation	3,04 ± 0,30	2,2	ESE	2,4
Single sided	2,05 ± 0,21	2,3	SSW	No data
Single sided	2,00 ± 0,20	2,68	S	No data
Single sided	1,17 ± 0,12	1,45	SSW	5,1
Single sided	1,56 ± 0,16	1,78	S	8,6

Operation of ventilative cooling

Figure 6 presents the ratio of operation time of the windows to the possible total opening hours by night (22h tot 6h) and the ratio of the operation of the IEC to the operation hours of the AHU by day. IEC and night-time ventilation are in use during 66% respectively 45% of the time.

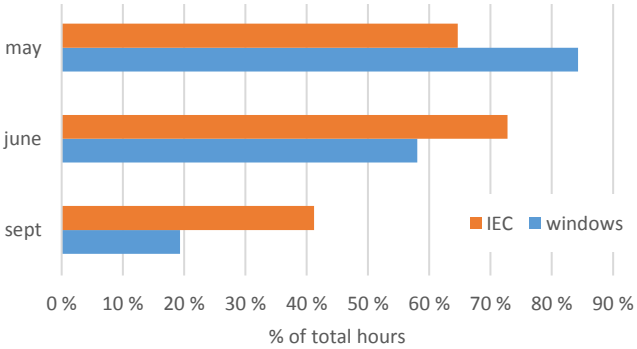


Figure 6. Percentage of hours of operation of windows by night and IEC by day from May to September 2017.

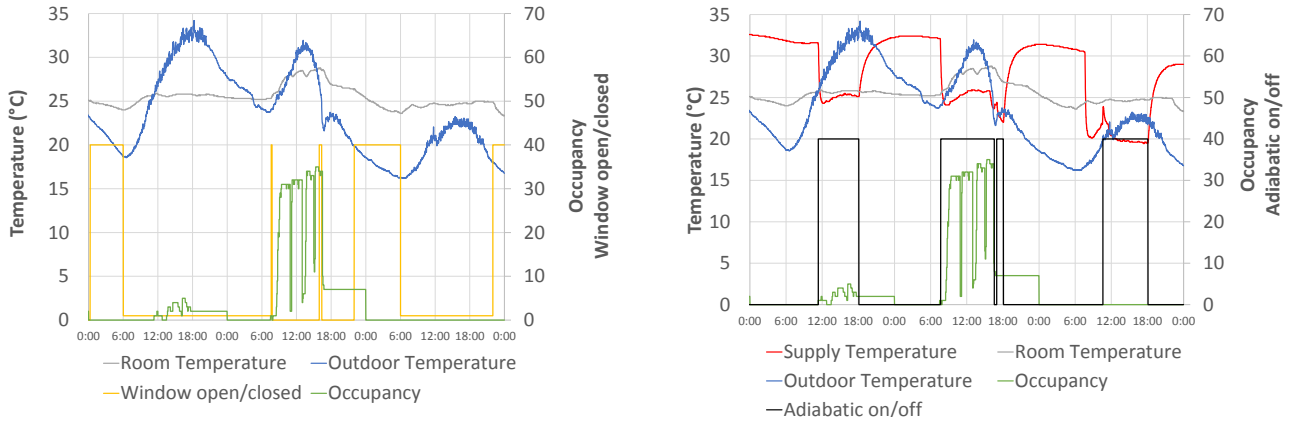


Figure 7. Operation of windows (above) and IEC (below) during an extremely warm period (21-23 June 2017).

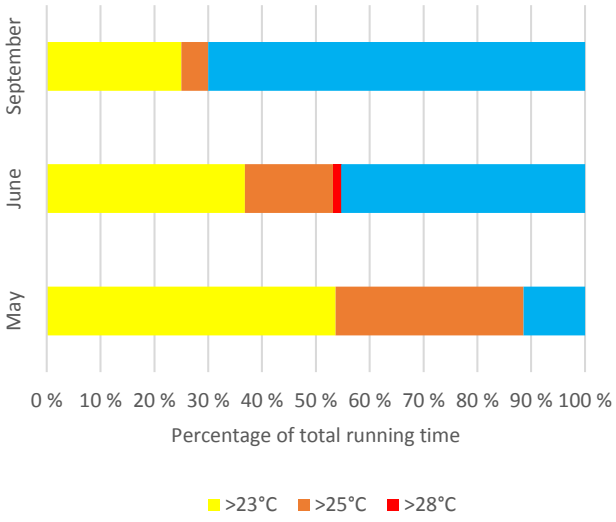


Figure 8. Percentage of hours above threshold values for internal temperatures in lecture room on 1st floor May-September 2017.

Figure 7 shows the operation of the windows for night ventilation respectively IEC during extremely warm days in June 2017. In that period, IEC operates the whole day and can lower the supply temperature significantly compared to the outdoor temperature. Natural night ventilation only operated very short time the second night in between two hot summer days because the requirement that the outdoor temperature has to more than 2°C lower than the room temperature was not fulfilled.

Thermal comfort

Figure 8 presents hourly indoor operative temperature in this lecture room, as a percentage of hours of exceedance per month above 23°C, 25°C and 28°. During operation of the AHU, 5.1% and 0.3% of the hours in 2017 exceeded 25°C respectively 28°C. This means a good thermal comfort according to EN 15251.

Thermal comfort in this lecture rooms is also evaluated as a function of the running mean outdoor temperature as defined by the Dutch adaptive temperature limits indicator (van der Linden et al., 2006) (see **Figure 9**).

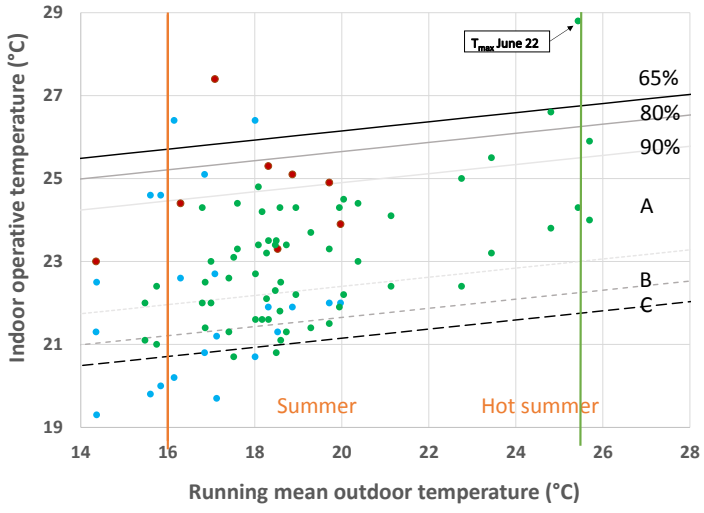


Figure 9. Thermal comfort evaluation according to the Adaptive Temperature Limits Method (van der Linden et al., 2006).

Overall, good thermal comfort is concluded. Only in hot summer and/or periods with high occupancy, high indoor temperatures are monitored. In addition, very low temperatures are noticed in September in the morning.

Conclusions and lessons learned

Thermal comfort and the performances of ventilative cooling in the test lecture rooms of KU Leuven Ghent Technology Campus was monitored during cooling season of 2017.

A good thermal summer comfort was measured in the test lecture rooms. Only during heat waves and/or periods with high occupancy rates, high indoor temperatures were monitored. Both night-time ventilation and indirect evaporative cooling operate very well. IEC can lower the supply temperature by day significantly compared to the outdoor temperature. IEC is in use during more than half of the occupied hours in the cooling season due to high internal heat gains in the lecture rooms.

The ACR of the night-time ventilation is rather low and, in case of cross ventilation, depends a lot on wind direction and velocity. The ACR in these lecture rooms can be increased and made more reliable and stable by adding mechanical exhaust. However, this measure will also increase the fan energy.

The extensive data monitoring system was of great value to detect malfunctions, to improve the control of the building systems and optimize the whole building performance. Monitoring showed e.g. that the windows for night ventilation opened and closed a lot at night during the first weeks. This was due to (1) bad translation of the signal of the rain sensor and (2) peaks in the wind velocity. These parameters are part of the control of the windows. This malfunctioning was discovered and solved by analysing the monitoring results.

Furthermore, attention must be paid to the users. A lot of different teachers give classes in these lecture rooms. Most of them are not used to automated blinds, ventilation and ventilative cooling. They open the door to the corridor and the windows even when it is warm outside and consequently cause a decrease in thermal comfort. It is important to educate and inform the users about the operation of the automated system to come to a comfortable and energy efficient building. ■

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Energy saving opportunities in operating theatres: a literature study

ALEKSANDRA ZARZYCKA
Royal HaskoningDHV
Eindhoven University of Technology
The Netherlands
al.zarzycka@gmail.com

WIM MAASSEN
Royal HaskoningDHV
Eindhoven University of Technology
The Netherlands
wim.maassen@rhdhv.com

WIM ZEILER
Eindhoven University of Technology
The Netherlands
W.Zeiler@tue.nl

Operating theatres are very strictly-controlled environments where any changes that are being introduced can have a direct impact on people's lives. The challenge of this research lays in providing solutions for energy savings which do not disturb the infection prevention measures and help maintain high quality of the surgery.

Keywords: Energy Savings, Hospitals, nZEB, Operating Theatres, Ventilation, Sustainable Healthcare, Infection Prevention

The health care sector is highly energy intensive. Worldwide, circa 6% of the total energy consumption in the buildings sector is represented by energy usage in medical centres. For this reason, hospitals strive to reduce their consumptions and CO_2-emissions. In order to meet the requirements, set by the European Union Energy Performance of Buildings Directive (EPBD), all buildings (residential and utility) need to comply to Nearly Zero Energy Building requirements according the EPBD [1]. Previous study [2] has looked into energy consumptions of various spaces within a hospital and concluded that for Dutch hospitals the energy reduction potential seems to be the highest in isolation rooms and operating theatres (OTs). For the OTs the highest energy consumption is attributed to the amount of supplied air, energy used for fans and the time that surgery rooms are in operation.

Methodology

In this study the possibility to reduce energy consumption in the OTs is investigated, using an approach that puts the human and his safety in the centre of attention. Most important factors in infection prevention are therefore categorized into four groups, the so called 'four Ps': pathogens, people, practice and place (**Figure 1**).

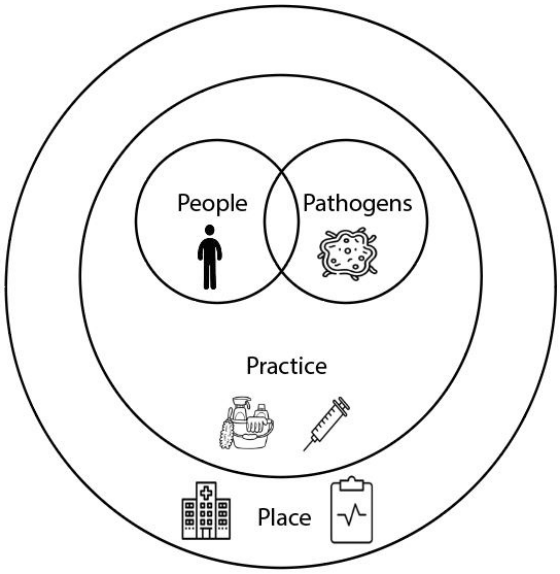

Figure 1. Four "Ps" of infection prevention.

In the Netherlands, a commonly used approach for an energy-efficient building design is the three-step strategy called 'Trias Energetica' [3]. Due to increasing concern and evolution of techniques, the 'Trias Energetica' has been upgraded to a 'Five-Step Method' [RHDHV], as can be seen in **Figure 2**. The additional steps to the original approach are: user demand and behaviour (point 1) and energy exchange and storage systems (point 4). The former step implements the 'user-oriented' concept through smart building designs and controls. The focus on the user and his primary process results in possibilities for improvements of indoor climate as well as productivity. Furthermore, it can substantially decrease energy use. This idea is further developed in this research. By investigating the parameters needed to create a safe environment, starting from the most basic layer such as bacteria transmission, the project aims to draw conclusions on the actual requirements for a healthy indoor environment in the OT, questioning the current standards. Is such a high air exchange rate necessary? Are current systems the most efficient infection prevention methods? How can the OT be optimized for a high surgical performance? These questions can only be answered by understanding the actual needs of this specific environment, therefore the focus on user demand and behaviour is crucial.

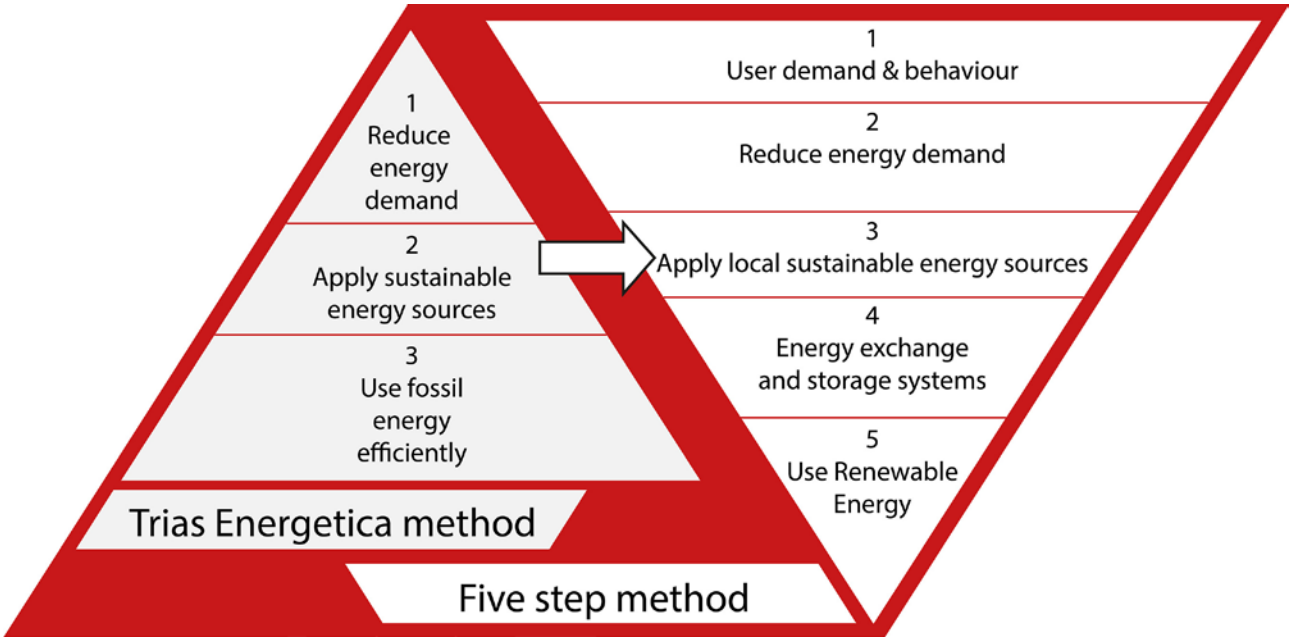

Figure 2. Building design approaches: 'Trias Energetica' versus the upgraded 'Five Step Method'.

Pathogens

The total annual number of patients that suffer from surgical site infections (SSIs) amounts to 1.12% for European hospitals [4]. Inside the operating theatre, bacteria can reach the wound either by dislocation within patient's own microbiota, through air or from poorly disinfected tools. The shedding of bacteria from staff's skin is considered one of the biggest potential sources of wound contamination [5]. Each person sheds around 10,000 skin particles per minute into the air while walking. Approximately 10% of these are estimated to carry bacteria [6]. Skin fragments carrying bacteria have an average size of 12 μm (range between 4–60 μm). Surgical-site contamination by airborne particles is ascribable in 30% of cases to direct settling of the particles on the wound and in 70% of cases to settling on the instruments and surgeon's hands followed by transfer to the wound [7].

There are several environmental factors that may impact the infection acquisition, from which four are of relevance in the operating theatre: relative humidity (RH), temperature, air speeds and movement intensity of the particles. There is research showing that maintaining the humidity levels in the range between 40 and 60% can be related to decreased infection rates in hospitals [8],[9]. This is due to lower possibility of droplets to remain suspended in the air for prolonged periods of time, prevention of mucous membrane from drying out, shorter life span of bacteria and viruses in such conditions and lack of accumulation of static electricity with higher humidities [10],[11].

On the other hand, professionals argue that relative humidity is not of such importance and there is no need to pay close attention to its levels.

People

While the primary focus of indoor environment in operating theatres is on infection prevention, thermal comfort of the workers tends to be generally overlooked. Study performed by Ilse Jacobs focused on the thermal sensation of surgical staff members in OTs equipped with different ventilation systems [12]. The conclusion of the research was that surgeons tend to feel from slightly warm to hot, anaesthetists and nurses from slightly cool to cold, and the patient from slightly cool to very cold. Only the surgery-assistant experiences a comfortable environment with the current environmental and clothing parameters according to Van Gaever et al. [13].

When it comes to the patient, a study by Khodakarami et al. stated that the temperature must not drop below 21°C [11]. However, a temperature above 23°C already becomes intolerable for the surgical staff. During an operation, body temperature is lowered due to open body wounds, infusion of cold fluids, inhalation of cold gases and lowering muscle activity or because of the pharmaceutical agents given to the patient. Even mild hypothermia can lead to numerous complications, which might lower the resistance to surgical wound infection [14]. A 36% decrease in infection rates was observed by Melling in patients who received some form of warming during the surgery [15].

Practice

In an environment where anaesthetic measures are suppressing immune system of a patient and a direct contact between him and OT staff is frequent, failure to maintain highest standards of (hand) hygiene can result in increased infection risk.

Table 1 summarizes factors associated with surgical-site infections. The icon representing a group of people means that a factor is related to discipline. Icon with a piece of paper shows the connection to rules and regulations. Icon with a light bulb means the relation with the skills of the operating team.

Table 1. *Factors associated with surgical-site infection.*

Operation characteristic	
	Inadequate surgical team preoperative hand and forearm antisepsis
	Inappropriate or untimely antimicrobial prophylaxis
	Inadequate sterilization of instruments
	Contaminated OT environment
	Inappropriate surgical attire and drapes
	Inadequate preoperative skin preparation
	Inappropriate preoperative shaving
	Poor surgical technique: excessive blood loss, hypothermia, tissue trauma, entry into a hollow viscus, devitalized tissues etc.
	Excessive duration of operation

Table 2 shows an overview of some of the factors that influence the occurrence of surgical site infections. It has to be noted that these values vary between studies and very often it is hard to estimate their role in reduction of SSI rates due to complexity of the surgical environment and too many factors that are mutually dependent. For some positions, for example surgical clothing, such an estimation was not possible, therefore these were not included in the table.

Place

Operating theatres can be classified depending on their performance as suitable for high-risk operations or not. Ventilation system which is installed in a given OT is responsible for providing clean air and maintaining the quality of the environment according to the class of the room.

In general, there are two main ventilation principles that are applied in OTs: mixing ventilation (turbulent mixed airflow TMA) and displacement ventilation (unidirectional flow UDF), as presented on **Figure 3**. Turbulent mixed airflow supplies turbulent streams of HEPA filtered air through diffusers on the ceiling, therefore creating a mixed ventilation in the whole space of an operating theatre. The system is based on dilution principle, which results in exponential decay of high concentrations of airborne microbes over time [19]. Second type is a system supplying conditioned air in a parallel stream to the surgical field. The streams of air move in parallel layers and, with equal speed of around 0.4 m/s, reach the operating table. This creates a sort-of protective curtain of airflow surrounding the surgical site. Apart from traditional systems, recent years have seen the emergence of new systems, based on mentioned principles. Halton Vita OT Space is a system that has been developed on mixing principle in the year 2015 and is presented on **Figure 4**.

The controlled dilution effect is created by circumferential air supply directed both inward towards the operating area and outward towards the room periphery. The emissions generated in the room periphery are diluted by additional air supplied to periphery zone. Based on room dimensions, operational needs and thermal comfort, airflow pattern can be adjusted. An example of a recently developed system working on the principle of UDF is Optimus Integrated Surgical Environment shown on **Figure 5**. In this approach the entire operating complex is integrated into one solution, including lighting, web cams, sensors, microphones and surgical cameras. The room air volume will be replaced 30 times per hour at very low velocities [21].

Table 2. *Influence of various factors on the decrease in surgical site infection rates [16],[15],[17],[18].*

Influencing factor	Decrease in SSI rates
Hand hygiene	13-54%
Proper antibiotic use	26-92%
Occurrence of hypothermia	36%
Preoperative showering with chlorhexidine	24.4%
Type of intervention	up to 83.7%
Health state of the patient	up to 86.4%

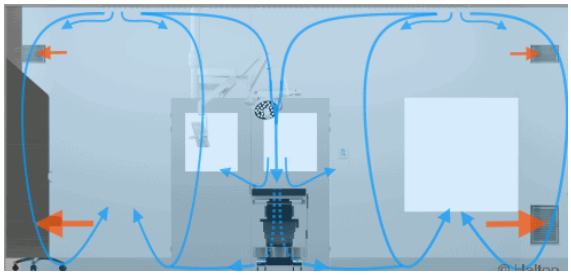

Figure 4. Halton - mixing ventilation principle [20].

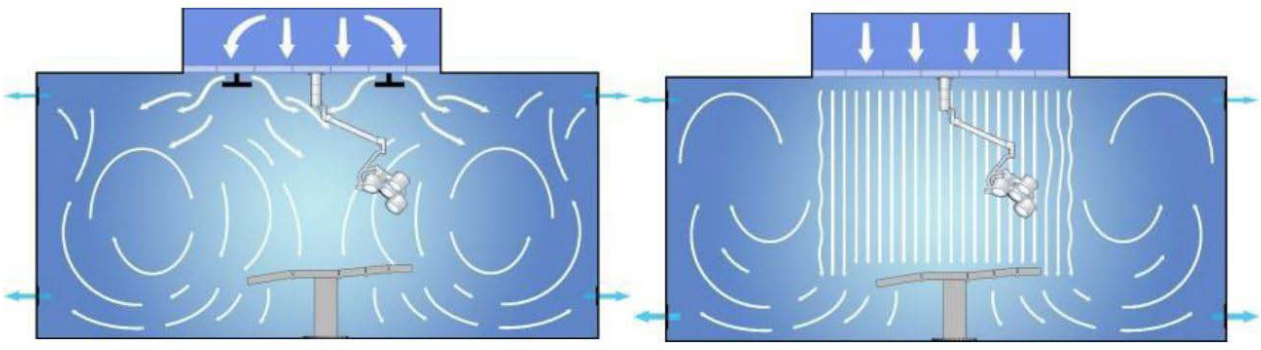

Figure 3. Flow patterns for the TMA (left) and UDF (right) ventilation systems [12].

A system called Opragon (**Figure 6**) is based on a modification of UDF - Temperature controlled Laminar Airflow (TAF). In this solution slightly chilled, HEPA-filtered air is introduced to the room and distributed by low impulse, half-spherically shaped air showers. They are mounted in a circle, creating an ultra-clean zone. Outside of the zone, eight additional diffusers are mounted on the ceiling, preventing stagnation zones in the periphery of the room. Higher density of chilled air causes it to fall to the floor at a speed controlled by the difference in temperature between the added air and the air at the level of the operating table. The temperature difference of –1.5 to –3°C between the added ultra-clean air and the surrounding air in the room at the operating table level needs to be maintained in order to guarantee a speed of around 0.25 m/s at the operating table level [22].

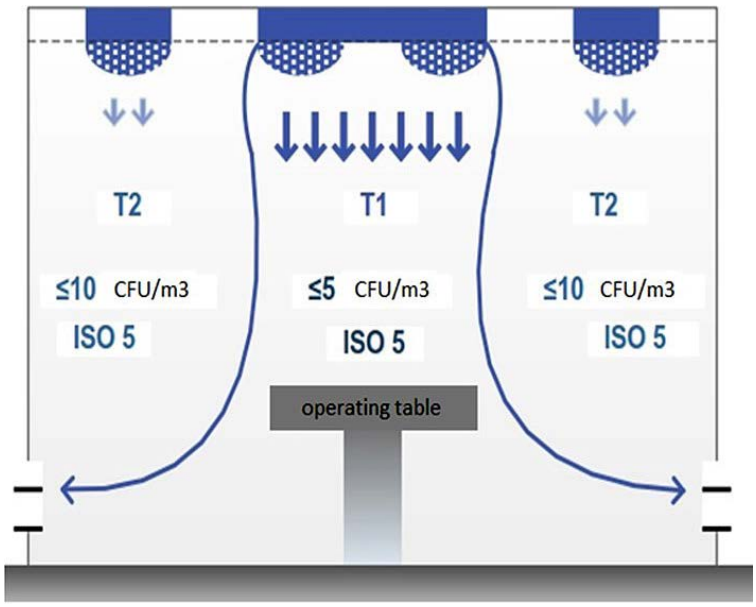

Figure 6. Opragon ventilation system based on TAF principle.

Figure 5. Optimus Integrated Surgical Environment – UDF ventilation principle [21].

The temperature gradient drives the central vertical flow of cooled air. The air showers located in the outside zone provide control of the room temperature, therefore there is no need for additional heating system, like in a laminar downflow. A comparison between three mentioned systems is presented in **Table 3.**

Conclusions and energy saving measures

Having conducted the literature research by starting from the human perspective it is possible to distinguish new strategies for energy reduction and process improvement. Traditionally the design of the operating theatres is based on many steady-state parameters, while in practice these values vary greatly. Aspects such as hand hygiene, skin shedding of the staff, parameters of the clothing (in case multi-use attire is used), movement of the staff etc. cannot be approximated with one number since they differ everyday depending on the team. Moreover, environmental factors such as relative humidity and indoor temperature can play a role in the spread of pathogens. When it comes to the systems themselves, their design parameters such as the location of inlets/outlets or location of heat sources in the room can greatly alter the way bacteria is transported within the OT.

It is therefore crucial for the engineers and designers of the OTs to be able to understand the way that bacteria travels in space and reaches the wound area of the patient. With better understanding of these mechanisms, ventilation systems could be adjusted to provide more precise and more energy-efficient solutions. However, before the research on the bacteria transmission is completed, there are several energy saving measures that can already be implemented in the hospitals:

- Airflow control based on particle concentrations,
- Variable temperature with the outdoor weather,
- Turning down the system for the night,
- Better planning of the use of OTs based on operation type,
- Removing humidification,
- Increased air recirculation.

One of the energies saving measures is airflow control based on particle concentrations. This energy saving measure at the same time provides increased infection prevention. By putting a real-time particle counter in the vicinity of the wound, it is possible to get an immediate feedback on the number of particles in that area. Although there is no direct correlation between the number of particles and the amount of colony forming units, bacteria always need a particle on which it can settle. Therefore, we can assume that if there is no or very little particles in the air, the chance of finding bacteria is also very low. Having a real-time feedback enables the system to reduce the amount of air if there are no particles in the air and increase it in case there is a significant of particles, thus improving infection prevention. This approach is in line with the statement that OTs design cannot be based on steady-state parameters. By the real-time measurement, the ventilation system can be adjusted to the current situation and its needs. Another measure is related to changing the absolute temperature inside the OT based on the outdoor conditions. Even though the temperature difference between the inlet and outlet air inside the room needs to be kept the same, the absolute values can vary with seasons, allowing for energy savings. Third measure is related to turning down the ventilation system for the night and it has been studied by Dettenkofer et al. [23]. The authors have concluded that shutting down OT ventilation during off-duty periods does not appear to result in an unacceptably high particle count or

Table 3. *Comparison of three ventilation systems [19].*

Description	Turbulent mixing	Unidirectional flow	Temperature controlled airflow
ISO class in the centre of the OR (steady-state)	7	5	5
ISO class in the periphery of the OR (steady-state)	7	7	5
Protected area	No	Yes	Yes
Recovery time <3 min	No	Yes	Yes
Type of flow	Turbulent	UDF	UDF
Acceptance for class Ia surgeries	No	Yes	Yes
Average airflow (m^3/h)	3 200 m^3/h	12 000 m^3/h	5 600 m^3/h
Recirculation of air	0%	70%	45%
Noise level in empty room	45 dBA	58 dBA	48 dBA
Ventilation power	2.8 kW	8.0 kW	5.7 kW
CFU/m^3 median(range)	10 (0-162)	0 (0-16)	1 (0-29)

microbial contamination and if the system is restarted 30min before the scheduled operation, high levels of air quality will be maintained. Fourth possibility is related to improved planning within the hospital management. Not all operations need to be conducted in the highest performance OTs, for which the energy consumption is very high in order to provide the highest levels of air cleanliness. If a classification of operation types is created, they could be distributed between two performance classes of the OTs, leading to energy savings. Last two measures are already being widely implemented in the USA with positive results regarding energy savings.

The article shows added value the approach was the focus on energy conservation begins primarily with the human needs and process conditions needed to supply a productive, healthy and comfortable indoor environment. Starting from the essential human and process needs it leads to an analysis resulting in relevant energy conservation possibilities. ■

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Third party certification for water-clear performances on an opaque market

A need for more transparency and reliability on the plate heat exchangers market

Suitable for a wide range of applications, single-phase (liquid-to-liquid) plate heat exchangers (PHE) are a compact and efficient heat transfer solution.

MARIE-CLÉMENCE BRIFFAUD
Project Development Engineer
Eurovent Certita Certification, Paris, France
mc.briffaud@eurovent-certification.com

The area of a plate varies from a few square centimetres to several square meters. Besides, the number of plates in a single exchanger can range from ten to several hundreds, thus reaching heat exchange surface areas up to thousands of square meters. Thanks to this high level of modularity, plate heat exchangers (PHE) can be customized to the end customer's specific needs.

However, the race towards design optimisation, originally customer oriented, created a perverse effect. Indeed, the final choice between two providers being mainly driven by prices, the manufacturer can be tempted to manipulate calculations, thus minimizing costs and making his technical offer more attractive. Yet, these adjustments often imply a heat capacity loss.

This malpractice is all the stronger as two different plate heat exchangers can look physically identical. However, there are differences of prime importance for the heat transfer, for instance the plate corrugation pattern, that are not visible from outside. These technical features, treated as confidential "know-how" data, are impossible to check without dismantling the heat exchanger.

Anyone involved in recommending, selecting and using such heat exchangers – consultant, specifier and end customer – is therefore breaking out into a cold sweat when the commissioning time comes. Indeed, if the installed heat exchanger does not function as expected, filling the performance gap generates additional, and sometimes, substantial costs which come on top of the investment already made, not to mention the lost time.

In a spirit of fair competition, some manufacturers have been trying to communicate on this risk to raise the general awareness, but such individual initiatives have not been as successful as expected. So far, the choice remains driven by the costs, no matter the level of commitment provided by the manufacturer.

Joining forces for a European solution

To encourage manufacturers to communicate on engineering performances of their products and to create a level playing field, the first step is to provide them a single, common, baseline for the product evaluation rules. This is where voluntary third-party certification comes into play.

Eurovent Certified Performance (ECP), is one the most renowned certification mark in the European HVAC&R. It is estimated that 66% of HVAC&R products sold on the European market are ECP certified[1]. That is the reason why a group of European manufacturers decided to join forces with Eurovent Certita Certification to establish a strong, reliable certification scheme guaranteeing that certified products will perform as advertised once set-up.

The committee thus formed worked between April 2017 and September 2018 on reference documents

[1,2] that provide a common, levelled playground to the market players. The resulting Liquid-to-liquid plate heat exchangers certification programme entered into force on October 15th, 2018.

A tailor-made certification programme…

The development of the programme also involved European laboratories consultation to elaborate an adequate test method based on, but amending, the EN 1148:1999+A.1:2005 standard [3] focused on water-to-water district heating applications. The test method detailed in the rating standard [2] is aligned with the certification scope i.e. plate heat exchangers operated for Heating, Ventilation and Air-conditioning (HVAC) single-phase applications.

To enhance comparability and fairness of the ratings the performance tests need to be fully reproducible. A great part of the work was therefore dedicated to bringing more details to the test protocol in order to leave no room for ambiguity. As a result, priority was given to measurement uncertainty requirements clarity and relevance.

Another aspect of the challenge was to select a number of standard temperature conditions representative of NTU-LMTD² pairings that can be actually found in the HVAC industry in order to properly map the product range operating area (see **Figure 1**). A final list of twelve conditions was adopted (see **Table 1** and **Table 2**).

Eurovent Certita Certification will vary the following parameters every time a selection is made to cover as many configurations as possible over the certification campaigns:

- temperature condition (see **Table 1**)
- heat exchange fluid nature on secondary side: aqueous solution - ethylene glycol, propylene glycol and ethanol – with a given mass fraction between 20 and 50% or clean water
- primary side heat exchange fluid³ inlet volume flow rate
- maximum allowed pressure drops on primary and secondary sides respectively

… for tailor-made products

Three main categories of plate heat exchangers, named after their respective sealing technology, are used in single-phase HVAC applications. Gasketed PHE on the one hand, are appreciated for their easy dismantling for cleaning and maintenance operations. Brazed⁴ and fusion-bonded⁵ technologies, on the other hand, can

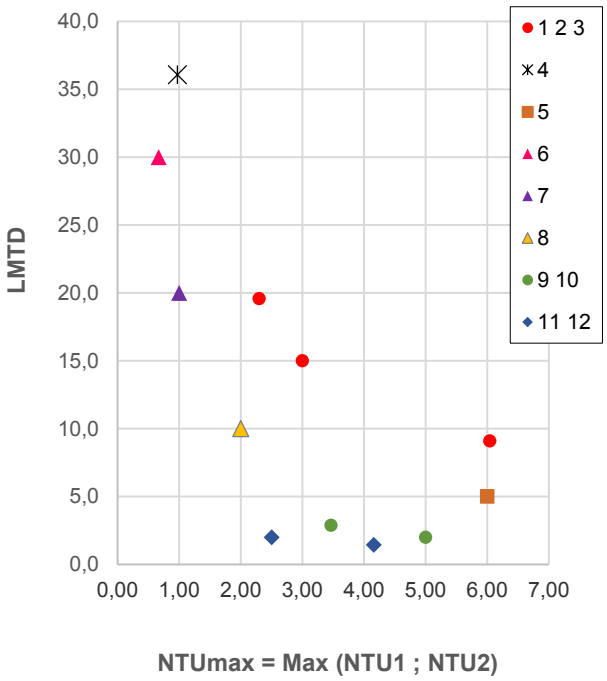

Figure 1. LMTD and NTUmax values corresponding to the 12 testing conditions adopted for the LPHE programme.

Table 1. *Standard temperature conditions for testing. [2]*

Temperature condition	t_{11}	t_{12}	t_{21}	t_{22}
1	70	15	10	55
2		25		
3		35		20
4				
5		40	35	65
6		50	20	40
7			30	50
8			40	60
9	22	12	10	20
10		14		
11		16	15	
12		17		

Table 2. *Abbreviations used in Table 1.*

t_{11}	Primary fluid inlet temperature (in °C)
t_{12}	Primary fluid outlet temperature (in °C)
t_{21}	Secondary fluid inlet temperature (in °C)
t_{22}	Secondary fluid outlet temperature (in °C)

sustain higher temperatures/pressures and are even more compact.

Playing with the plate size and number enable determining the most appropriate heat exchanger design for a given project specification. As a result, each and every plate heat exchanger sold to a customer is tailor-made.

Manufacturers generally use a software to compute the calculations. Hence, the software ability to provide accurate performance data is critical.

The certification requirements defined for the LPHE programme involve product performance testing to check the software outputs accuracy, but also production sites auditing and selection tool checking as complementary guarantees.

Indeed, the production site audit is an opportunity for Eurovent Certita Certification to verify that the software version used in situ – sometimes made available to the project owner - is the same as that declared for the certification. Besides, Eurovent Certita Certification verifies that essential manufacturing checks[6] are included in the standard operating procedure, conducted and registered. Eventually, the auditor checks that the products selected for testing are consistent with products sold to customers.

Towards increasing levels of transparency

Third-party certification purpose is to provide common rules for the product performance evaluation as a solution towards a fair competition between manufacturers.

Certification is not a single pass process (see **Figure 2**). Once a range is certified, an annual surveillance procedure, comprising tests and audits, is initiated to verify that the requirements continue to be fulfilled throughout the years. This surveillance procedure is mandatory for the manufacturer to see renewed his authorization to use the ECP mark on documentation and products.

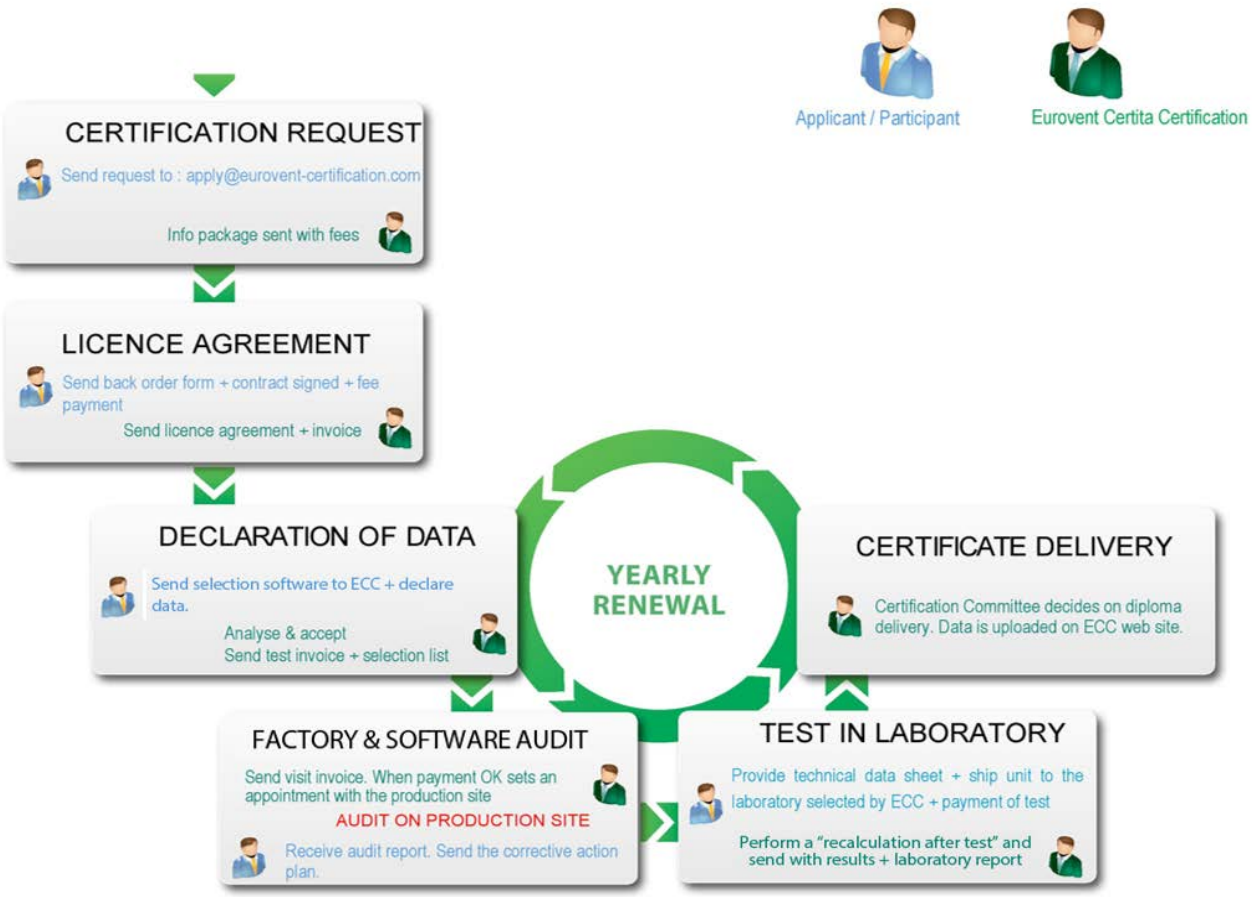

Figure 2. LPHE programme process overview.

The LPHE programme will constantly evolve throughout the years to capitalize on the certification campaigns feedback. Besides, it is already planned to re-evaluate in 2023 the possibility to switch from a range certification to a "certify-all" policy to enhance full transparency on the market. Every year, a dedicated committee composed of participating manufacturers will gather to suggest or validate updates managed by Eurovent Certita Certification.

In the meantime, any end-user will be able to ask Eurovent Certita Certification to check the software printout provided by a participating manufacturer free of charge.

With this brand new LPHE certification programme, Eurovent Certita Certification and plate heat exchangers manufacturers expect to raise the standard for transparency and reliability of the products data, thus restoring confidence in the plate heat exchangers industry over time.

How to get further information?

Anyone willing to get further information about the LPHE certification can visit the dedicated webpage where the applicable reference documents are available in English[7].

For specific questions or to apply for the certification scheme please contact apply@eurovent-certification.com specifying "LPHE" in the e-mail object. There is no deadline as this is a voluntary registration. ■

Endnotes

1 2014 data valid for Chillers, Heat Pumps, Fan Coil Units, Heat Exchangers and Filters within the certified scope

2 NTU (Number of heat transfer units) and LMTD (Logarithmic Mean Temperature Difference) definitions can be found in standard [4]

3 The primary side fluid is always clean water for simplicity

4 Using copper as brazing material

5 Using stainless steel as fusion material for hygiene and corrosion resistance

6 See Operational Manual OM-25 [1] for further details

7 http://www.eurovent-certification.com

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REHVA / EPB Center news

– Supporting the dissemination and roll-out of the EPB standards

On September 21, 2018 the Service Contract ENER/C3/2017-437/SI2-785.185, "Support the dissemination and roll-out of the set of Energy Performance of Building standards developed under mandate M/480", was signed between DG ENER and a consortium led by ISSO, including among the partners REHVA and EPB Center.

Keywords: EPB standards, support, dissemination, roll-out, national level.

On September 21, 2018 the Service Contract ENER/C3/2017-437/SI2-785.185, "Support the dissemination and roll-out of the set of Energy Performance of Building standards developed under mandate M/480" (SC-ENER-EPBCenter) was signed between DG ENER and a consortium led by ISSO, including REHVA and the EPB Center.

This 3-years long service contract shall serve its purpose by:

- Providing support to Member States and National Standardisation bodies as needed when preparing the national annexes or national data sheets of the overarching EPB standards;
- Supporting the wide dissemination of the annexes of the overarching EPB standards and their use by Member States (including as part of the obligations in Annex I of the revised EPBD);
- Setting up and running a public frequently asked questions database on developing annexes or data sheets, practical application of the standards, etc.
- Preparing practical case studies to support the use of EPB standards (e.g. by financial institutions, industry stakeholders, researchers, international fora, etc.);
- Developing and disseminating calculation tools for individual EPB standards;
- Setting up a large network of current and future practitioners (i.e. building professionals) and support the uptake of standards by organising regular hands-on workshops, webinars, online courses, etc.

The core part of the communication and dissemination is the EPB Center website (www.epb.center) acting as interface to and from the target groups, as well as the dedicated LinkedIn EPB Standards Community (https://www.linkedin.com/groups/13619324/) and BuildUp (The European Portal for Energy Efficiency in Buildings) topic 'Energy performance calculation procedures and CEN standards'[1].

Overview of activities

The activities of SC-ENER-EPBCenter are structured under 3 main tasks as illustrated in **Figure 1**:

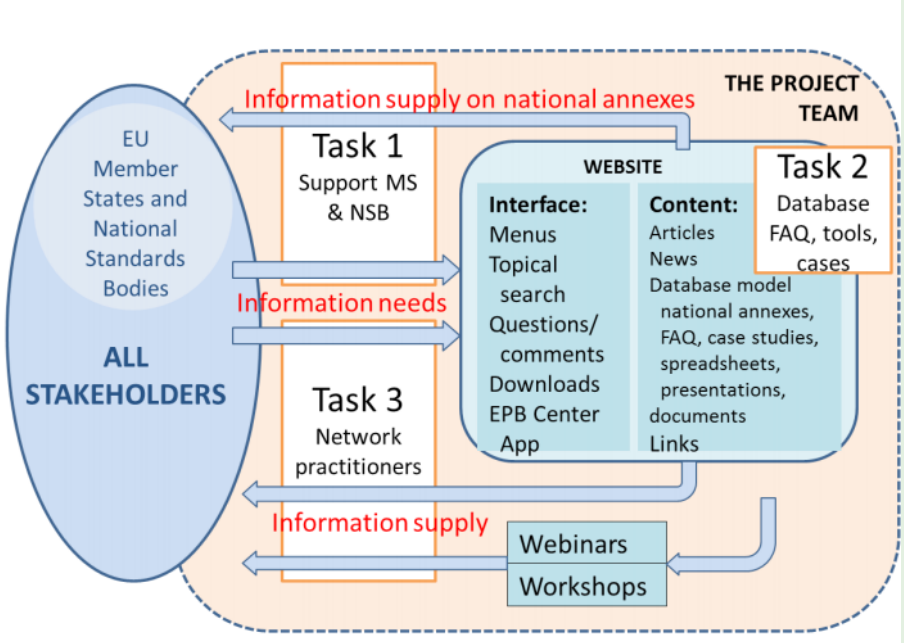


Figure 1. Relation between the tasks of Service Contract ENER/C3/2017-437/SI2-785.185.

1 http://buildup.eu/en/topics/energy-performance-calculation-procedures-and-cen-standards

- Task 1: Support to Member States and National Standardization Bodies;
- Task 2: Setting up a database of FAQs, calculation spreadsheets and case studies;
- Task 3: Creating a network of practitioners.

In line with the revised EPBD (2018), priority is given to the following 'overarching' standards: EN ISO 52000-1, EN ISO 52003-1, EN ISO 52010-1, EN ISO 52016-1 and EN ISO 52018-1. These five 'overarching' EPB standards have in common that each of them describes an important step in the assessment of the energy performance of building. Based on early feedback from the stakeholders, additional priorities are proposed by the SC-ENER-EPBCenter team. These deal with specific areas in the domain of the EPB standards describing the performance of the technical building systems that require special attention because of their importance and complexity.

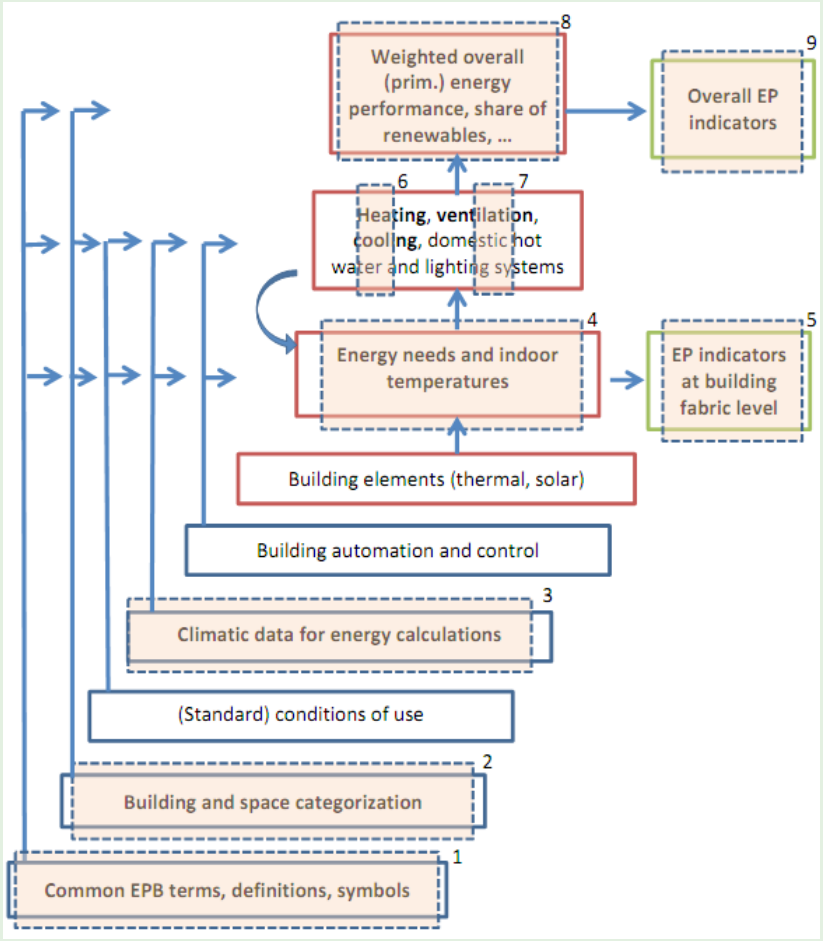


Figure 2. Flow chart in energy performance assessment and selected priority standards:

1. EN ISO 52000-1;
2. EN ISO 52000-1;
3. EN ISO 52010-1;
4. EN ISO 52016-1;
5. EN ISO 52018-1;
6. Ventilation standards;
7. Heat pump and chiller calculations;
8. EN ISO 52000-1;
9. EN ISO 52003-1.

Get involved!

Stay informed about the activities of SC-ENER-EPBCenter team (e.g. FAQs, calculations spreadsheets, EPB Standards Academy) and become already part of the EU network of EPB standards practitioners by registering to the newsletter on the EPB Center website (http://www.epb.center/) and joining the LinkedIn EPB Standards Community (#EPBstandards) (https://www.linkedin.com/groups/13619324/).

Furthermore, be sure to become attendee/learner at the 13th REHVA World Congress CLIMA 2019, 26-29 May, Bucharest, Romania (https://www.clima2019.org/congress/) and save the date for the **parallel workshop organized by the SC-ENER-EPBCenter team i.e. 16h00 – 17h30, 27 May 2019**, during which you can meet the team, learn more about the activities of SC-ENER-EPBCenter and actively engage by providing valuable feedback about national level practices and needs. Follow the following links for more details about SC-ENER-EPBCenter workshop "Dissemination and roll-out of the set of EPB standards. Asking feedback from practitioners." (https://www.rehva.eu/index.php?id=1847#c3261) and for more details about all workshops organized during REHVA World Congress CLIMA 2019[2]. ■

2 https://www.rehva.eu/event/clima-2019/clima-workshops.html

REHVA report of events in 2019

This year, REHVA had participated and presented in a range of events. This involved a series of visits across Europe and Asia to present and promote REHVA as an association through workshops and seminars. Below, REHVA has collated reports of highlights from four events of 2019 so far.

World Sustainable Energy Days 2019 - REHVA highlights

Date: 27th February-1st March 2019
Report by Matteo Urbani, REHVA

More than 660 experts from 60 countries attended the World Sustainable Energy Days 2019, which took place from 27 February – 1 March in Wels/Austria. REHVA was present with a booth showcasing six Horizon 2020, a poster presentation and organised two workshops representing hybridGEOTABS, ALDREN, CEN-CE, and the EPB Center during the afternoon workshops sessions.

WSED 2019 focused on energy efficiency and renewable energy as key elements for boosting economic competitiveness and the potential of using the clean energy transition to the benefit of all citizens through specialized conferences, among others the Young Energy Researchers Conference, the European Energy Efficiency Conference and a session of Innovation Workshops in the field of Energy and Buildings.

REHVA had a booth in the poster section showcasing on-going H2020 EU projects and other REHVA knowledge sources. We presented six projects presenting a poster about hybridGEOTABS and distributing promotional materials of QUANTUM, ALDREN, EPB Center, CEN-CE, TripleA-RENO. REHVA knowledge sources, such as the REHVA European HVAC Journal and the REHVA guidebook series were also disseminated.

European Energy Efficiency conference

The European Energy Efficiency Conference addressed policies, innovation and business in specialized conferences and interactive events. In two days, the European Energy Efficiency Conference offered delegates 5 dedicated conferences, technical visits to innovative energy efficiency projects and a major tradeshow on building efficiency and renewable energy with more than 100,000 visitors and 1,600 exhibiting companies.

REHVA booth with the hybridGEOTABS poster.

The event addressed a range of topics in this field. It gave an update on the Clean Energy Package, had a focus on industrial energy efficiency and presented innovations in building and energy and smart e-mobility. Experts from all over the world discussed latest research results and successful energy efficiency policies and presented innovative best practice examples.

An interactive element, of a digital voting was engaged the audience by inviting them to answer questions regarding their sustainability consciousness and behaviour, as well as their opinions about the current situation and future trends of the energy transition. The results of the voting can be found on the conference website www.wsed.at.

Energy Efficiency Policy Conference

The Energy Efficiency Policy Conference took place on Thursday, 28 February with the "Energy Efficiency Lab: Tomorrow's solutions" session, chaired by REHVA Managing Director **Anita Derjanecz**. The speakers of the session introduced EU projects, new products and services in the field of energy efficiency in buildings. Various examples were presented showcasing solutions with a possible future market uptake, among them initiatives by REHVA: a joint workshop by the EPB Center, ALDREN and the CEN-CE projects presented by **Johann Zirngibl** (CSTB, France) and the hybridGEOTABS project presented by **Wim Boydens** (Boydens Engineering, Belgium) linked to two workshops in the afternoon session.

hybridGEOTABS Workshop

REHVA is partner of the hybridGEOTABS project that aims to develop a high energy efficient combination of geothermal heat pumps and TABS (thermally activated building systems) increasing the share of low valued (low-grade) energy sources by means of using low exergy systems on the one hand while upgrading low/moderate temperature resources on the other hand. The project develops a new design concept using Model Predictive Control (MPC) to generate a controller model with precomputed model inputs such as disturbances and HVAC thermal power to avoid case by case development. 7 experts of the consortium presented all aspects of the project, among others the potentials of decentralized storage and its impact on renewable share in grids and buildings, the new approach of the Model Predictive Control (MPC) and how it can manage interconnected technologies. The small but active audience had a lively discussion after the presentations about

Conference panel chaired by REHVA Managing Director, Anita Derjanecz.

hybridGEOTABS workshop, WSED2019.

the MPC model operation and the data predictions and related indicators, about technical aspects and also about the scalability and possible market deployment of the project.

ALDREN, CEN-CE and EPB Center joint Workshop "World sustainable Energy Days – ALDREN dedicated Workshop

REHVA, the EPB Center and two complementary EU projects CEN-CE and ALDREN organized a second workshop dedicated to EU projects supporting EPBD implementation. The aim of this workshop was to give an insight in the 3 initiatives **Jaap Hogeling** presented the EPB Center services to Member States and professionals on hot to adopt and use the new EPB standards:

- Presenting the ALDREN project that aims at the development of a European Voluntary Certificate (EVC) is to provide transparent advisory tools for building owner, tenant, financial institutions and policy makers by energy ratings and targets comparable at European scale.
- Introducing the CEN-CE project that developed a training and certification scheme for building professionals using EPB standards and the related performance calculation methodologies.
- Around 20 participants (building professionals, designers, installers, European organizations, public authorities, industrials, students) attended the workshop engaging in a fruitful exchanges and discussion after the presentations, which where appreciated by the workshop.

Joint workshop on Projects supporting EPBD implementation, WSED2019.

ACREX 2019 - REHVA highlights

DATE: 28th February- 2nd March 2019
Report by Giulia Marenghi

ACREX exhibition has been once again an important occasion for the exercise of the REHVA-ISHRAE cooperation and an incentive for partnership enhancement.

ACREX was also the occasion to make evident to Indian HVAC professionals the ongoing technical collaboration between REHVA and ISHRAE experts. On 28 February, the two associations co-organized a seminar about High Performance Educational Buildings and their Indoor Environmental Quality. REHVA representatives were also deeply involved in institutional meetings with ISHRAE, to foster and to further strengthen the exchange of knowledge between Europe and India, by the set-up of new REHVA-ISHRAE initiatives and by the enhancement of the existing ones. In this framework can be inserted the meeting organized by the "Women in ISHRAE" group, attended by REHVA representatives. The meeting, regularly organized during each ACREX edition, represents moment of reflection about gender equality issues in this sector: counting more than 15,000 members, 4% of which are women, ISHRAE promotes networking activities for the female members at national level and aims to bring this action international, paving the way for future collaboration with our Federation and other international actors.

The 2019 edition of ACREX, South Asia's largest exhibition on heating, ventilation and smart buildings, took place from 28 February until 2 March 2019 in Mumbai. The fast-paced capital of Maharastra was a convenient venue for the exhibition, showcasing how the increasing importance of the HVAC industry in India in terms of turnover, number of employees and research and pivotal role to tackle the energy sustainability challenge.

REHVA-ISHRAE seminar "High Performance Educational Buildings and their Indoor Environmental Quality"

On the opening day of the show, 28 February, REHVA and ISHRAE organized a joint seminar about "High Performance Educational Buildings and their Indoor Environmental Quality". Speakers from ISHRAE and REHVA provided the around 100 seminar attendants with interesting insights about the current situation of Indian and European schools in terms of thermal comfort and IEQ, the most suitable technologies to improve these conditions and how to manage the energy implications of an IEQ-oriented design.

ISHRAE President **Chandrasekaran Subramaniam** welcomed the audience introducing the joint REHVA-ISHRAE Task Force on IEQ in Schools. This Task Force builds upon and further develops the work of REHVA Guidebook 13 "Indoor Environment and Energy Efficiency in Schools", by updating contents and opening to the Indian context. President Chandrasekaran highlighted the importance of the IEQ in school's topic for ISHRAE, affirming it is necessary to set different kind of goals for assessing quality of life in schools, which should include IEQ.

The contents of each presentation of the seminar are summarized in the following and the full presentations are available on REHVA website.

- **Proposal for universal Indoor Environmental Quality Requirements for classrooms**

Atze Boerstra, REHVA Vice-president; Frank Hovorka, REHVA President-elect

The presentation, prepared in collaboration between **Atze Boerstra** (author) and presented by **Mr. Hovorka**, referred to the REHVA-ISHARE Joint statement on Indoor Environmental Quality in nearly Zero Energy Schools as general framework of the research carried on by the two parts on the topic. Several field studies results were displayed to prove the link not only between IEQ and health -notably the "bad buildings syndrome"-, but also between ventilation and absenteeism and learning performances at school. The REHVA-ISHRAE joint Task Force for IEQ in nZEB schools aims to define common strategies and adapt them to the local contexts, since even though the main issue is felt both in the European and the Indian context, specific concerns are related to the particular context.

Audience during the REHVA-ISHRAE joint seminar on high performance educational buildings and their indoor environmental quality"

- **Implementing ISHRAE-IEQ Standard: Experiences through one-year IEQ monitoring**

  Prof. Dr. Jyotirmay MATHUR and Dr. Shiv NAGENDRA, ISHRAE members

  The presentation focused on the update IEQ standard presented by ISHRAE. Back in 2016, ISHRAE had released the first set of IEQ Standard: 10001-2016, which is defining three levels for various parameters, related to Indian context as well as combining global levels of the IEQ accordingly. ISHRAE presented during ACREX the second IEQ set of standards, that has been updated by an ad-hoc committee set up for reviewing and modifying the standards. This second edition of ISHRAE IEQ standard has been available for public review for 60 days, starting from its presentation at ACREX. Prof. Mathur presented a case study of a Jaipur campus, which was used to assess the validity of the proposed standard.

- **Visual and acoustic comfort requirements in educational buildings**

  Prof. Dr. Livio MAZZARELLA, REHVA Technology and Research Committee Co-Chair

  Prof. Mazzarella, Co-Chair of REHVA Technology and Research Committee, firstly introduced the on-going revision of the REHVA Guidebook no. 13 "Indoor Environment and Energy Efficiency in Schools": the revised version will focus both on general IEQ principles and on case studies providing technical solutions and inserted in the European and Indian context. The presentation showcased how two specific aspects of IEQ, visual and acoustic comfort, impact well-being, comfort and productivity of educational building users, would they be teachers or students.

- **Retrofit for Thermal Comfort and Energy Efficiency – Case study of a College Building in Mumbai**

  Dr. Roshni UDYAVAR, ISHRAE member

  Dr. Udyavar, who worked at the International Institute for Sustainable Future until 2013, a United Nations NGO DPI affiliated organization based in Mumbai and New York, presented the case study of the retrofitting of a college building in Mumbai. Dr. Udayvar presented the results of the educational building retrofitting, comparing values pre retrofitting and post retrofitting for different IEQ parameters, such as visual comfort and perceived temperature.

- **Measuring IAQ in educational buildings: old school handled approach vs. continuous measurement with sensor networks.**

  Maija VIRTA, REHVA fellow and ISHRAE member

  The presentation showcased how, when and why we should keep monitoring IAQ, highlighting which are the current technologies to do it and their cost. Dr. Virta discussed the active role of IAQ monitoring in the educational buildings IEQ management, its direct link with the creation of correct benchmarks for the setup of IEQ standards and of awareness of IEQ role in assuring health, learning and productivity for educational buildings users.

The REHVA Awards at ACREX 2019

During ACREX, two REHVA Awards was handed out.

Maija Virta, REHVA Fellow and ISHRAE Member, has received a Professional Award: after her presentation at the REHVA-ISHRAE Seminar, the REHVA President-elect, Mr. Frank Hovorka, has conferred her this award in reason of her outstanding professional achievements and of her contribution to the REHVA knowledge sharing action.

The second award was addressed to the ACREX organizers themselves: a REHVA Partner Organization Award was awarded to ISHRAE and handed out by President-elect **Frank Hovorka** to the ISHRAE President, Mr. **Chandrasekaran Subramaniam** and to Mr. **Vishal Kapur**, ISHRAE Immediate Past President, during the ACREX Award of Excellence ceremony. The Award was bestowed in reason of the establishment of continuing professional cooperation in the HVAC Sector.

Futurebuild 2019 - Uniting Future thinkers to tackle environmental issues - REHVA highlights

DATE: 5th-7th March 2019
Report by Fatima Ahmed, REHVA

On the 5th-7th March 2019, Futurebuild had held an exhibition event at Excel London in which REHVA had participated as an Exhibitor. The aim of future build was to tackle the biggest challenges impacting the industries. The theme of the conference 'Time for Action' was to provide all the visitors with insight and experience around the latest technology regulations which inspired visitors to act through insights from leading experts.

The collaborative forums where a place for visitors to develop plans for implementing change and proposing action for a more sustainable future. This was implemented across six cultural hubs:

- Buildings Hub – where visitors will have access to some of the world's most innovative building systems and technologies, as well as the opportunity to speak to pioneering brands working across construction and maintenance.
- Urban Infrastructure Hub – the latest solutions across blue, green, grey and social infrastructure will be explored.
- The Materials Hub – where visitors can experience all of the possibilities of concrete, timber, steel, masonry and natural building products. The Hub is supported by The Concrete Centre and TRADA, among other leading organisations, with exhibitors including Nudura, Glavloc, Cemex UK, Creagh Concrete, Piveteaubois and Steico.
- Offset Hub – This is where the professionals working across the built environment can experience the opportunities in offsite construction.

REHVA at Futurebuild stand, Knowledge forum.

- Interiors Hub – New for 2019 – This is where the newest product designs, emerging trends and the latest guidance on health and wellbeing in buildings will be illustrated. Delivered in partnership with the International WELL Building Institute and sponsored by Herman Miller and Milliken, the Hub will include a dedicated seminar programme which will explore cutting-edge topics such as biophilic design and the use of colour and light to promote wellbeing.
- Energy Hub – Smart heat solutions, whole-house retrofit, and Part L of the Building Regulations are among the topics being tackled in the Energy Hub Seminar Theatre – delivered with strategic partner, the Association for Decentralised Energy (ADE).

A new feature for future build in 2019, is the knowledge forum. This section provided a "deeper dive" workshop that was presented by various industry leading stakeholders as well as academics. The sessions were to tackle one of the biggest immediate issues facing the built environment and will provide practical solutions and guidance for professionals to take home. One of the workshops were held by REHVA. The QUANTUM-Project workshop* was held on the 5th of March at the Knowledge Forum between 15:00-16:10 titled: The QUANTUM-Project: New Standards, Tools and Services for Quality Management of Building Performance presented by **Stefan Plesser**, CEO, Synavision, **Michele Liziero**, Energy Manager, Energy Team and **Benjamin De Bruyn**, Consultant, Factor4. The workshop was split into five sections beginning with an introduction of the research project which had then entered a deeper dive to the three innovative ICTdriven tools (https://www.quantum-project.eu/tools/). The workshop ended with questions and discussions.

To read learn more on Futurebuild 2019 and their future events, please visit their website https://www.futurebuild.co.uk/.

* https://www.rehva.eu/fileadmin/news/2019/QUANTUM_workshop_agenda_Futurebuild_FINAL_V2.pdf)

REHVA-day at ISH2019

DATE: 14TH MARCH 2019
Report by Anita Derjanecz, REHVA

REHVA was presented at the ISH 2019 in a new format by having a REHVA Forum space for a full-day event on the 14th March 2019 at exhibition hall 11 featuring building automation technologies and digital engineering services. This new setting enabled us to have two successful seminar sessions with a networking lunch between the morning and the afternoon part, closed by a reHVAClub cocktail after the seminar net to the exhibitors, which gave a great opportunity for professional networking.

QUANTUM workshop "New Standards, Tools and Services for Quality Management of Building Performance"

In the morning, REHVA organized a workshop entirely dedicated to the QUANTUM project supported by The European Union's Horizon 2020 programme chaired by REHVA Managing Director, **Anita Derjanecz**. Reducing complexity and increase effectiveness with ICT-based tools that collect, monitor and interpret representative data sets are critical steps on the way to close the performance gap between predicted and real energy consumption, as well as to enhance occupant comfort. The workshop presented the QUANTUM approach and the developed ICT based tools: The digital performance test bench for technical monitoring, the ENG9 energy monitoring tool, and the Comfortmeter survey tool assessing perceived comfort of occupants, which are all being demonstrated in many buildings across Europe. The QUANTUM technical monitoring concept is now endorsed by AMEV, the German federal government agency for public buildings, proving its potential to be up taken by regulatory frameworks. The four presentations of the tool owner partners were followed by a lively discussion with the participants that lasted during the networking lunch.

REHVA seminar "Smart buildings and digitalization in light of the revised EPBD"

After a dynamic networking lunch, participants continued with the traditional REHVA seminar dedicated this year to the topic of smart buildings and digitalisation and the Smart Readiness Indicator chaired by REHVA President-elect **Frank Hovorka**.

REHVA Day at ISH 2019, 14/03/19 Frankfurt.

Digitalization and ICT based technologies are changing the entire HVAC and construction sector. These trends lie also at the heart of the latest revision of the Energy Performance of Buildings directive (EPBD) introducing important changes and new policies. The seminar discussed key aspects of the revised EPBD, such as the new requirements about BACs and digital monitoring and the newly introduced Smart Readiness Indicator (SRI). REHVA experts presented different aspects linked to the digitalization of our industry: the technical aspects of smart buildings, user-centred smart building technologies, BIM standardization and the digitalization of HVAC products and IoT and HVAC systems.

Anita Derjanecz on the revised EPBD, REHVA Seminar, ISH2019.

REHVA President-elect Frank Hovorka opened the seminar with a presentation about the Smart Readiness Indicator, followed by an introductory presentation of REHVA Managing Director, Anita Derjanecz about the digitalisation and smart technologies related aspects of the revised EPBD and how digitalisation is changing the entire HVAC sector.

REHVA President-elect Frank Hovorka on the SRI, REHVA Seminar, ISH2019.

Nejc Brelih-Wasowski, Knowledge Manager at Boydens Engineering highlighted some technical aspects of smart buildings followed by a visionary presentation of **Andrei Litiu**, REHVA expert and KTH PhD candidate, discussing the future user-centred approach in the design & operation of smart buildings.

Forest Reider, Senior Expert at Belimo presented practical applications of IoT based technologies enabling transparency of building from the installation till the operation phase enabling digital monitoring and maintenance using cloud services. **Vincent Henault**, Project Manager at PRODBIM closed the panel presenting a further aspect of digitalisation talking BIM standardisation and digitalisation of HVAC products.

The REHVA Day was closed by a reHVAClub cocktail reception providing participants with another informal networking opportunity.

REHVA thanks all the speakers and participants who joined the REHVA Day at ISH 2019. The presentations are available on the REHVA website* ■

* https://www.rehva.eu/events/event-presentations.html

Our REHVA member TVVL honoured Jaap Hogeling by awarding the Honorary Membership of TVVL

"Because of exceptional service for the professional community and TVVL in particular"

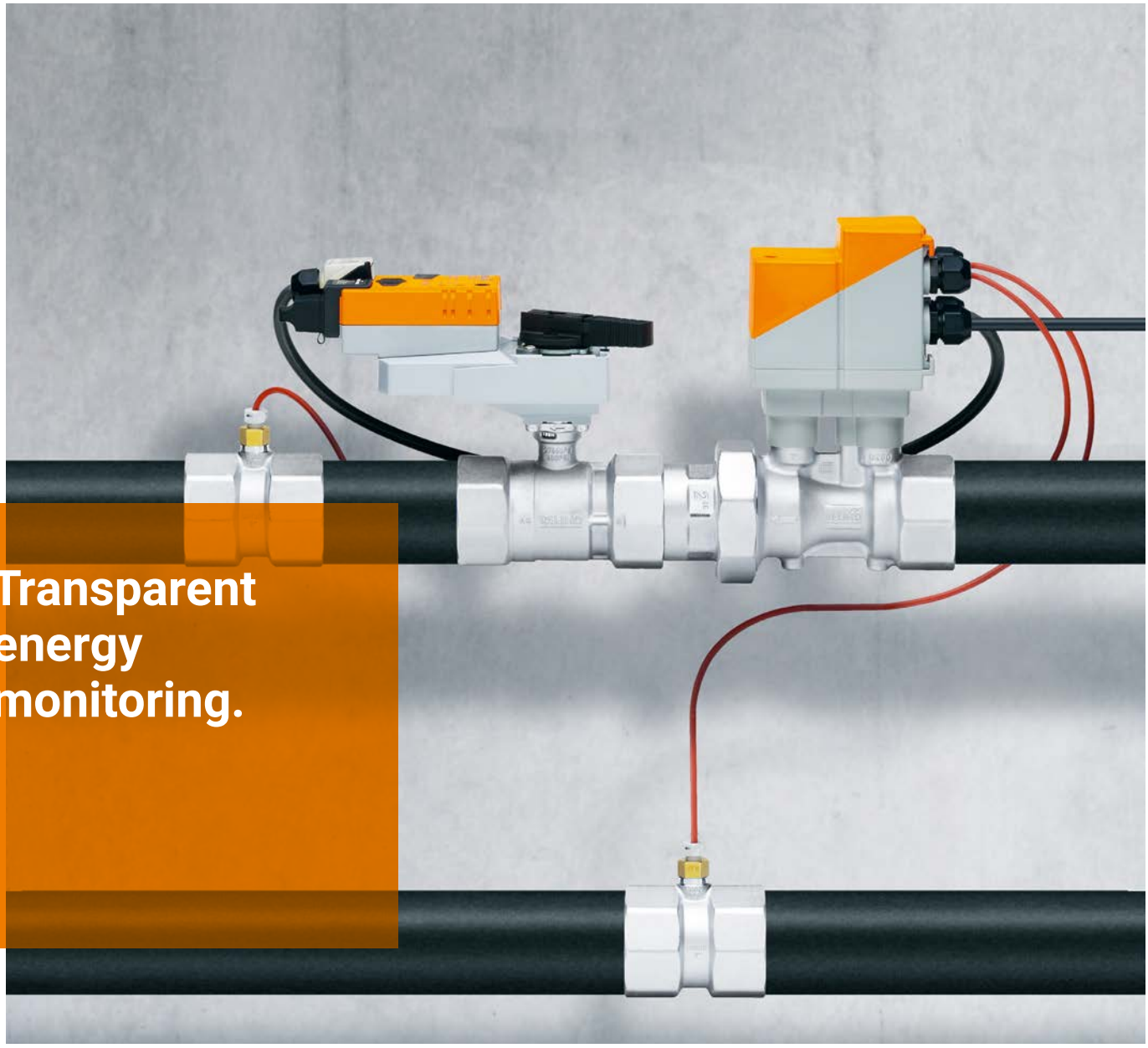
During the TVVL General Assembly meeting, **Jaap Dijkgraaf** was welcomed as the new TVVL President. Jaap Dijkgraaf succeeds **Henk Willem van Dorp**, who served for 5 years as TVVL President.

Jaap Dijkgraaf was welcomed as the new TVVL President

The new TVVL president welcomes the task to further strengthen the position of TVVL in the Netherlands. The transition to a sustainable society places technology in a more and more important position, where TVVL place an important role representing all relevant technical disciplines in the built environment.

Jaap Hogeling receiving his award.

By combining our forces and bundling our professional fields of expertise, we can reach out to integral solutions. Cooperation, developing and sharing knowledge and expertise, are the pillars of our technological progress facilitated by TVVL and its members. ■



Transparent energy monitoring.

Multifunctional Belimo Energy Valve™.

The Belimo Energy Valve™ combines many functions in a single installation-friendly unit. Building owners, facility managers, contractors and system integrators will not fail to recognise the advantages of this intelligent technology such as:

- Quick and certain dimensioning as well as simple commissioning
- Energy-saving through automatic, permanent hydronic balancing
- Correct volume of water despite differential-pressure changes and partial loads
- Efficient operation ensured through the Delta-T management

With the integration of the Belimo Energy Valve™ into the Belimo Cloud the users create their own account to have full transparency about the energy consumption in the cooling/heating application.

BELIMO Automation AG
info@belimo.ch, www.belimo.com

BELIMO®

Seamless energy monitoring in the "Flagship" of the Lenzerheide

The slopes and ski lifts in the Arosa Lenzerheide ski resort had just barely shut down in 2017 before the bulldozers moved in to tear down the old Motta Hut. The new flagship project had to be ready by the start of the 2017/2018 ski season. The new Motta Hut has room inside for 120 people and outside for 240 more on its ample, multi-level sun terrace. The innovative timber-frame construction ensures a rustic, yet modern ambiance, both inside and out. This makes the new ski restaurant an international flagship and an experience for every snow sport enthusiast. To ensure that the restaurant operators would be able to take care of their guests, a HVAC system with the maximum amount of automation was once again selected for the Motta Hut. As with other projects, the plant was also equipped with Belimo products. The new sensor product range attracted just as much attention as the Belimo Energy Valve™ with Cloud connection.

The networked future of HVAC systems

As with the new construction of the Scharmoin mountain restaurant, there was also a tight schedule for the Motta Hut. Absolute delivery reliability was just as indispensable as the selection of products which met the high quality requirements and offered even more transparency and control with regard to the function of the HVAC system. This was ensured with the installation of the Belimo sensor product range and the new Belimo Energy Valve™ with Cloud connection. "Thanks to the sensors and the connection to the Belimo Cloud, the evaluations can be broken down even more precisely to the individual valve. In addition, we can also view the data and the evaluations without difficulty, and thus better distribute the energy costs.", said **Samuel Lorez**, Head of Technology at Lenzerheide Bergbahnen AG.

The new Motta Hut is the hub for hungry and thirsty snow sports enthusiasts.

Samuel Lorez, Head of Technology at Lenzerheide Bergbahnen AG (pictured at the upper left, with Hanspeter Moser of Belimo in the middle and Martin Eckhoff of AZ systems AG on the right).

Comprehensive range of HVAC sensors

For over 40 years, Belimo has been constantly developing and expanding its range of new products and technologies to improve efficiency in buildings. With its complete sensor product range for temperature, humidity, air quality and pressure, Belimo can provide all of the HVAC field devices from a single source. The sensors feature a unique and uniform housing and assembly concept, which allows quick installation and makes them fully compatible with all major building automation and control systems. Particularly eye-catching is the housing, which provides IP65 protec-

tion. The catch fastener makes it possible to open and close the lid without the use of tools, thus enabling rapid and reliable installation.

Thanks to their tool-free housing concept, Belimo sensors can be installed easily and quickly, here in the Motta Hut heating pump.

The integration of the sensors makes it possible to control, monitor and check the entire HVAC system even better than before. At the Motta Hut, the Belimo sensors were installed in the air handling unit, in the heating lines and for measuring the outdoor temperature.

Multifunctional Belimo Energy Valve™ for transparent energy monitoring

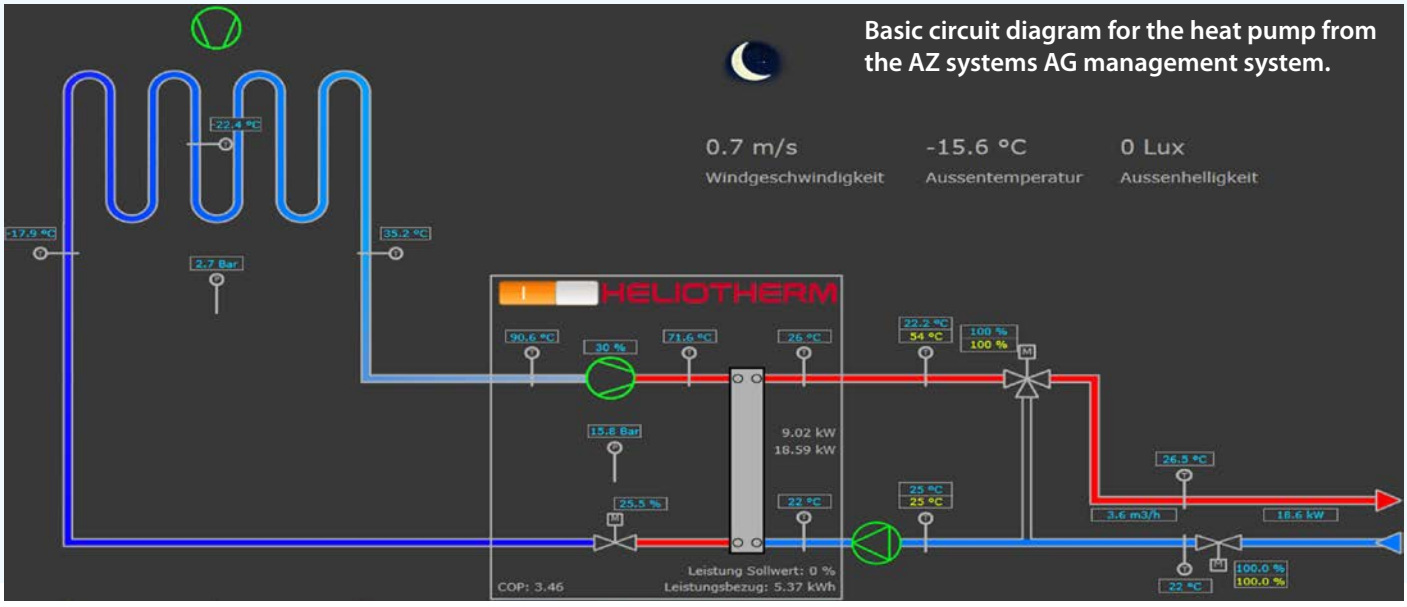
The intelligent, pressure-independent valve combines five functions in a single, easy-to-assemble unit. The further development into an IoT device (Internet of Things) thanks to the connection to the Belimo Cloud makes measuring, controlling, balancing, shutting off and energy monitoring even more transparent and the corresponding operation even easier. Unique functions such as the Delta-T manager or the possibility of direct power control provide clarity, enhance efficiency and reduce costs.

By being integrated into the Belimo Cloud, Lenzerheide Bergbahnen AG receives all information on the energy consumption of the heat pump, heating group and ventilation units in its own account. Other advantages of the cloud, in addition to transparency, are cloud optimisations: To improve system performance and stability, the Delta-T settings recommended by Belimo experts can be made available using a cloud-based analysis. Furthermore, the online updates ensure that the Belimo Energy Valve™ represents the very latest state of technology at all times. In addition, support via Cloud aids technicians in commissioning or solving technical problems. For this reason, Belimo also grants a 7-year guarantee for the Belimo Energy Valve™ with Cloud connection. Particularly in cases of new systems, such as with the reconstruction of the Motta Hut, we recommend that the settings be checked at the beginning. This means that the system will have optimum function from the very beginning and that there will be no unnecessary energy consumption. The main responsibility of the Belimo Energy Valves™ is regulating individual components and identifying the performance that each consumer requires.

Operation optimisation with Delta-T manager

With too low a differential temperature, the energy consumption of the pumps as well as the cooling and heat generation increases above a certain operating point - without increasing the output.

Delta-T management, either integrated in the Belimo Energy Valve™ or done by Belimo experts via the Belimo Cloud, always ensures an efficient operation. This means that it is no longer possible for the heat exchanger to become flooded. ■



Basic circuit diagram for the heat pump from the AZ systems AG management system.

Maintaining HVAC CO_2 measurements the easy way

Background

Carbon dioxide measurement (CO_2) is used in HVAC applications to control the amount of fresh air in buildings. This is especially useful in buildings with varying levels of occupancy. Typical examples would be schools, auditoriums, and convention centres, but modern office buildings can also have highly variable occupation levels. Recent research shows that employee performance decreases significantly at CO_2 levels previously considered acceptable – approximately 1,000 ppm. With employee wages accounting for about 90% of the total cost of running an office building, it's easy to see why it pays to properly measure and control CO_2 levels.

Factors to consider when choosing a CO_2 transmitter for your application

"Install and forget" is a regrettably common approach when it comes to HVAC sensors. This approach might suffice if you are only controlling the temperature, as temperature sensors are very stable; however, for CO_2 sensors this approach is definitely the wrong one. In HVAC applications one of the most important specifications for a CO_2 sensor is its long-term stability, as this determines how often it needs adjusting or at very least checking. Your accuracy needs will of course influence the services/adjustment interval, but in many cases a 5-year service interval will be enough in HVAC applications for Vaisala CARBOCAP® sensors.

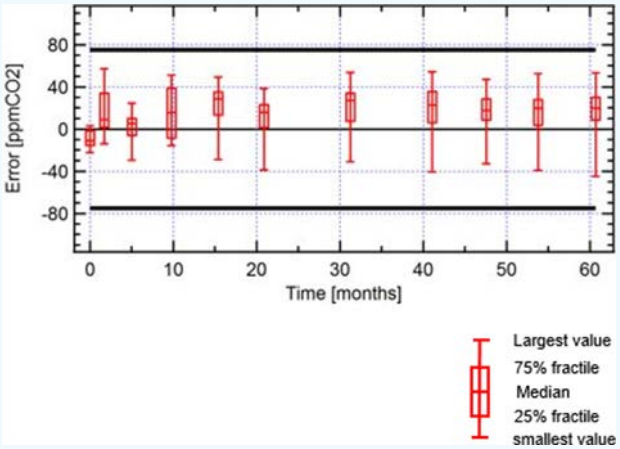


Figure 1. Five-year stability test results for 23 Vaisala CARBOCAP® sensors at 1,000 ppm CO_2 test concentration; all are within the specified ±75 ppm range.

LARS STORMBOM
Senior Product Manager
Vaisala

Don't be fooled by claims from manufacturers about "automatic calibration" – this is a software trick that has nothing to do with calibration, which means comparing the sensor readings with a known traceable reference instrument. Instead, the software merely gradually adjusts the lowest measurement reading of the week towards the average outdoor concentration of 400 ppm. This type of algorithm doesn't work in spaces that are continuously occupied, and can also be fooled by building automation systems that aggressively ramp down fresh-air intake during off-peak hours. In some cases, even the concrete in the walls that the sensors are mounted on may absorb CO_2 and therefore provide inaccurate readings. The key here is to always opt for a sensor with an internal reference, such as a dual beam device or a Vaisala CARBOCAP® sensor.

In most office environments the temperature varies only a little over time, whereas in other locations like warehouses it may be worth compensating for the internal temperature. For dusty or wet environments, a sensor enclosure with a higher IP rating may also be necessary.

What to look for in a transmitter to make maintenance easy

There are several ways to check or adjust a CO_2 transmitter. If you have a large number of sensors and access to properly trained maintenance personnel, checking against a reference gas bottle is a good choice. In this case the sensor needs to have a reference gas port and a way to adjust the reading. The gas port and the adjustment controls should be easy to understand and easy to access. The advantage of this method is that you can decide at which CO_2 concentration you want to adjust.

Another way to check and adjust your sensors is to use a calibrated handheld reference instrument. The advantage of this method over using a reference gas source is that there are no consumables involved (and of course no gas bottles to lug around); the drawback is that you are checking at whatever the CO_2 concentration in the space happens to be at the time. It's also important in this case that the adjustment controls are easy to understand and access.

In both these cases an intuitive display on the sensor will help you to understand what you are doing.

The easiest way to ensure accurate and stable CO_2 measurement is to choose a device with exchangeable measurement modules because these only require personnel to have basic maintenance skills. The module can be quickly replaced with a spare part, which may come with a multipoint calibration certificate. The module is adjusted at multiple CO_2 concentrations to ensure it measures correctly in all conditions.

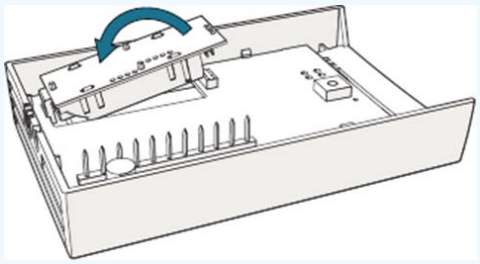


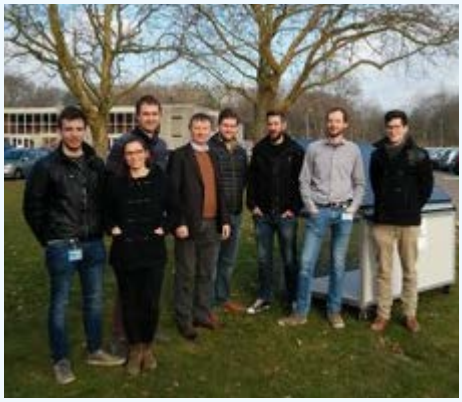
Figure 2. Changing a GM10 CO_2 module in a Vaisala GMW80-series transmitter.

The most important thing to understand is that your CO_2 sensors will need some maintenance over their lifetime. ■

Read the original VRTNEWS story (in Dutch).
Translated and published here with permission
from the original authors.
Last edited on 6 March 2019:
https://www.vrt.be/vrtnws/nl/2019/02/24/belgische-wetenschappers-kraken-de-code-voor-betaalbare-groene-w/

KU Leuven scientists crack the code for affordable, eco-friendly hydrogen gas

Bioscience engineers at KU Leuven have created a solar panel that produces hydrogen gas from moisture in the air. After ten years of development, the panel can now produce 250 litres per day – a world record, according to the researchers. Twenty of these solar panels could provide electricity and heat for one family for an entire winter.



Professor Johan Martens and his team at the Centre for Surface Chemistry and Catalysis. © Tom Bosserez

Under a watery sun, Professor **Johan Martens** and his research team roll the solar panel onto the lawn in front of the Centre for Surface Chemistry and Catalysis at KU Leuven. The device looks like an ordinary solar panel. The engineers have attached a flask with water to the device so that we can see the hydrogen bubbles escape. A meter indicates the quantities. After a couple of seconds, the first bubbles begin to rise to the surface.

Hydrogen gas is an energy vector that can easily be stored and transported, and it can be converted at will into both electricity and heat. The gas doesn't release any greenhouse gases or toxic substances, provided that you use clean energy to produce it. That's what Professor Martens' team has developed: a device that turns sunlight and water vapour into hydrogen gas in a sustainable way.

"It's a unique combination of physics and chemistry. In the beginning, the efficiency was only 0.1 percent, and barely any hydrogen molecules were formed. Today, you see them rising to the surface in bubbles. So that's

Bioscience engineers from KU Leuven have designed a solar panel that converts 15 percent of the sunlight straight into hydrogen gas – a world record. © Tom Bosserez

ten years of work – always making improvements, detecting problems. That's how you get results."

A traditional solar panel converts between 18 to 20 percent of the solar energy into electricity. If you then have to use that electric power to split the water into hydrogen gas and oxygen, you lose a lot of energy. The KU Leuven bioscience engineers solved this exact problem by designing a solar panel of 1.6 m² that converts 15 percent of the sunlight straight into hydrogen gas. That's a world record in the category of devices that don't require precious metals or other expensive materials (*see following*).

Most hydrogen gas is produced using oil and gas – not a big win for the climate or the environment. We believe this is about to change.

Hydrogen gas from renewable energy sources – green hydrogen gas – has been a promising prospect on the energy market for years, but the real breakthrough hasn't happened yet. Hydrogen gas is considered to be expensive and difficult to produce and store. Today, most hydrogen gas is produced using oil and gas. 'Grey' hydrogen gas, in other words – not a big win for the climate or the environment. The KU Leuven researchers believe this is about to change.

Last week, Toyota announced that it wants to produce hydrogen gas with a prototype designed by Johan Martens' team in 2014. This device is a little screen (10 cm²) that the engineers will scale up to a large panel.

In Leuven, they already have one of these large panels. On campus, we see the meter rise steadily on the device in front of us. The bubbles keep coming, despite the watery sun. "The panel produces around 250 litres per day over a full year. That's a world record," says KU Leuven researcher Jan Rongé. "Twenty of these panels produce enough heat and electricity to get through the winter in a thoroughly insulated house and still have power left. Add another twenty panels, and you can drive an electric car for an entire year."

Of course, all this is still based on calculations. But soon, the researchers will start a pilot project to field-test the theory.

In any case, a benefit of hydrogen gas is that it can replace fossil fuels. Around 80% of our energy comes from oil, gas, or coal. We need to replace these sources if we want to tackle global warming, says Jan Rongé.

However, hydrogen gas comes with risks of its own. Like most fuels, the gas is highly flammable. This poses a danger, especially in closed spaces. At the same time, it's also a light gas, so when it escapes, it will rise up immediately instead of spreading over the ground.

In any case, the new prototype of Johan Martens' team is ready for field testing outside of the campus. For the first project, we're driving to Oud-Heverlee, a rural town in Flemish Brabant. The house we visit is well insulated and gets most of its power from solar panels, a solar boiler, and a heat pump. It is not connected to the gas grid. It only uses power from the grid in the winter.

Soon, 20 hydrogen gas panels will be added to this mix. If all goes well, more panels will be installed on a piece of land in the street. This will allow the other 39 families in the street to benefit from the project as well. The hydrogen gas produced in the summer will be stored and converted into electricity and heat in the winter.

Hydrogen gas is easier to store than electricity. Buffering electricity requires batteries that are expensive and slowly lose voltage as well. Therefore, it's not a good idea to buffer electricity from summer until winter. With hydrogen gas, it's a different story. The hydrogen gas produced in the summer can be stored in an underground pressure vessel until winter. One family would need about 4 cubic metres of storage. That's the size of a regular oil tank.

We wanted to design something sustainable that is affordable and can be used practically anywhere.

For Johan Martens, a test project like the one in Oud-Heverlee is what he and his team have been working towards for years. "We wanted to design something sustainable that is affordable and can be used practically anywhere. We're using cheap raw materials and don't need precious metals or other expensive components."

The actual cost of the hydrogen gas panels is still unknown, as the mass production is yet to start. The researchers, however, say that it should be affordable. This invention could completely change the future of green energy. The emphasis will not so much be on large production units, but rather on the combination of smaller, local systems. It will also require less energy-guzzling transport of energy, whether it's gas, oil, or electricity. The researchers, in any case, are optimistic: "the sky is the limit." ■

Send information of your event to Ms Giulia Marenghi gm@rehva.eu

Exhibitions, Conferences and seminars in 2019-2020

Exhibitions 2019

6-8 May	ISH China & CIHE	Beijing, China	https://ishc-cihe.hk.messefrankfurt.com/beijing/en.html
3-5 September	ISH Shanghai & CIHE	Shanghai, China	https://www.hk.messefrankfurt.com/content/ishs_cihe/shanghai/en/visitors/welcome.html
2-5 October	ISK-SODEX 2019	Istanbul, Turkey	www.sodex.com.tr/en
21-23 November	REFCOLD	Hyderabad, India	http://www.refcoldindia.com/

Conferences and seminars 2019

8-10 May 2019	CIAR - Congreso Iberoamericano de Aire condicionado y Refrigération	Santiago de Chile, Chile	
24-25 May	International Buildair Symposium	Hannover, Germany	
26-29 May	CLIMA 2019	Bucharest, Romania	www.clima2019.org/congress/
17-21 June	EUSEW	Brussels, Belgium	https://www.eusew.eu/
12-15 July	ISHVAC 2019 - 11th International Symposium of Heating, Ventilation and Air-Conditioning	Harbin, China	
18-22 August	ISIAQ	Kaunas, Lithuania	http://isesisiaq2019.org/
24-30 August	ICR 2019 - 25th IIR International Congress of Refrigeration	Montreal, Canada	https://icr2019.org/
2-4 September	Building Simulation Conference 2019	Rome, Italy	www.buildingsimulation2019.org
5-7 September	IAQVEC 2019	Bari, Italy	www.iaqvec2019.org
26-28 September	Annual Meeting of VDI-Society for Civil Engineering and Building Services	Dresden, Germany	
15-16 October	AIVC 2019 Conference - From energy crisis to sustainable indoor climate	Ghent, Belgium	https://www.aivc2019conference.org/

Exhibitions 2020

27-29 February	ACREX	New Delhi, India	http://acrex.in/home

Conferences and seminars 2020

14-17 June 2020	NSB 2020 Building Physics Conference	Tallinn, Estonia	www.nsb2020.org/

ISH CHINA CIHE

May 6–8, 2019, Beijing, China

Asia's leading trade platform for clean energy heating returns this May

Those looking to expand their sourcing options for HVAC and energy solutions will do well to head to Beijing this 6 – 8 May for ISH China & CIHE 2019, Asia's leading industry trade platform. Headed by the biennial ISH event in Frankfurt, the world's leading trade fair for HVAC + water, the sourcing options on offer this year are boosted by ongoing initiatives and investments by the Chinese government to spur the development of clean-energy technologies, which is driving innovation by local manufacturers.

ISH China & CIHE – China International Trade Fair for Heating, Ventilation, Air-Conditioning, Sanitation & Home Comfort Systems will host around 1,300 Chinese and global brands from more than 20 countries this year, and expects to welcome some 75,000 trade buyers from around the world. The fair showcases a diverse range of products including HVAC, building water supply and drainage solutions, home comfort systems and much more for civil, commercial, residential, industrial and agricultural use.

International pavilions and dedicated product zones

- Water Pump Zone featuring renowned worldwide water pump exhibitors
- Overseas Area promoting global HVAC technologies
- German Pavilion presenting advanced HVAC solutions
- Debut of Clean Energy District Heating Area showcasing district heating and intelligent heating
- Zhejiang Pavilion gathering HVAC brands from Zhejiang Province

Local HVAC trends drive innovation by Chinese producers

The government's coal-to-clean-energy initiatives provide a positive push for China's HVAC industry to thrive. In particular, the coal-to-electricity and coal-to-gas switching policies are driving innovation of electric floor heating technologies. Due to a greater emphasis placed on constructing a higher-quality housing supply the market for furnished deluxe apartments is growing swiftly and requires more advanced household-based heating systems.

The Chinese government's Internet Plus initiative calls for the integrated use of mobile internet, cloud computing, big data and IoT. This is facilitating the widespread adoption of smart heating systems, and with mobile remote control applications, cloud computing and smart heat meters, all on display at the fair, these advanced products are becoming as popular as traditional methods in China.

Electric floor heating is another emerging trend. New materials such as carbon crystal and graphene are widely deployed in the manufacturing of electric heating films and heating cables. These advancements have shortened the pre-heating time of the heating devices and allow users to easily construct and install the electric floor heating systems, making electric heating a popular choice.

Technologies developed for catering to regional variations and utilising multi-energy systems are also accelerating industry innovation. Low nitrogen technologies, cooling technologies and low temperature inverter technologies can all be found at the fair.

Concurrent events add to experience of exhibitors and visitors

In response to a series of national policies and initiatives tackling air pollution, the fair will host the China Clean Energy Heating Forum, inviting industry experts from around the world to explore the future of clean energy heating. Another highlighted concurrent event is the International HVAC Congress (iHVAC), which comprises six key presentations such as heating, home comfort (fresh air and water purification systems) and air-source heat pumps that shed light on significant industry developments. The China International HVAC Forum and Technical Forum for Floor Cooling & Heating Systems will also take place.

To find out more about the fair, please visit web site* ■

* https://ishc-cihe.hk.messefrankfurt.com/beijing/en.html

February 13, 2019, Moscow, Russia

International Ventilation Congress AirVent-2019

a specialized event for the ventilation market participants

Co-operative work of the exhibition Aquatherm and international congress set up the best conditions not only for mutually beneficial contracting, but also for promotion of the latest technology and developments in different fields of this branch of industry.

The peculiarity of the Congress was the unique composition of authoritative representatives of the international professional community: **Iurii A. Tabunshchikov**, Professor, Doctor of science, President ABOK, (Microclimate: In Search of Excellence); **Frank Hovorka**, REHVA President-elect (BIM – the building avatar towards information evaluation in real estate); **Dušan Petráš**, PhD. prof. Ing. Department of Building Services, Slovak University of Technology (Indoor environment by energy retrofitting of apartment buildings); **Alessandro Sandelewski**, engineer, founder of the engineering company ASC Engineering Srl (Can high-rise buildings be NZEB?); **Erick Melquiond**, President of Eurovent Certita Certification (Ventilation installations in hygienic design); **Andreas Lücke**, Hauptgeschäftsführer, BDH (Market development, technological trends and European benchmarks in the field of heating); etc.

The program of the Congress included reports covering the issues of environmental safety and the creation of a high-quality microclimate in buildings for various purposes, as well as the tasks of modernizing and developing the market for engineering climatic equipment, both in Russia and in European countries. It is difficult to single out the most interesting reports, since recognized representatives of the global engineering community made presentations on the global problems of engineering development and the practical implementation of engineering ideas.

The International Congress was an event that determines the level of development of modern technical progress in the field of engineering, which will be remembered for interesting performances and the possibility of exchanging views and creative plans.

A pleasant addition to the program of staying international guests of the Congress was a tour of Moscow with a visit to Red Square, St. Basil's Cathedral, Alexander Garden, the Cathedral of Christ the Savior and the Moscow Metro.

Following the results of the work of the international Congress, a high level of organization of the event and a well-thought-out program were noted, which allowed to discuss a wide range of issues and promising solutions in the field of development and improving the energy efficiency of climate equipment.

The International Congress has become an event that determines the level of development of modern technical progress in the field of engineering. ■

ORGANISERS:

ABOK · Reed Exhibitions® · ITE

THE CONGRESS WAS SUPPORTED BY THE LARGEST PROFESSIONAL ASSOCIATIONS AND ORGANIZATIONS:

REHVA Federation of European Heating Ventilation and Air-conditioning Associations · BDH Bundesverband der Deutschen Heizungsindustrie · FGK · CHVAC · EUROVENT EUROPEAN INDUSTRY ASSOCIATION

THE ORGANIZING COMMITTEE CHAIR:

MARIANNA BRODACH
Vice-President, ABOK

REHVA courses at CLIMA 2019

#1 NZEB design: approach, principles and best practices

DATE: 27/05/2019
TIME: 10:30-13:00
LOCATION: JW Marriott Hotel

After this training you will: 1. Clarify the design approach for a NZEB, 2) Illustrate the difference in NZEB principles moving from cold to hot climate, 3) Analyse the suitable technologies according to the different energy targets and 4) Use cost-optimality as a tool to compare solutions.

Contents

- Designing and building a NZEB represents, since the first concept, a challenge between strictly costs controlling and reaching high energy efficiency targets, taking into account also architectural quality and elevated level of indoor comfort.
- The challenge of planning and building high performance buildings is of increasing interest in South Europe and in Mediterranean countries. The specifics of Mediterranean climate, in which winter heating loads and summer cooling loads have to be balanced, require a detailed re-visitation of the approaches aimed at reducing energy consumptions of buildings.
- The designers face with a multitude of opportunities, which have to be taken up by mixing traditional constructive measures and approaches and new technologies available on the market. An increasing awareness of the need of specifics in designing zero-energy buildings and the ability in reinterpreting the existing design experiences have to be consolidated; different climatic conditions require ad hoc design, specific for each building.
- Cost-optimal analysis bands together energy and financial performances of different design configurations and identifies the so-called cost-optimal level that represents the energy performance solution which leads to the lowest cost during the economic building lifecycle. Specifically, the methodology represents a decision-making tool to guide design team and owners' choices. Nowadays, maybe the simple cost-approach is not sufficient, but it is necessary to take into account also benefits and co-benefits in order to evaluate in a complete way different NZEB solutions.
- Case studies analysis.

Introduction to the training

A clear design approach to follow, starting from the very first conceptual phase, is fundamental to get the target of developing a zero-energy building up to a positive energy building. Nowadays, the problem is not to find suitable technologies but to apply innovative technologies in a systemic way, considering at the same time their energy, environmental and economic effect. The selection of the proper mix of energy technologies is the crucial issue in the design phase, and the cost optimal approach can be a powerful tool to compare solutions and select the best one. Indeed, in NZEB designing it is fundamental taking into account both the energy and the financial perspective right from the preliminary phases of the project. Success in realizing NZEBs lies in finding the right balance between energy performances, architectural quality and costs, which include investment, maintenance and running costs, incurred by the project owner during a defined period.

In this course, the design principles for an NZEB are not only introduced and discussed, but also their application is examined by analysing successful case studies.

Target audience of the training

The target group of the training are professionals interested in getting the full vision about the design methodologies considering practical implication too. The course in also addressed to Master and PhD students that want to deepen their knowledge about the design approach for NZEB.

Teachers

STEFANO P. CORGNATI
Full Professor, Politecnico di Torino

Stefano Paolo Corgnati, graduated with honors in Mechanical Engineering and Ph.D in Energetics, is Full Professor at the Energy Department and Vice Rector for Research at the Politecnico di Torino. He teaches building physics, building energy systems and sustainable building design at the Faculty of Architecture. He works in the TEBE Research Group focusing on energy and buildings and indoor environmental control. He is the author of more than 250 scientific, technical and didactic publications, mainly concerning: radiant panels technologies, objective and subjective assessment of indoor environmental comfort, building energy certification, influence of occupant behaviour on building energy consumption and cost-optimal design of zero energy buildings. For the quality of his research activity, he won in 2009 the Rehva "Young Scientist Award". Moreover, in 2011 he was nominated "Rehva Fellow". He is involved in a number of National, European and International Research Projects on building energy consumptions. He is also chair of the REHVA Task Force on "NZEB design strategies for Mediterranean region".

CATALIN LUNGU
Associate Professor, Technical University for Civil Engineering

Associate Professor at The Technical University for Civil Engineering since 1996 where he teaches heating systems and computational methods for energy performance of buildings , he graduated PhD in Civil Engineering (2004) at the Technical University for Civil Engineering from Bucharest with specialised training at the University Paris XII Val de Marne, France; he is invited professor at the Technical Military Academy in Bucharest and at the Ecole Nationale Superieure de l'Energie, l'Eau et l'Environment ENSE 3 in Grenoble, France. Since 2016 he is vice-dean of the Building Services Engineering Faculty and since 2012 Senate member of The Technical University for Civil Engineering. He is also vicepresident of AIIR-The Romanian Association for Building Services Engineers since 2012, since May 2017 vice-president of REHVA (and REHVA fellow since 2016), and chair of the organising committee of the HVAC world congress CLIMA 2019 (2016-2019). His main research areas are the Dynamic Modelling of HVAC systems and buildings, nZEB Buildings (BREEAM Assessor and energy auditor); he was director of 2 research projects and member in other 4; member in 4 technical committees of ASRO (Romanian Standardisation Agency). Publications: 5 books (co-author), more than 40 articles.

CRISTINA BECCHIO
Assistan Professor, Technical University for Civil Engineering Bucharest

Cristina Becchio, graduated with honors in Architecture and Ph.D. in Technological Innovation for Built Environment, is currently Assistant Professor at the Energy Department of the Politecnico di Torino. She teaches Building Physics in the courses of Architecture of PoliTO. She works in the TEBE Research Group focusing on energy and buildings. Her activity deals with energy performance assessment of buildings using dynamic simulation software, financial valuations with the application of cost-optimal methodology, economic estimations using methods as cost-benefit and multicriteria analysis, and evaluations of indoor environmental quality and its effects on users' health, well-being, comfort, productivity and satisfaction. She is also the operative coordinator of the REHVA Task Force on "NZEB design strategies for Mediterranean region".

#2 How to design hybridGEOTABS buildings' components

DATE: 28/05/2019
TIME: 10:30-13:00
LOCATION: JW Marriott Hotel

After this training you will: 1. Understand the design and optimization of the borefield from an economical and security of thermal supply point of view. Thermal balance and operation in hybrid installations, 2) Understand the design, construction and system integration of TABS. The advantages of TABS and its suitable application in the respective building type and energy systems, 3) Understand how an MPC approach works, which benefits it can create and why it has especially advantages when applied in hybridGEOTABS buildings.

Contents

- ABOUT THE BOREHOLE FIELD:
  - Borefield: design phase
  - Geothermal Response Test and borehole optimization.
  - Real cases on field and simulations
  - Borefield: operation phase
  - Hybrid operation and thermal balance
- ABOUT GEOTHERMAL HEAT PUMPS:
  - primary and secondary temperature boundaries of heat pumps.
  - bèta curves (heat pump power as a function of building heat loss and consequent energy delivery by heat pump) and the relation to bore hole sizing
  - different ways to couple an energy storage tank with their advantages and disadvantages
  - bivalent coupling of e.g. gas boiler with its advantages and disadvantages
  - different refrigerants used in heat pumps with their advantages and disadvantages (relation to F-gas)
  - one compressor versus 2 compressors versus invertor
  - hydraulic coupling of Natural Cooling, the use of a cooling buffer
- ABOUT TABS:
  - TABS introduction and its working principle
  - Optimal Design of TABS
  - Construction of TABS
  - Hydraulic Integration of TABS …
  - Cost perspectives of TABS…
  - Special applications of TABS in practice…
- ABOUT MPC:
  - Model Predictive Control (MPC) strategy and role as system integrator
  - Advantages of MPC
  - Application of MPC to hybridGEOTABS buildings

Introduction to the training

hybridGEOTABS refers to the efficient integration of the combination of GEOTABS (GEOthermal heat pumps in combination with Thermally Activated Building Systems (TABS)) and secondary heating and cooling systems in a building.

This course deals with some specific components of hybridGEOTABS installations, presenting them in the context of the necessary holistic design:

OPTIMIZED DESIGN OF BOREHOLE FIELDS. Geothermal energy, a low temperature, efficient and reliable source, is used to cover heating and cooling base load of hybridGEOTABS buildings.

OPTIMIZED DESIGN OF GEOTHERMAL HEAT PUMPS. The heat pumps are a major component in the hybridGEOTABS concept, serving the upgrade from low temperature geothermal energy to high(er) temperature TABS heating energy.

OPTIMIZED DESIGN OF TABS. Thermally Active Building Systems (TABS) have proven to be one of the innovative radiant heating and cooling systems for future sustainable buildings.

Optimal energy management in these hybrid installations is provided by a Model Predictive Control (MPC) strategy which decides between different production sources and distribution systems, thereby anticipating on future disturbances (weather, user behavior …). The course will also provide an overview of what MPC is and why it is crucial in hybridGEOTABS buildings.

Target audience of the training

The target groups of the course are: HVAC designers and manufacturers, architects, drillers, researchers, engineering students.

Teachers

HÉCTOR CANO ESTEBAN

M.Sc., Project Manager in "R&D and Projects Department", Geoter

MSc Civil Engineer by ETSICCP of the Polytechnic University of Madrid. Specialising in Hydraulics and Energy. Manager of Audits and R+D for Geothermal Energy Company SL., responsible for planning and implementing projects and engineering studies of HVAC through geothermal and other renewable energies in residential, commercial, industrial and public buildings. Project Manager and participation in different Spanish R+D projects (GREENMAR, REACT, ENERGYSIS and REHABILITA-GEOSOL). Expert in coordination and planning energy audits. Professor in ERMA Master Programme at Polytechnic University of Madrid and in RERU Master Programme at Polytechnic University of Valencia. National and international experience (Spain, Chile, Bolivia and Argentina).

JAN HOOGMARTENS

Ing. Project Engineer, Viessmann Belgium

Jan Hoogmartens is an industrial engineer in electro-mechanics (MSc 2008) from Campus Denayer. After four years of project work about heat pump applications in dwellings and offices (WP-DIRECT and GEOTABS), he started as product manager for heat pump at Viessmann Belgium sprl-bvba. As member of WPP he follows the Flemish heat pump sector.

QIAN WANG

Ph.D., Research and Innovation Specialist, Uponor AB / Division of Fluid and Climate Technology, KTH Royal Institute of Technology

Qian Wang graduated as a HVAC engineer, PhD in Building Science in KTH Royal Institute of Technology, Sweden. He has long research and development experiences in the area of sustainable HVAC and energy technology in the built environment. His main R&D focus on low-temperature heating/high temperature cooling system, indoor climate, building energy performance and retrofitting technology. Qian Wang is a main project developer and leader of several Swedish and EU research projects currently and in the past years. Areas of expertise also involve ventilation and thermal comfort, numerical and analytical modeling, business development for building/community energy and water supply.

LIEVE HELSEN

Prof. PhD Head of the Thermal Systems Simulation research group, KU Leuven/EnergyVille

Lieve Helsen graduated as Chemical Engineer (Leuven, 1993), PhD in Mechanical Engineering (Leuven, 2000), she was awarded a Postdoctoral Fellowship from the Research Foundation Flanders (FWO), and currently she is Full Professor in Mechanical Engineering at the University of Leuven (KU Leuven) in Belgium. She is head of the Thermal Systems Simulation (The SySi) Research Group. Her expertise can be mainly situated in the field of optimal design, dynamic system behaviour, global system integration and (optimal) control of thermal systems (both experimentally and theoretically). Model Predictive Control (MPC) is now being demonstrated in multiple hybridGEOTABS buildings, and steps are taken to move from building to district level. Lieve Helsen is affiliated member of OPTEC, WP Leader within IBPSA Project 1, member of the management committee of the KU Leuven Energy Institute, core-member of EnergyVille, Chair of the BS2021 Conference, member of the International Scientific Committee of the ZEN Centre at NTNU and of UCEEB connected to TUPrague, member of AcademiaNet, EHPA, IBPSA-NVL, ATIC, ODE.

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CLIMA 2019 workshops

Venue: National Library of Romania, Bulevardul Unirii 22, București 030833				
Day 1 - Monday 27 May 2019				
10:30-13:00 **Workshop no. 1** The Value of Good Performance; How High-Performance Buildings Protect the Asset value and Increase your Bottom Line BRE-Building Research Establishment	10:30-13:00 **Workshop no. 2** The Power of the Cloud Belimo Automation AG	10:30-13:00 **Workshop no. 3** Third-party confidence for building projects: Eurovent tools to deliver value EUROVENT CERTITA CERTIFICATION, PRODBIM, COPILOT	10:30-12:00 **Workshop no. 4** Why people matter? Exploitation strategies for people-centred design TripleA-reno & MOBISTYLE projects	
16:00-18:00 **Workshop no. 5** Supporting dissemination and roll-out of the set of energy performance of building (EPB) standards EPB CENTER, REHVA, EPEE, EVIA	16:00-17:30 **Workshop no. 7** Building commissioning in Europe QUANTUM	16:00-17:30 **Workshop no. 8** NZEB concepts in Europe and Japan REHVA & SHASE		
Day 2 - Tuesday 28 May 2019				
10:30-13:00 **Workshop no. 9** Indoor Environment Design for Smart Buildings HALTON	10:30-13:00 **Workshop no. 10** Energy renovation of building stock towards nZEB levels - How to prepare the market for the challenge? Fit-to-nZEB & iBRoad, Grundfos Romania	10:30-12:00 **Workshop no. 11** BACS supported performance, technical monitoring and certified commissioning of HVAC systems REHVA & eu.bac	10:00-11:30 **Workshop no. 12** Energy in Buildings Paths in Europe and China - Two Zooming Experiences REHVA & CCHVAC	11:30-13:00 **Workshop no. 13** Costs and benefits of antibacterial filter and its effects on energy saving, human health and worker productivity Rhoss
16:00-17:30 **Workshop no. 14** Towards optimized performance, design, and comfort in hybridGEOTABS buildings hybridGEOTABS	16:00-17:30 **Workshop no. 15** Progress in demand-oriented non-uniform air distributions City University of Hong Kong & Technical University of Denmark			
Day 3 - Wednesday 29 May 2019				
10:30-13:00 **Workshop no. 16** BIM FOR Built Environment IMTECH BELGIUM & ALLBIM NET	10:30-13:00 **Workshop no. 17** Advanced HVAC/R Measurement Technology and Indoor Air Quality Monitoring TESTO	10:30-12:00 **Workshop no. 18** Evidence-based ventilation needs and development process of future standards REHVA & ISIAQ		

CLIMA 2019
Built environment facing climate change
REHVA 13th HVAC World Congress
26 - 29 May, Bucharest, Romania

Workshop summaries

WS 1: The Value of Good Performance; How High-Performance Buildings Protect the Asset value and Increase your Bottom Line	
TIME	DAY #1: Monday 27 May 2019 at 10:30-13:00
ORGANISERS	BRE www.bregroup.com
CHAIRS	James FISHER, Head of Real Assets, BRE, UK
SPEAKERS	James FISHER, Head of Real Assets, BRE, UK Dr. Andy LEWRY, c/o BRE acting as a Consultant (Please contact via James Fisher) Adrian POP or Simona SANDU, ADP Green Building or WSP Romanian Engineering Traian DESPA, Head of Construction, REWE Romania

Scope

ESG programmes provide real estate companies with the ability to identify relevant material risks and opportunities to factor into asset acquisition and inform their business strategy. Managing risk creates long term value creation, drives sustainable financial performance and increases shareholder value. For example, in a 2017 CFA Institute survey, 65% of investors said that their motive for taking ESG issues into consideration was to help manage investment risks.

Companies with a comprehensive ESG strategy equip investors and real estate managers with quantifiable data to measure performance. This provides actionable opportunities to prioritize assets for energy studies, capital upgrades, retrofits, green building certifications, and more.

But often the good intentions don't work out as planned. In this session we will explore the value of certification in ESG, the experiences of practicing engineers and architects and those of clients and explore the things that can both right and wrong:

- We can design good buildings and the knowledge to operate them in an effective and efficient manner – so why doesn't it happen?
- Why doesn't the design intention feed into the operational performance?
- How do we solve this performance gap?
- What is the effect on the asset and its value due to poor performance?
- What are the solutions to remediate and control bad performance?
- How can investment funds maximise the value of their assets?

This session will be a showcase for high performance buildings in Romania. Case studies will be presented with lessons learned for all on how sustainable performance and certification can be achieved.

Audience

- Clients, designers, specifiers and building engineers working on commercial development projects
- Real estate owners, investors and asset managers responsible for CRE portfolios
- Real Estate Fund Heads of CR & CSR reporting against ESG & SDG principles.

Expected results

The aim of this session is to explain the link between poor asset performance and the value of commercial real estate and fund performance. By attending, delegates will understand how they protect their assets and make them resilient in a financial, operational and environmental sense.

Programme

15 min	**Making the business case for real asset certification in ESG** James FISHER, BRE
15 min	**Closing the performance gap in real assets** Dr. Andy LEWRY, Consultant
15 min	**Best practice in Romania** Adrian POP or Simona SANDU, ADP Green Building or WSP Romanian Engineering
15 min	**A Developer & Client viewpoint** Traian DESPA, Head of Construction, REWE Romania
30 min	**Open Panel Discussion**

WS 2: The Power of the Cloud	
TIME	DAY #1: Monday 27 May 2019 at 10:30-13:00
ORGANISERS	BELIMO Automation AG www.belimo.com
CHAIRS	Dr. Marc THUILLARD, BELIMO Automation AG
SPEAKERS	Dipl. Ing. Marc STEINER, BELIMO Automation AG Dipl. Ing. Forest REIDER, BELIMO Automation AG

Scope

Introduction

Over the past 20 years, technology has evolved at an astounding rate. The amount of silicon required to perform a set of processing operations has shrunk to such sizes that even our mobile phones are capable of huge throughput. The cost of computing has followed the decreasing size, laying the groundwork for today's internet of things (IoT). After the turn of the millennium, the cheap availability of processors made its mark on the building automation industry by making its way down to individual components. This caused an increase in the functionality at the device level, and local component control became highly tuned by the manufactures, experts in their domain. In turn, components were more easily integrated into building systems while providing increased functionality. The processing capacity was an integral component to connect different devices into networks of "things". Along with computing power, many of these little computers were also able to communicate through the standard IP infrastructure. The unprecedented number of computers and devices eventually led to the development of IP v6 to increase the number addresses for internet "things" because 4.3 billion is a crowded space. With the processing and communication foundation in place, the past several years has seen the rise of various cloud infrastructures within the building technology industry and is beginning to penetrate down to the component level.

At the last CLIMA conference in Aalborg, we introduced the Energy Valve, a performance device capable of monitoring and optimizing energy efficiency thanks to the integrated ultrasonic flow sensor, two temperature sensors, and advanced logic. The flow control will reject any pressure fluctuation. The Delta-T Manager can improve the system temperature difference over the heat exchanger to combat delta-T degradation, a well-documented problem with many systems. Need to check something? Log onto the integrated web page and see the relevant information.

In this workshop, we will show how the Energy Valve has evolved to leverage the Belimo Cloud. Introduced in 2017, the Belimo Cloud brings building transparency the next level by providing easy access to information in a central location. With state-of-the-art security standards and an openly documented interface, customers can access their data from anywhere. We will explore the opportunities offered by the cloud and look into what the future holds by showing research into augmented reality (AR) at Belimo. Let us start by discussing how the cloud can benefit commissioning and operation of a plant.

Commissioning

A future, cloud supported, commissioning workflow will be simpler and more reliable than today. System integrators will enter and upload all configurations at their office to the cloud system. Installers can easily configure an actuator or room unit using their smartphones and near field communication (NFC). NFC means device configuration is possible before power is connected.

During commissioning, the cloud can support tests and validation. Quick verification that devices have been configured is simple. Running a test and generating a report is equally simple. System integrators can focus more of their attention on the system level.

Advanced monitoring and optimization

Beyond commissioning, the cloud lays the foundation for greater transparency. The increased computation power available to servers can easily aggregate multiple sources of information to accomplish various tasks. Report generation, dashboards, and real time fault detection with intelligent diagnostics are several examples of services that are greatly improved with access the right information.

1. Report generation can periodically collect important information from your devices to provide an overview of any issues. Naturally, device specific reports are also produced.

2. Customers can track thermal energy flows in their buildings quickly and easily. Simply upload a floorplan and place your energy monitoring devices via drag-and-drop.

3. Using data analytics, we can infer root causes of undesired behaviours to provide meaningful diagnostics. Combining data from multiple devices can further improve fault detection by reducing "false positives" and validate the diagnosis of root causes originating beyond a single device's sensing capacity.

IoT is powering Augmented Reality

We would like to explore how the cloud and augmented reality can come together to create exciting new possibilities. Augmented reality is a technology that can use modern devices with cameras to overlay information on a scene or object. Today AR is available on every modern smartphone and tablet making this technology very interesting. If you have a smartphone with you, you are "augmented reality ready". As simple as that. In this workshop, we will present a few live demonstrations showing the power of AR.

During the planning phase, system integrators can create, store, and administer entire commissioning processes digitally that are accessible through to the cloud. The technician on the building site may use AR as a display interface to access cloud information, for example installation instructions or installation errors, in real time. This reduces time and save costs.

Augmented reality also improves remote services. In the example of a maintenance service response, an on-site technician can leverage AR video chats. The customer support is able to provide information precisely, not only via voice and video, but also via sketching directly onto the location aware video stream. This reduces time and saves costs.

Outlook

The power of the cloud will be increasingly important when devices have access to information from other HVAC components independent of the manufacture's specificities. This means that the exchange of key information between different manufacture's products needs to be easy. Effort to support open cloud interfaces is key to making buildings perform to the full satisfaction of the occupants.

Audience

This workshop is suitable for consultants, system integrators, mechanical contractors, building owners and operators, facility contractors and building automation professionals as well as for professors and students from relevant universities.

Expected results

Visitors will learn about the present and future role of technology in the building automation industry from the perspective of Belimo's research department.

WS 3: Third-party confidence for building projects: Eurovent tools to deliver value

TIME	DAY #1: Monday 27 May 2019 at 10:30-13:00
ORGANISERS	EUROVENT CERTITA CERTIFICATION, PRODBIM, COPILOT, http://www.eurovent-certification.com
CHAIRS	Erick MELQUIOND, EUROVENT CERTITA CERTIFICATION
SPEAKERS	Sandrine MARINHAS, EUROVENT CERTITA CERTIFICATION Cormac RYAN, EUROVENT CERTITA CERTIFICATION Vincent HENAULT, EUROVENT CERTITA CERTIFICATION

Scope

Third-party confidence for building projects: Eurovent tools to deliver value - How to de-risk projects

Construction projects of performant buildings have always been a risky business.

Uncontrolled risk assessment could cost a lot of money to the investors especially since risks can arise at any stage of the project, from the pre-design to occupation.

Therefore Prodbim, Eurovent Certita Certification, & COPILOT combine their expertise to offer a De-Risk solution regarding Heating, Ventilation, Air Conditioning and Refrigeration (HVAC&R) that guarantees:

- Building risks management all along its life cycle
- Building performance management & building digitalised data management according to commissioning process

Focus on Prodbim Database service

With the new digital usage of the Building Information Modelling (BIM), and the multi-standards and countries codes, there is a need to deliver proper multi-formats of correct product data to the market. Prodbim, as part of the Eurovent group, provides a new service to HVAC&R manufacturers for the management of their product information (PIM).

The new BIM standard for the information exchange (standard file IFC format under ISO 16739) redefines the catalogue and custom product data to send to software.

As each European country has worked nationally in parallel until today, the first issue is to match the European HVAC&R object and product dictionaries, and their properties. Idea is to create a common usage, so each national dictionary can be linked to it as a kind of translation tool.

Moreover, precision of data necessary for a project is different depending of the stage of the project. Reference default objects need to be commonly defined. At the second stage of a project, only limited data are necessary: the list of minimum properties will be commonly accepted. At last stages of the project, complete list of attributes is a must: completeness and correctness of the product fiche will be an available information of the end-user.

Prodbim proposes to organise the European work through BIM HVAC&R manufacturers committees by products (Air Handling Units, Heat Pumps, Air Conditioners…).

Finally, the quality of product data, i.e. the coherence of data, the source of data, the values, and the certification of data is key to the users to select the relevant product according to its performance in the building and BIM project requirement. Prodbim will use its expertise to check and improve quality of the data provided by their source. Data will be offered on a dedicated platform.

To summarize, Prodbim data base service ensures:

- Harmonisation expertise
- PIM services
- Multi-countries & formats
- Security
- Updating
- Data Consistency
- Trustworthy 3rd party

This focus on Prodbim activity will highlight and explain status of the European work on data and its contribution to a harmonised database of products and properties.

Focus on Eurovent Certita Certification service

Eurovent Certita Certification (ECC) is a major European certification body providing voluntary 3rd party certification in the field of HVAC&R.

ECC relies on four pillars for a strong, simple, transparent and fair certification:

- strong: a large brand recognition of the certification brand, first of all locally, but also on European and even 'emergent' markets, supported by manufacturers;
- simple: a one-stop-shop certification body, able to take advantage of the same test or audit report through smart sampling based on datamining for certification of multiple models or ranges, and even mutual recognition of schemes;
- transparent: a functioning based on Committees dedicated to each products, with a strong implication of manufacturers and laboratories for participative and consensual rules; and a Commission in charge of harmonisation and treatment of eventual appeals;
- fair: constantly evolving reference documents, annually reviewed by skilful programme managers, committed to write documents based on more recent practices thanks to their involvement in standardisation and findings during testing campaigns.

The Certification Mark guarantees specifiers, installers and end users that the products and/or systems have been submitted to independent checking and that they have been accurately rated by an accredited and independent third party and that they conform to standards and will perform as advertised.

So, at last, it does not only give guidance but also confidence in the products.

The focus on Eurovent Certita Certification will go over every step of the certification process highlighting the impact on Indoor air quality. A specific programme is under development regarding ventilation systems, based on a simulation of reaction of equipment in regard to numerous cases of building configurations, would they be residential or commercial.

Focus on COPILOT Building service

Eurovent Certita, certifier of HVAC&R products, joined forces with REHVA to establish COPILOT Building Commissioning Solutions. The goal is to de-risk the entire HVAC&R ecosystem - from product manufacture to system operation.

COPILOT's mission is to certify HVAC&R commissioning. This provides third party reassurance that systems are designed, installed, tested and documented in accordance with client requirements.

COPILOT de-risks HVAC&R projects by:

- Planning projects to client objectives
- Reviewing system design
- Verifying and testing system installation

- Testing system performance
- Documenting and certifying the entire HVAC&R commissioning life cycle

COPILOT accredits commissioning experts to verify quality and performance on site in real-time:

- QUALITY via standardised protocols developed with international experts (cf REHVA)
- PERFORMANCE via client objectives which drive every step of the commissioning process

COPILOT's process can be applied to new and existing buildings. Energy savings alone generate payback of 1 to 4 years depending on project profile.

If you want to use COPILOT Certified Commissioning, please contact Cormac RYAN at c.ryan@copilot-building.com.

Conclusion

Coherence of a project is determined by consistency on its design and implementation. Good quality equipment, nowadays well numerically defined, need to be properly installed and maintained. Thanks to Eurovent tools, quality in buildings increases for investments to be safer, and comfort in buildings to be increased.

Audience

All: Academics, technical experts, HVAC-R professionals...

Expected results

Good understanding of Eurovent tools and its ability to de-risk building project and drastically increase the quality & comfort in buildings for investments.

Programme

20 min	**Workshop introduction** Erick MELQUIOND, EUROVENT CERTITA CERTIFICATION
25 min	**Focus on Quality of data in Building Information Modelling** Vincent HENAULT, PRODBIM
25 min	**Focus on Certification of Ventilation equipment and Indoor air quality** Sandrine MARINHAS, EUROVENT CERTITA CERTIFICATION
25 min	**Focus on Commissioning** Cormac RYAN COPILOT BUILDING
5 min	**Conclusion of the Workshop** Erick MELQUIOND, EUROVENT CERTITA CERTIFICATION
10 min	**Open discussion**

WS 4: Why people matter? Exploitation strategies for people-centred design

TIME	DAY #1: Monday 27 May 2019 at 10:30-12:00
ORGANISERS	MOBISTYLE &Triple A-Reno (www.mobistyle-project.eu, www.triplea-reno.eu)
CHAIRS	Dr. Simona D'OCA, Huygens Engineers & Consultants
SPEAKERS	Dr. Simona D'OCA, Huygens Engineers & Consultants Dr. Dan PODJED, Institute for Innovation and Development of the University of Ljubljana Ana TISOV, Huygens Engineers & Consultants

MOBISTYLE -project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 723032.

Triple A-Reno -project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 784972.

Scope

The latest assessments of the European energy strategy for 2030 targets show that energy efficiency and building renovation targets are not being met with a sufficient pace. This implies that sustainable buildings are nothing but buzzwords without considering the need and wish of the occupants within. Too often we forget from whom buildings and innovative technical systems are tended.

H2020 MOBISTYLE and TripleA-reno Projects are adopting a people-centred approach to reduce final energy usage in the EU building stock, thus going beyond the limited focus on technology-driven solutions alone. This approach is supporting the upcoming perception within the field of energy and buildings that people (and not buildings!) consume energy – including the important effect of the behaviour of people living or working in buildings together with the values, habits and motivation factors connected to energy usage. In a broader perspective, the *human factors* responsible for the success of reduced energy consumption, enhanced building performance and user comfort and health, must be taken into consideration.

During this 1 ½ hour workshop we will discuss the TripleA-reno approach to make renovation more affordable and attractive and brainstorm on the way how we engage people (users, stakeholders, designers, engineers, etc.) involved in renovation processes through gamification features. In a dynamic interaction with the audience, the workshop will explore how acceptance,

usability and co-design of advanced retrofit solutions can be improved by leveraging on anthropology, social psychology, and cost-benefit research approaches.

Additionally, learning from the experience gathered in the MOBISTYLE project, the workshop will engage participants to reflect on how people-centred approaches have been implemented to support development of user friendly ICT solutions (game, dashboard) raising occupants awareness and informing them on how to reduce energy consumption, as well as improve occupants' comfort, health and wellbeing in residential and commercial buildings, from the building to the city scale.

Audience

Architects, engineers, designers, ICT experts, building practitioners.

Expected results

This workshop will deliver storyboards, based on the "hero's journey" approach, developed by the participants. Storyboards are concise narrative descriptions of one or more people using a product or service (the TripleA-reno gamified platform for deep renovation, the MOBISTYLE ICT tools) designed on the basis specific user needs, requirements, and expectations. These storyboards have the objective to put focus on people (users) rather than solely on technology or business goals. They will explain how people think and behave in different contexts and how they make decisions, i.e. for initiating a home renovation or interacting with the building controls. These derived value propositions will be presented as easy-to-understand and intuitive reasons why a customer should purchase / use the TripleA-reno and MOBISTYLE products and services.

Programme

5 min	**Introduction**
15 min	**"We do need another hero!" The importance of outstanding individuals and their stories for making a change** Dr Dan Podjed, IRI-UL
15 min	**The TripleA-reno deep renovation journey of heroes** Dr Simona D'OCA, Arch, PhD, Huygens Engineers & Consultants
15 min	**The MOBISTYLE solutions encouraging a positive behaviour change** Ana TISOV, Huygens Engineers & Consultants
30 min	**How can you become a hero?** Storytelling working session
10 min	**Conclusions of discussions & action planning**

WS 5: Supporting dissemination and roll-out of the set of energy performance of building (EPB) standards

TIME	DAY #1: Monday 27 May 2019 at 16:00-18:00
ORGANISERS	EPB CENTER epb.center, REHVA www.rehva.eu, European Partnership for Energy and the Environment (EPEE) www.epeeglobal.org, European Ventilation Industry Association (EVIA) www.evia.eu
CHAIRS	Jaap Hogeling, Director, EPB Center Dick van Dijk, Senior Expert, EPB Center
SPEAKERS	Pau Garcia AUDI, Policy Officer, DG ENER, European Commission Iuliana Chilea, Director General, ASRO Johann ZIRNGIBL, Senior Expert, CSTB Gerhard ZWEIFEL, Senior Expert, Consultant Andrea VOIGT, General Director, EPEE Claus HÄNDEL, Technical Director, EVIA Andrei Vladimir LITIU , Project Consultant, REHVA

Scope

EU Member states are required to transpose and implement the Energy Performance of Buildings (EPB) policy in their country. Moreover, they are expected to use the EPB standards and report back to the European Commission (i.e. the revised EPBD requires Member States to fill in a few specific templates)

The EPB Center (www.epb.center) has been set up to support EU Member States with the uptake of the (CEN and CEN ISO) EPB standards, by providing tailored information, technical assistance and capacity building services for involved stakeholders.

The set of EPB standards, published in 2017, provide EU Member States a toolbox to help the implementation of the Directive and furthermore aim at higher transparency regarding the energy performance calculation methodologies. Each EPB standard has a template for a National Annex that enables Member States to tailor the methodology to the national situation and needs.

The main scope of this workshop is to inform and ask feedback on the implementation of EPB policy at

national level. The organizers endeavour to help participants with the requirement of filling in the templates required by the revised EPBD. Additionally, they shall provide information and interact with participants for collecting feedback from professionals involved or interested in the EPB assessment and implementation.

Participants will benefit of the following:

- Support with filling in the National Annexes of the key EPB standards;
- Information about the use of the EPB standards;
- Information on the set-up /structure of the EPB standards;
- Discussion about the first output and further plans, as a first step in the development of the network of EPB practitioners who are interested to receive or share information and to provide feedback to identify the most urgent needs;
- A demonstration on the use of the EPB Center website – the online knowledge hub on EPB standards:
  - FAQ on key issues (e.g. How to fill in the National Annexes? How to use the standards?);
  - Calculation tools for individual standards;
  - Case study pool of practical examples tailored to the needs of different stakeholders;
  - Practitioners platform to share knowledge and support the ambitious uptake of standards.

Participant will preview a first version of FAQs, examples for filling the National Annexes and the first examples of calculation tools for selected individual standards (including user guide) as basis for practical case studies.

The EPB Center aims to exploit all emerging synergies with other ongoing activities and new initiatives. For the moment a close collaboration has been established with related EU projects i.e. CEN-CE and ALDREN.

Audience

The workshop is recommended for Member States, National Standardization Bodies (NSB), building professionals and students involved or interested in the EPB assessment and implementation (such as implementing the EPBD at national level, using the EPB standards in practice, conducting calculations for energy audits and energy performance certificates of buildings, building performance research) and also industry and finance stakeholders.

Expected results

Participants will be able to understand the why, how and what of the EPB standards and will be guided towards tools and relevant practical information needed to work with these standards.

Programme

10 min	**WELCOME AND INTRODUCTION**
	Jaap Hogeling, EPB Center
20 min	**The promising prospect of EPB standards and the revised EPBD**
	Pau GARCIA AUDI, European Commission
10 min	**Introduction to the roll-out of the set of EPB standards**
	Jaap Hogeling, EPB Center
10 min	**The national implementation process of the EPB standards in Romania**
	Iuliana Chilea, Director General, ASRO
10 min	**EN ISO 52016-1 Energy need calculation (heating/cooling) and calculation of indoor temperatures: hourly or monthly?**
	Dick van Dijk, Senior expert, EPB Center
10 min	**EN 16798-5-13 How to use the set of ventilation and cooling standards?**
	Coordination issues with heat pump calculation (EN 15316-4-2)
	Gerhard Zweifel Senior Expert, Consultant
10 min	**QUESTIONS AND ANSWERS**
	Questions will be collected in writing during the presentations via the Presentation tool.
10 min	**Synergies with linked EU projects: CEN-CE & ALDREN**
	Johann Zirngibl, CSTB, ALDREN & CEN-CE coordinator
5 min	**EPB Standards Community facilitated by REHVA**
	Andrei Vladimir Litiu, REHVA
10 min	**Benefits and challenges of the roll-out of EPB standards. Industry perspective.**
	Andrei Voigt, EPEE
10 min	**Ventilation related EPB standards and their contribution to deliver high IEQ**
	Claus Händel, EVIA
25 min	**INTERACTIVE DISCUSSION AND POLLS**
10 min	**Closing remarks**
	Dick van Dijk, EPB Center

WS 7: Building commissioning in Europe

TIME	DAY #1: Monday 27 May 2019 at 16:00-17:30
ORGANISERS	QUANTUM www.quantum-project.eu
CHAIRS	Dr. Stefan PLESSER, IGS TU Braunschweig/ synavision
SPEAKERS	Dr. Stefan PLESSER, IGS TU Braunschweig/ synavision Jan MEHNERT, IGS TU Braunschweig Ole TEISEN, Sweco Manuel KREMPL, E7 Cormac RYAN, Copilot

QUANTUM -project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 680529.

Scope

New buildings and deep retrofits with their sophisticated systems for heating, cooling and air conditioning are rather complicated technical systems. Especially building automation and control systems with their new IT-protocols and technical requirements have added complexity to building projects. Apparently, they are a huge challenge to designers, engineers, construction companies and facilities managers. Therefore, the performance gap appeared: buildings do not work as intended and miss their initial performance targets in operation. This is doubly costly: first, design and construction cause additional cost and then, later, operation cost are also higher than expected.

A solution to this problem can be found in other industries: quality management. In engineering, "quality" describes the degree, to which a set of inherent characteristics of an object fulfils requirements. In short: a building owner should get what he pays for!

Consequently, "quality management" is a process of supporting the fulfilment of requirements. Over the last years, two services have evolved as reliable quality management services and are becoming increasingly popular: Technical Monitoring and Commissioning.

The workshop will present the current stage of Quality Management for building performance, showcasing relevant ongoing initiatives, guidelines, methods and tools. It will also be the occasion for the official presentation of the REHVA-QUANTUM guidebook *Quality Management for Buildings*, that offers a structured overview of these practices.

Audience

The workshop addresses especially public and private building owners as well as service providers for quality management in building design, construction and operation.

Expected results

Participants will get to know Quality Management tools and guidelines, to be used for an efficient and reliable administration of real estate portfolios.

Programme

15 min	**New Standards and Services for Quality Management of Building Performance** Dr. Stefan Plesser, IGS TU Braunschweig/synavision
15 min	**Technical Monitoring at TU Braunschweig** Jan Mehnert, IGS TU Braunschweig
15 min	**Commissioning** Ole Teisen, Sweco
15 min	**Applying TMon and Cx in Projects** Manuel Krempl, e7
15 min	**Certified Performance** Cormac Ryan, COPILOT Certification
15 min	**Open discussion**

WS 8: NZEB concepts in Europe and Japan

TIME	DAY #1: Monday 27 May 2019 at 16:00-17:30
ORGANISERS	REHVA www.rehva.eu SHASE www.shasej.org 公益社団法人空気調和・衛生工学会 The Society of Heating,Air-Conditioning and Sanitary Engineers of Japan
CHAIRS	Jarek KURNITSKI, Research and Technology Research Committee at REHVA, Tallinn University of Technology Gyuyoung YOON, Special Committee for Joint Study on NZEB between SHASE and REHVA, Nagoya City University
SPEAKERS	Hideharu NIWA, NIKKEN SEKKEI RESEARCH INSTITUTE Martin THALFELDT, Tallinn University of Technology Gyuyoung YOON, Nagoya City University Jarek KURNITSKI, Tallinn University of Technology

Scope

Recent developments of nearly zero and zero energy requirements in EU and Japan are discussed and possi-

bilities to benchmark European NZEB and Japanese ZEB Ready performance levels will be analysed. A refence office building is used to simulate energy use in Oceanic and North European and Japanese Sapporo climate. When moving from one to another climate building envelope U-values are adjusted according to economic insulation thickness approach and national input data and calculation rules are applied. The aim is to show how energy performance requirements are set and how these can be compared so that climatic differences, national input data and calculation rules are considered. The proposed methodology enables to benchmark energy performance requirements of these countries. More widely the results contribute to the development of a common energy performance scale applicable for European energy performance certificate enabling also global benchmarking of non-residential buildings.

Audience

All practitioners, researchers and public sector representatives affected by energy performance requirements or working with the aim to improve energy performance and indoor climate of buildings are welcomed to the workshop.

Expected results

This workshop is aiming to build knowledge and general understanding which factors are needed and how they are to be considered to enable an objective comparison of energy performance requirements in different countries and climates. The results reported will show how NZEB requirements from two European countries and ZEB Ready requirement from Japan stand against European Commission recommendation for NZEB in different climate zones.

Programme

10 min	**ZEB current activities in Japan** Hideharu Niwa, NIKKEN SEKKEI RESEARCH INSTITUTE
10 min	**ZEB best practices in Japan** Speaker
10 min	**NZEB best practices and European energy performance scale** Martin Thalfeldt, Tallinn University of Technology
15 min	**Japanese energy assessment procedure and performance levels** Gyuyoung Yoon, Nagoya City University
15 min	**Comparison of energy performance requirements for Japanese and European office buildings** Jarek Kurnitski, Tallinn University of Technology
30 min	**Open discussion**

WS 9: Indoor Environment Design for Smart Buildings

TIME	DAY #2: Tuesday 28 May 2019 at 10:30-13:00
ORGANISERS	Halton Oy www.halton.com
CHAIRS	Anna Gagneur, Halton Oy
SPEAKERS	Prof. Arsen MELIKOV, Technical University of Denmark (DTU) Dr. Panu MUSTAKALLIO, Halton Oy Prof. Risto KOSONEN, Aalto University

Scope

This workshop presents and discusses the intelligent indoor climate technologies for smart buildings. The workshop focuses to non-residential buildings. It starts from the overall target of providing and ensuring wellbeing for building occupants. Smart buildings refer to the capability of a building to sense, interpret, communicate and respond to changing conditions, which are introduced by requirements of occupants to indoor climate, operation of technical building systems and demands of intelligent energy systems.

The need for paradigm shifts in generating indoor environment that complies with the needs of smart buildings is presented. Design options focused on providing indoor climate for single or group of occupants in smart buildings is discussed. In such buildings the design of indoor climate system sets boundaries for smart management of indoor conditions. Important question is how to assess indoor environment in future buildings. Current and future methods for control and assessment of indoor environment is presented and discussed.

The design of Halton Vario demand based indoor climate system for smart office building is introduced. This demand based indoor climate system consists of an intelligent ventilation control system, airflow control dampers, room ventilation units, indoor air quality sensors and a user interface for advanced indoor environmental control. The design of ventilation ductwork zones is based on constant static pressure regulation with one static pressure management damper. This design enables flexible variable airflows in spaces with different needs, based on intelligent room units with sensors and user interfaces. The system responds to floor layout changes and operates in energy efficient manner. Case study of Halton Vario system in European research project LowUp is presented.

Room systems as a service platform for smart buildings is introduced. The performance of the concept is demonstrated in seven meeting rooms of an educational building. This new concept is easy to utilize also as retrofit of existing buildings. The main benefits of the novel, smart system compared to the standard ones are the improved monitoring of the ventilation system performance, enhanced controllability of indoor climate in energy efficient manner, and improved users' perception on the indoor climate. Overview of the trends in smart management of indoor climate conditions with the Smart Readiness Indicator (SRI) for buildings as established by the European Union is presented.

There will be discussion and brainstorming of the subject between the presentations.

Audience

Real estate owners, property managers, HVAC and lighting consulters, researchers, HVAC and lighting manufactures, policy makers and others interested in smart indoor climate control are welcomed to the workshop.

Expected results

The main objective of this workshop is to identify possibilities and challenges of **indoor environment design for smart buildings that will** provide and ensure wellbeing for building occupants.

Programme

10 min	**Objective of the workshop** Anna Gagneur, Halton Oy
15 min	**Future design and assessment of indoor environment** Prof. Arsen Melikov, Technical University of Denmark (DTU)
5 min	**Questions and discussion**
15 min	**Halton Vario system design giving flexibility for smart indoor climate** Dr. Panu Mustakallio, Halton Oy
5 min	**Questions and discussion**
15 min	**Room systems as a service platform for smart buildings** Prof. Risto Kosonen, Aalto University
5min	**Questions and discussion**
50 min	**Open discussion** – *What are barriers for implementing of occupant-based design of indoor environment in smart buildings?* – *What are research and development needs?* – *How to provide individual and smart indoor climate with maintaining flexibility of system to floor layout changes?*

WS 10: Energy renovation of building stock towards nZEB levels - How to prepare the market for the challenge?

TIME	DAY #2: Tuesday 28 May 2019 at 10:30-13:00
ORGANISERS	Fit-to-NZEB project www.fit-to-nzeb.com iBRoad project ibroad-project.eu Grundfos Pompe Romania ro.grundfos.com
CHAIRS	Horia PETRAN, INCD URBAN-INCERC & Cluster Pro-nZEB Dragomir TZANEV, Eneffect
SPEAKERS	Horia PETRAN, INCD URBAN-INCERC & Cluster Pro-nZEB Dragomir TZANEV, Eneffect Octavian ȘERBAN, Grundfos Pompe Romania

Fit-to-NZEB -projec has received funding from the European Union's HORIZON 2020 research and innovation programme under grant agreement No 754059

iBRoad -project has received funding from the European Union's HORIZON 2020 research and innovation programme under grant agreement No 754045.

Scope

The workshop will demonstrate the achievements of two complimentary international initiatives – the Horizon 2020 projects Fit-to-NZEB (Innovative training schemes for retrofitting to nZEB-levels) and iBRoad (Individual Building Renovation Roadmaps), supporting deep energy retrofit through developing streamlined educational schemes and individual building roadmaps for staged renovation, thus overcoming some of the main barriers for large-scale market uptake of energy efficient building retrofit around Europe. The applicability of new technological developments in the process and the opportunities that technologies bring for cost-effective renovations transforming the building stock will be presented by one of the leaders in this area – Grundfos Pompe Romania, reflecting on the response of the business sector to the new policy development and social challenges.

Focusing of deep energy building retrofit, the workshop will include a dynamic interactive consultation session around the following topics:

- Increasing the demand for quality nZEBs, both new builds and renovations;

- Introducing innovative user-oriented building certification schemes, supporting end-user engagement and providing new tools for more informed and proactive market behaviour;
- Decreasing the performance gaps through large-scale improvement of the skills of the building specialists at all levels – from designers to blue-collar workers;
- Presenting technological developments focused on comfort, cost-efficiency, interconnectedness and quality of habitation;
- Specifics of the building renovation support programmes in countries in Eastern Europe and opportunities for their further development.

Audience

The target audience is broad and includes professionals (from energy auditors for buildings and designers to representatives of construction companies and on-site tradespersons), decision makers (central and local authorities, representatives of financial institutions and building owners) and technology suppliers.

Expected results

Through presented content and its discussion-intensive format, the workshop is expected to contribute to a better understanding about relevant current tools and initiatives to facilitate deep energy renovation, while delivering specific recommendations for stimulating the market for deep energy building retrofit in several dimensions:

- *Legislative*: improvement of the legislative framework in the process of adoption of the new EPBD, including further instrumentalization of building certification;
- *Skills-oriented*: putting clear focus on the need for nZEB-oriented qualitative transformation of the training and educational system for building specialists at all levels, targeting both the national education system and informal training and education, including on-site training and recognition of skills and knowledge acquired at the working site.
- *Market-oriented*: involvement of major business actors in the process and support for introduction of new technologies, having positive impact on comfort, health, efficiency and market value of the dwellings;
- *Policy-making*: recommendations for future development of national and, where applicable, local support programmes in the light of the expected national long-term renovation strategies;

Programme

5 min	**Short introduction by the Chairs on the topic and workshop structure**
25 min	**iBRoad – Individual Building Renovation Roadmaps** Horia Petran, INCD URBAN-INCERC & Cluster Pro-nZEB
25 min	**Fit-to-NZEB – Innovative training schemes for retrofitting to nZEB-levels** Dragomir Tzanev, Eneffect
25 min	**The BetterHome initiative and BetterBuildings** Octavian Şerban, Grundfos Pompe Romania
60 min	**Open discussion**
10 min	**Conclusions**

WS 11: BACS supported performance, technical monitoring and certified commissioning of HVAC systems

TIME	DAY #2: Tuesday 28 May 2019 at 10:30-12:00
ORGANISERS	REHVA www.rehva.eu eu.bac – European Building Automation and Controls Association https://www.eubac.org/
CHAIRS	Atze BOERSTRA, REHVA Vice-President Peter HUG, eu.bac Managing Director
SPEAKERS	Pau GARCIA AUDI, European Commission, DG ENER Bonnie BROOK, eu.bac Stefan PLESSER, Synavision Cormac RYAN, COPILOT

Scope

This joint workshop organised by REHVA and the European Building Automation and Controls Association will present the wide spectrum of tools and technologies supported by BACS to improve and optimize HVAC systems' performance and make it transparent to Building Owners/Operators.

The first presentation will introduce the EU policy framework. Mr. Pau Garcia Audi will give an overview of the current EU policies with focus on the main new elements regarding BACS in the revised EPBD. Mr. Garcia Audi will also explain how certain BACS, if able to deliver certain functionalities, will become mandatory in large non-residential buildings to preplace physical inspections.

In the second presentation, Ms. Bonnie Brook will give more information to the participants about these "EPBD compliant" functionalities: how to distinguish the BACS that can deliver them from the ones that cannot, the importance of them, how they can ensure ongoing

commissioning and why they are an essential precondition for the buildings of the present and of the future.

Dr. Stefan Plesser will explain how technical monitoring as the key service for quality management for quality management can be applied in buildings. He will describe the principle roles and responsibilities, technical requirements regarding BACS and the individual steps from the early design stage via construction and commissioning until regular operation.

The last presentation by Mr. Cormac Ryan will focus on Certified Commissioning, introducing the COPILOT scheme showing how HVAC and BMS can be certified with details on the quality of design, installation and operation quality.

The presentations will be followed by an interactive Q&A session, moderated by Mr. Hug.

Audience

Building owners, facility managers, designers, policymakers, architects, system integrators, installers, building commissioners, industry, energy inspectors, energy auditors, students.

Expected results

With this event the organizers seek to inform the audience about the latest policy developments in the revised EPBD concerning technical building systems, with a focus on the key role of BACS functionalities. Further, essential tools to optimize the performance of the systems, such as technical monitoring and commissioning certification scheme, will be introduced, for participants to understand how to successfully apply them.

Programme

5 min	**Introduction** Atze Boerstra, REHVA Vice-President
15 min	**BACS in revised EPBD and current results from the implementation of regular HVAC inspections from the former EPBD in Member States** Pau Garcia Audi, DG ENER
15 min	**BACS option: relevant functionalities, ongoing commissioning, outlook**, Bonnie Brook, eu.bac
15 min	**Technical Monitoring option** Stefan Plesser, synavision
15 min	**Certified Commissioning option** Cormac Ryan, COPILOT
20 min	**Q&A session** (moderated by) Peter Hug, eu.bac
5 min	**Conclusion**, Peter Hug, eu.bac

WS 13: Costs and benefits of antibacterial filter and its effects on energy saving, human health and worker productivity

TIME	DAY #2: Tuesday 28 May 2019 at 11:30-13:00
ORGANISERS	RHOSS www.rhoss.com
SPEAKERS	Stefano Paolo CORGNATI, Rhoss S.p.a Micaela RANIERI, Rhoss S.p.a

Scope

In the present-day society, people spend about 80% of their time inside buildings, and specifically 30-40% in workplaces. From this evidence, the indoor environmental quality needs to be investigated, and, the possible sources of indoor-outdoor pollutants and their impact on the human health, comfort and productivity.

Through an examination of the indoor sources of pollution, the research analysed the main substances that affect indoor air quality in an office. Second, the pollution of external origin and its effects on the performance of employees were taken into consideration. The outdoor air pollution and the insufficient hygiene of HVAC systems often result in the low quality of indoor air. The World Health Organization estimated that 50% of indoor biological contamination comes from the air-handling system. Some studies demonstrated that the air filters are sources of pollution due to the accumulation and proliferation of bacteria on the surface. Furthermore, the presence of contaminants in indoor environments can have a negative impact on health and productivity of the occupants. To guarantee not only a better indoor air quality but also a lower health risk and an increase in worker productivity, a new concept of biocidal filtration has been introduced. In this context, we explored how to integrate the health and performance effects on building occupants into the economic benefits of the antibacterial filter. The research focuses on the methods used to evaluate costs and benefits produced by the application of a biocidal filter, comparing it with a traditional one, by means of computing both direct and indirect costs. Therefore, this article tries to enhance the focus on energy technology developing an analysis of the impact on human health and employee performance.

Two scenarios were designed for a Heating Ventilation Air Conditioning (HVAC) system in an office building; one by the installation of a biocidal filter and the other by a traditional one. Two methods were applied to

evaluate and compare those scenarios; the Cost Benefit Analysis and the Monte Carlo Simulation. From a financial point of view, the investment and management costs of the filters were considered. Instead, the annual benefits included increasing productivity and reducing days of absence from work due to illness.

Audience

Designers interested to find new solution to implement to solve the issue of the Indoor Air quality adopting innovative strategies of evaluation of the problem.

Expected results

Raise the level of attention and awareness around the IAQ theme proposing also a new approach to this issue.

WS 14: Towards optimized performance, design, and comfort in hybridGEOTABS buildings

TIME	DAY #2: Tuesday 28 May 2019 at 16:00-17:30
ORGANISERS	hybridGEOTABS www.hybridgeotabs.eu
CHAIRS	Prof. Dr. Lieve HELSEN, KULeuven/ EnergyVille
SPEAKERS	Dr. Eline HIMPE, UGent Dr. Ongun Berk KAZANCI, DTU Dr. Qian WANG, Uponor/KTH Prof. Wim BOYDENS, Boydens Engineering

hybridGEOTABS -project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 723649.

Scope

HybridGEOTABS refers to the efficient integration of the combination of GEOTABS (Geothermal heat pumps in combination with Thermally Activated Building Systems (TABS)) and secondary heating and cooling systems in a building. This technology offers huge potential to meet heating and cooling needs throughout Europe in a sustainable way, while providing a very comfortable conditioning of the indoor space. In this workshop the effects of radiant heating and cooling systems on Indoor Environmental Quality (IEQ) are discussed, as well as the design of hybridGEOTABS buildings.

In the first part of the workshop, the benefits of TABS for the IEQ in buildings are highlighted. Because TABS are most easy to apply in new buildings, a newly developed solution for existing buildings (renovation) is introduced, which is a radiant heating and cooling system with high thermal mass (using Phase Change Materials).

The second part of the workshop starts from the challenge of optimally sizing both the GEOTABS and the secondary heating/cooling system in hybridGEOTABS buildings, controlled by Model Predictive Control (MPC). Starting from the state-of-the-art design processes, the ongoing R&D towards a new design procedure allowing optimal integration and sizing of hybridGEOTABS is explained. These developments will lead to a holistic and easy-to-use design procedure for feasibility studies and predesign, avoiding case-by-case simulation work.

Audience

The workshop is targeting HVAC and building designers, HVAC manufacturers, researchers, teachers and engineering students.

Expected results

Attendants will learn the advantages of radiant heating and cooling systems from an energy and comfort perspective and how these are designed in the context of the overall optimization of hybridGEOTABS systems. They will also be introduced to innovative design procedures for these systems.

Programme

10 min	**Introduction to hybridGEOTABS project-challenges and opportunities of hybridGEOTABS buildings** Dr. Eline HIMPE, UGent *Part I – Focus on hybridGEOTABS primary distribution systems*
15 min	**Indoor Environmental Quality benefits of radiant systems** Dr. Ongun Berk KAZANCI, DTU
10 min	**TABS in hybridGEOTABS buildings** Dr. Qian WANG, Uponor/DTU
10 min	**PCM ceiling panels as a renovation solution in hybridGEOTABS buildings** Dr. Ongun Berk KAZANCI, DTU *Part II – Design challenges of hybridGEOTABS buildings*
25 min	**Innovative procedures for the optimized design of hybridGEOTABS buildings** Prof. Wim BOYDENS, Boydens Engineering
20 min	**Open discussion**

WS 16: BIM FOR Built Environment IMTECH BELGIUM & ALLBIM NET	
TIME	DAY #3: Wednesday 29 May 2019 at 10:30-13:00
ORGANISERS	DosetIMPEX www.dosetimpex.ro, ALLBIM NET www.allbim.net
CHAIRS	Lucian Dan MORARU, ALLBIM NET Alin EPURE, ALLBIM NET Wim MAASSEN, TVVL Ioan Silviu DOBOSI, DOSETIMPEX Frank MILLS, FANK MILLS CONSULTING Ioan Silviu DOBOSI, DOSETIMPEX
SPEAKERS	Paolo Stefano CORNIATI, Rhoss S.p.a Micaela RANIERI, Rhoss S.p.a

Scope

Building Information Modelling developed from a modern approach of designing to a "digital revolution" in the AEC sector, proving its undisputable benefits in every step of a project's lifecycle.

The scope of this workshop is to bring forward to the audience the **Business and Environmental Value of BIM**, using examples from completed projects.

The workshop showcases a broad range of costs lowering of basic project designing/building activities, while decreasing the waste generated by it, as exemplified in the following main points:

Reduced Design Rework/Staff Costs

Whenever design changes are necessary, only the central model is modified, which is then automatically reflected in all affected drawings. Therefore, no time is lost to update individual drawings, as in regular CAD.

This approach translates in time saving and less work hours paid.

Reduced Construction/Rework Costs

Construction problems, overlaps, collisions and conflicts can be identified right from the design phase, reducing significantly construction reworks due to design flaws. The building goes up right from the start, without unpleasant surprises on the site work, and eliminating the subsequent cost of those modifications.

Sustainable Facility Management and Building Operation

The intelligent 3D models provide to owners and facility managers data-rich models, which are easily analysed and optimize resources. These models are invaluable tools for performing spatial validation for tenant charge-backs or keeping scheduled facility operations.

The larger and more complex the project, the greater the opportunity for savings, because of the greater probability of error and change elimination, meanwhile putting a brick in building a sustainable and eco-friendly AEC sector. Every aspect presented will be backed with examples.

Audience

Building Owners, Contractors, AEC Specialists (Architecture, Engineering, HVAC) will find the benefits of using BIM in daily work.

Expected results

We expect to convince the audience to adopt BIM, and for people that already use it to increase the BIM level to achieve a higher precision and productivity.

Programme

25 min	**Introduction in BIM. Definitions, showcases, best practices.** Dan MORARU, ALLBIM NET
25 min	**Common Data Environment - PDF based collaboration. Case studies** Alin EPURE, ALLBIM NET Dubai-UAE
10 min	**Open discussion: BIM creates value!?**
25 min	**'Towards net-zero hospitals in the Netherlands' - ASHRAE-REHVA Guidebook: Towards Energy Neutral Hospital Buildings!** Wim MAASSEN, Royal HaskoningDHV **'Towards net-zero hospitals in the Netherlands' - ASHRAE-REHVA Guidebook: Towards Energy Neutral Hospital Buildings!** Wim MAASSEN, Royal HaskoningDHV
25 min	**'Towards net-zero hospitals in the UK' - ASHRAE-REHVA Guidebook: Towards Energy Neutral Hospital Buildings!** Frank MILLS, Frank Mills Consulting

WS 17: Advanced HVAC/R Measurement Technology and Indoor Air Quality Monitoring	
TIME	DAY #3: Wednesday 29 May 2019 at 10:30-13:00
ORGANISERS	TESTO ROMANIA www.testo.ro
CHAIRS	Horaţiu BAŞA, Testo Romania
SPEAKERS	Raul SMOCZER, Testo Romania

Scope

During the workshop we will discuss about two important topics

- Air flow measurements in ducts according to DIN EN 12599
- Comfort level measurement in the workplace

Considering the first topic it is well know that nowadays we spend most of the day in closed rooms. Therefore heating, ventilation and air conditioning (HVAC) systems are installed which are intended to ensure pleasant ambient conditions indoors. Ventilation is of importance here. Firstly, it is not only used to provide fresh air, but also for extracting pollutants, for instance removing excess humidity from rooms.

Ensuring adequate air exchange and thus determining the volume flow is an important quality factor when it comes to commissioning and operating HVAC systems. The reliable determination of air velocity in ducts is one of the most challenging measurements which a ventilation and air conditioning technician must carry out.

Importance of air velocity - In line with the motto: "The more, the merrier", HVAC systems are often operated with air volumes that are too high. This excessive requirement leads to increased operating costs. Energy expenditure for the fan rises, because a larger volume of air has to be moved through the system. However, costs are also incurred for conditioning the air (cooling, heating, humidifying or dehumidifying) and these can be reduced when the system is set correctly. In addition, a high air exchange often leads to draughts occurring in the room, making people feel uncomfortable. On the other hand, too low a volume flow can also be problematic. The people in the room have too little fresh air to breathe in. The indoor air is "stale", because the CO_2 content in the room is too high. Low volume flows can also have negative impacts on the system's hygiene: there is the risk of germ formation in the system when movement of the humidified air in the ducts is too slow. A correctly set HVAC system therefore not only helps make the indoor climate comfortable, but also helps save costs.

Measurement of the correct air velocity - The key parameter for evaluating the functional capability of the HVAC system is the air volume flow. This is the product of flow velocity and duct area. Since, in practice, flow velocity in the duct cross-section is not the same, an individual point measurement does not suffice when it comes to determining the average air velocity. Disruptors, such as dampers, elbows and the like, have an influence on the velocity profile in the duct, which means a so-called grid measurement has to be carried out at several locations in the duct. In order to meet quality requirements when it comes to determining volume flow, there are different standards all over the world dealing with the correct measurement of flow velocities. In addition to EN 12599, which is the leading standard in large parts of Europe, there are also EN 16211 and ASHRAE 111. What all methods have in common is that the measuring points are distributed over the duct cross-section according to the size of the duct in line with defined specifications, that a distinction is made between rectangular and round ducts and that the readings are averaged.

We will go into the correct measurement of volume flow according to EN 12599 and discuss about:

1. The right measuring location
2. The measurement method
3. Evaluation of the readings

The right measuring location - The decisive factor when it comes to meaningful measurements is selecting a suitable measuring point. This is already established by the system planner in the execution plan (project plan). The following criteria must be considered here:

- Air flow measuring points must be allowed for on all main ducts and on supply lines to rooms with high requirements.
- Minimum distances from disruptions must be adhered to at least 6-times the hydraulic diameter downstream and 2-times the hydraulic diameter upstream
- The measuring points must be easily accessible and there must be enough space available for handling the measuring instrument.
- The flow must be free of any return flow or swirling

Air which flows through a duct does not have a uniform velocity. As a rule, the air in the middle flows faster than at the duct wall. There are greater resistances at the duct wall due to friction and these must be overcome. A distinction is made between two basic flow profiles: laminar flow and turbulent flow.

Ideal flow profiles are almost exclusively found in very long ducts which run in a straight line and where there are no disruptions. For this reason, minimum distances from disruptions must be adhered to.

The measurement method - The representative average flow value in the duct cross-section must be established to determine the air volume flow. To do this, the measurement area is split into partial areas and the velocity are determined at the central point of the partial areas. This method is called grid measurement. The method for dividing the duct cross-section into partial areas is different for rectangular and round ducts.

DIN EN 12599 envisages the following two measurement methods:

- the trivial method for measurements in air ducts with a rectangular or square cross-section
- the centroidal axis method for measurements in ducts with a circular cross-section

Evaluation of the readings - There is a requirement in DIN EN 12599 for the accuracy of the air volume flow to be determined with a measurement uncertainty of ±10%. Here, the question that now must be asked is how accurate was the measurement which has just been carried out. DIN EN 12599 also provides answers to this.

In addition to the uncertainty of the measuring instrument and the probe used, the irregularity of the flow profile is a crucial factor for determining the total error. Where there is a large profile irregularity, the required measurement uncertainty of ±10% can only be achieved with several measuring points that is just as large, but this is very time-consuming. The number of measuring points must therefore always be seen in connection with the distance from disruptions, because these are decisive when it comes to irregularity in the profile.

Considering the second topic of the workshop we will discuss also the importance of the comfort level measurement in the workplace.

We know that several hundred million people all over the world work in offices. Many of them are dissatisfied with the ambient conditions where they work. The most common reasons are complaints about thermal comfort and indoor air quality.

The complaints usually need to be investigated by a measuring technology technician. This person is faced with the challenge of objectively evaluating employees' thermal sensations in order to determine whether the complaints are justified and, where applicable, pinpoint their causes and eliminate them. From a business perspective alone, it goes without saying that the complaints need to be taken seriously, since employee performance directly relates to the ambient conditions in the workplace.

The aim of this workshop is to offer support to those responsible for the indoor climate and to identify possible ways of objectively evaluating subjective impressions about comfort level in the event of complaints.

As we all know thermal comfort plays a decisive role in influencing physical and mental capabilities. The human body's sensitivity to heat essentially depends on its thermal equilibrium (thermal balance). This thermal equilibrium is affected by physical activity and clothing, as well as ambient atmospheric parameters. These are:

- Air temperature
- Radiant temperature
- Air velocity (draught)
- Humidity

Thermal comfort occurs when a person feels thermally neutral. This happens when people find the ambient parameters (temperature, humidity, draught and thermal radiation) in their surroundings pleasant. There is no requirement for warmer or colder, dryer or more humid indoor air. Thermal comfort also depends on the type of activity and clothing.

Reasons for using measuring technology for thermal evaluation in the workplace

Thermal comfort in the workplace is not an unnecessary luxury for employees, it is a basic requirement for performance and productivity. Which is why, from an economic perspective, appropriate ambient conditions need to be created. As soon as an employee complains about the ambient conditions in the workplace, the employee's assertion about thermal discomfort has to be converted into an objective measurement result using appropriate measuring technology. This allows optimum evaluation of the situation. If the meas-

urement results are all within the normal range, the measuring technology technician can immediately rule out any incorrect configuration of the HVAC system. Analysis of the employee's thermal discomfort must then be pursued on another level. There could be other reasons for the complaints, for example dissatisfaction with work, problems with colleagues, private issues or health complaints can all have an impact on how the thermal comfort level is perceived.

This workshop will also present the advantages of professional measuring technology together with all measurements that are necessary to evaluate the comfort level inside a building.

With an increasing number of fully air-conditioned workplaces in new buildings or buildings renovated to make them more energy-efficient, employee complaints about thermal discomfort at the workplace are also on the increase. Without the appropriate measuring technology, it is virtually impossible for air conditioning/in-house technicians to detect the difference between personal discomfort and real, negative indoor climate effects. However, this is essential in order to eliminate any possible negative impacts of the HVAC system for regulatory purposes. In this respect, simple and economical implementation of measurement methods is disproportionate to the risks which poorly or incorrectly configured ventilation and air conditioning technology in buildings can cause.

During the workshop we will also presents and test the latest measurement technology in the HVAC/R market and will demonstrate how SMART instrumentation is able to considerably reduce the commissioning time and costs for any HVAC/R technician.

With these measuring instruments and its extensive range of probes, technicians can record, analyse and document all the key parameters quickly and efficiently, so that they can take the appropriate corrective measures.

We will demonstrate why the communication between the measuring instruments and mobile devices is a huge benefit for any technician who wants to become more efficient.

Audience

HVAC engineers and technicians.

Expected results

Inform the participants about the latest technologies for air flow and comfort level measurement.

Programme

60 min	**Air flow measurements in ducts according to DIN EN 12599** Horatiu Basa, Testo Romania
60 min	**Comfort level measurement in the workplace** Raul Smoczer, Testo Romania
30 min	**Open discussion**

WS 18: Evidence-based ventilation needs and development process of future standards

TIME	DAY #3: Wednesday 29 May 2019 at 10:30-12:00
ORGANISERS	REHVA Technology and Research Committee www.rehva.eu, ISIAQ, the International Society of Indoor Air Quality and Climate https://www.isiaq.org
CHAIRS	Jarek Kurnitski, REHVA Technology and Research Committee, Tallinn University of Technology Pawel Wargocki, ISIAQ, the International Society of Indoor Air Quality and Climate, Technical University of Denmark
SPEAKERS	Pawel Wargocki, Technical University of Denmark Bjarne Olesen, Technical University of Denmark William Bahnfleth, Pennsylvania State University Jarek Kurnitski, Tallinn University of Technology Olli Seppänen, FINVAC

Scope

Recent research findings, their interpretation and meaning for ventilation system sizing is discussed with the aim to establish evidence-based design criteria of ventilation rates for residential and non-residential buildings. The workshop attempts to summarize existing evidence, possible knowledge gaps and to specify further actions what are needed to implement evidence-based ventilation rate values into future indoor climate standards such as in EN 16798-1:2019 and possibly in some other ventilation system standards. More specifically, the workshop discusses would it be possible to set up

ventilation criteria which is based on the ventilation effects on acute health symptoms and mental performance, making a difference to perceived air quality based common approach. Some new results for instance isolating the effects of bioeffluents have made it possible to distinguish ventilation rates needed for health and comfort. Another question discussed is how the research evidence typically available as ventilation rate L/s per person should be converted to residential ventilation design values which should be either in L/s per room or m² format, as occupancy is typically not known for designers. In this field, a recent REHVA residential ventilation guidebook has proposed new design values based on common occupancy assumptions and category II indoor climate ventilation rate. Similarly, in Finland, ventilation guidelines have been recently updated based on practical design problems and long-time experience of the use of mechanical ventilation.

Audience

Practitioners, researches, authorities and other private and public sector representatives working with ventilation systems and product and ventilation regulation are welcomed to the workshop.

Expected results

The workshop is expected to summarise the existing evidence on ventilation need being based on different criteria and should build understanding how this evidence can be used in the development of ventilation sizing and design principles with consequences to relevant indoor climate and ventilation standards.

Programme

12 min	**Recent evidence on health and mental performance** Pawel Wargocki, DTU
12 min	**Performance criteria in ISO and EN standards** Bjarne Olesen, DTU
12 min	**ASHRAE 62.1 Indoor Air Quality Procedure vs. 62.2 approach** William Bahnfleth, Pennsylvania State University
12 min	**From performance criteria to design values: REHVA residential ventilation design procedure** Jarek Kurnitski, TalTech
12 min	**Principles of New Finnish Ventilation Guidelines** Olli Seppänen, FINVAC
30 min	**Open discussion**

CLIMA 2019 summaries by keynote speakers

Keynote programme

Sunday 26 May			Monday 27 May			Tuesday 28 May			Vednesday 29 May		
			8:30-8:50	IM TECH	20 min	8:30-8:50	PAB	20 min	8:30-9:10	**William P. Bahnflet**	40 min
			8:50-9:30	**Shin-ichi Tanabe**	40 min	8:50-9:30	**HUI Zhang**	40 min	9:10-9:20	Sponsor (free slot)	10 min
			9:30-9:50	Sponsor (free slot)	20 min	9:30-9:50	EU representative	20 min	9:20-10:00	**Ovidiu Noran**	40 min
			9:50-10:00	EUROVENT	10 min	9:50-10:00	HALTON	10 min			
			10:30-13:00	Sessions & WSs	150 min	10:30-13:00	Sessions & WSs	150 min	10:30-13:00	Sessions & WSs	150 min
16:30-17:40	Opening speech	70 min	14:00-14:40	**Francis Allard**	40 min	14:00-14:40	**Werner R. Lutsch**	40 min			
17:40-18:20	**Cătălina Turcu**	40 min	14:40-14:50	AM TEH	10 min	14:40-14:50	ISHREA	10 min	14:00-16:30	Awards ceremonies, pleanary presentations, closure speech	150 min
18:20-18:40	DAIKIN	20 min	14:50-15:30	**Mika Halttunen**	40 min	14:50-15:30	**Bjarne W. Olesen**	40 min			
18:40-19:00	REHVA	20 min	16:00-18:00	Sessions & WSs	120 min	16:00-18:00	Sessions & WSs	120 min			

Current Status and Future Prospects of Optical Radiation for Infection Control

WILLIAM P. BAHNFLETH
Professor PhD.Eng.
Director of Indoor Environment Center Department of Architectural Engineering, USA

Control of viral and bacterial pathogens in the built environment is an important aspect of indoor environmental quality with severe personal and economic consequences. Diminished quality of life, premature mortality, decreased worker productivity, and increased healthcare costs are all possible outcomes. Healthcare environments are particularly at risk due to the state of health of patients and the prevalence of increasingly drug-resistant pathogens. The World Health Organization (WHO) estimates that in developed countries, 7% hospital patients overall and roughly 30% of intensive care unit patients will contract at least one healthcare acquired infection (HAI) during their stay.

The role of heating, ventilation, and air-conditioning systems in an infection control program is to prevent exposure through a combination of ventilation, pressurization, compartmentalization, and air treatment. By lowering airborne loadings of infectious aerosols, a beneficial effect may be achieved with respect to both inhalational and intermediate surface (fomite) transmission. These measures are becoming of greater importance as the ability to stop infections with drug therapy (e.g., the use of antibiotics for bacterial infections) decreases. Conventional approaches include the use of large quantities of outside air and high air change rates, which increase energy use in combination with high efficiency filters.

It has been known for nearly a century that certain wavelengths of light have germicidal capability that is not affected by drug resistance. Optical radiation in the UVC band, particularly 254 nm UVC produced by low pressure mercury vapor lamps has been used to good effect not only for air disinfection, but also as an adjunct to surface disinfection using oxidants and other cleaning materials. This presentation summarizes the state of the art with respect to optical radiation disinfection air and surface technology and applications, surveys available evidence of effectiveness, and discusses the potential of future developments. The context is primarily healthcare facilities, but with applicability to other types of residential and non-residential facilities.

Importance of Environment, Social and Governance (ESG) in Building Industries -Toward Zero Energy Building with High Indoor Environment Quality

SHIN-ICHI TANABE
Professor, Ph.D, FASHRAE
Council member, Science council of Japan, Department of Architecture, Waseda University

Investors look for Environmental, Social, and Governance (ESG) factors when considering investee companies. In 2005, the United Nations Secretary-General invited a group of the world's largest institutional investors to participate in a process of developing the Principles for Responsible Investment (PRI). The PRI were launched in April 2006 at the New York Stock Exchange. The investment principle of real estate ESG is a global trend. The Global Real Estate Sustainability Benchmark (GRESB) is one of the evaluation systems. Real estate that reduces environmental impacts and provides super health and comfort to workers has attracted attention from the viewpoint that improving the workplace productivity. LEED, CASBEE, and Energy Label are assessment systems that are popularly employed worldwide to assess the environmental performance of buildings. Ultimate case is Zero Energy Building (ZEB). However, perfect net Zero onsite energy building may be very hard to realize for all type of buildings. We needed clear definition of ZEB in Japan. Roadmap Committee under the Ministry of Economy, Trade and Industry was organized and published definition of ZEB and ZEH (Zero Energy House) including family in December 2015. ZEB family is consisting of ZEB Ready, nearly ZEB, ZEB and ZEB Oriented. More than 44,000 detached houses with ZEH has been newly constructed during 2017 in Japan. On the other hand, for social aspect the deterioration of the indoor environment and long-term sedentary work are detrimental to the health of workers. The Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) of Japan published a certification system concerning buildings that can provide excellent health, comfort, and other services to workers based on the research committee outcome conducted since 2007. This keynote lecture provides the background, trends and scientific evidence of the policy.

Assessing Urban Heat Islands: stakes and recent advances in design solutions and technology

FRANCIS ALLARD
Professor PhD.Eng
Université de La Rochelle, FRANCE

During recent years, most of the world population has known an important transformation. It is the first time in our history that the urban population becomes more important than the rural one. This structural change has many impacts on social aspects, health, energy supply and primary resources consumption and of course on the climate change. Furthermore, we can identify everywhere that these big cities concentration produces additional phenomena called Urban Heat Island effect which consequences on the urban microclimates could be dramatic. Its intensity, measured in many cities in the world above 10 Celsius, leads to many consequences on health, comfort or energy supply of these cities and demonstrates clearly a need of innovation in order to reduce drastically these effects. Specific efforts are needed in identifying long-term strategies in urban design as well as short term technological solutions. The main drivers show the need of a better knowledge of the urban climate and of its prediction in order to quantify the effects of various strategies. The interaction between the built environment and the local climatic conditions has to be described, analyzed and predicted. The technical solutions such as the radiative treatment of urban surfaces, the integration of water and vegetation, the management of green and cool spaces, as well as new technologies for conditioning the buildings must be evaluated and disseminated. In our presentation, we will discuss these various strategies at city level, neighborhood scale or building dimension and present recent initiatives.

From wellbeing indoors to built environment facing climate change – and beyond

MIKA HALTTUNEN
M.Sc.(Eng)
President and Chairman of the Board
Halton Group - FINLAND

Helsinki was the host for 2007 CLIMA Conference, titled Wellbeing Indoors. Same year was the last strong economical year of a long expansion in the world before the global financial crisis.

Since the financial crisis the world has seen an unprecedented surge of new technologies that are literally revolutionizing the lives of consumers and businesses.

Energy-efficiency of buildings was a major issue before 2007. Since then, our industry has experienced a strong movement of putting the building users, the ultimate clients of construction industry, in the focal point of buildings' performance. Certifications like WELL have become more popular, complementing already well-established LEED and BREEAM. Human wellbeing has finally become an important element in CRE industry and is not going away.

There are already numerous new means to improve user satisfaction, quality and productivity of construction as we move towards 2030. We have just recently started to implement in addition to Building Information Modelling new opportunities like Big Data, Machine Learning, Artificial Intelligence, Additive Manufacturing, Virtual and Augmented Reality and Robotics. More possibilities are coming from themes like Distributed Ledgers.

CLIMA 2019 in Bucharest is titled Built Environment Facing Climate Change. The awareness of global risks coming from changing climate to humans has risen dramatically in 2018, the fourth hottest year ever recorded on earth, following 2016, 2017 and 2015.

It is crucial, that Climate Change is fought against in the construction industry, one of the largest contributors of greenhouse gas emissions. Platform economy will improve the resource effectiveness. Modular prefabrication will improve productivity and quality. Our challenge towards 2030 is to create energy-positive buildings at the same time as we are promoting the wellbeing of building users. After all, buildings are built for people.

These goals will be achieved with new ways of working and new technologies.

Assessing Urban Heat Islands: stakes and recent advances in design solutions and technology

WERNER R. LUTSCH
PhD.Eng
Euroheat & Power President - AGFW e. V. Frankfurt am Main, GERMANY
District Heating and CHP – Clean Energy for all Europeans

The Clima 2019 takes place at a pivotal moment in the evolution of European energy policy. The clear recognition of the importance of sustainable heating and cooling in the recently finalized Clean Energy for All Europeans Package was an important step forward but much remains to be done. Looking ahead to the upcoming European elections and arrival of a new set of Commissioners later this year, it is vitally important to establish policy frameworks and market conditions at European, national and local level that will foster the uptake of greener and more efficient heating and cooling solutions, including district energy networks.

Going for Maximum Efficiency in Thermal Comfort

HUI ZHANG
University of California at Berkeley, Center for the Built Environment, US

The engineered indoor environment consists almost entirely of systems in which temperature and humidity are tightly controlled. Such systems are simple to visualize, design, and control. They are however inherently electricity-intensive and consume in aggregate a large fraction of the world's energy. They also leave at least 20% of their occupancies dissatisfied.

Future buildings will save *energy* and improve satisfaction by using *personal comfort systems (PCS)*, such as heated/cooled chairs, footwarmers, and fans. They can offset intensive central systems using two orders of magnitude less energy per occupant than central systems and are especially useful in less-controlled and difficult spaces like lobbies and perimeter zones.

PCS can overcome the variability in occupant individual preferences. An analysis of occupants worldwide shows that the standard deviation among people is 3K at any ambient temperature. PCS has the corrective power to overcome this, and in addition can create alliesthesia –pleasure perceived from thermal corrections in spatial and transient environments.

Over the past 15 years, at the Center for the Built Environment at UC Berkeley, we have designed/built/lab-and-field-tested several energy efficient PCSs. The maximum 14-Watt heating and 3-Watt cooling chair can broaden ambient temperature setpoints by 6K. Field studies show that PCS can improve occupants' satisfaction rate from about 50% to 80%, while reducing HVAC energy use up to 50%.

Pushing for the maximum efficiency in PCS systems, we have measured and mapped the thermal sensitivity to warming and cooling across the entire human body. The maps allow designers of PCSs and thermal wearables to efficiently address the most sensitive areas of each body segment, maximizing their effectiveness.

International Standards for Indoor Environmental Quality: Similarities and Differences

BJARNE W. OLESEN
Professor, PHD, Dr. H.C., R
International Centre for Indoor Environment and Energy, Technical University of Denmark

The quality of the indoor environment is an important parameter to account for in new and existing buildings due to the increasing number of people spending more than 90% of their time indoors. Generally, the design and evaluation of indoor environment in buildings rely on appropriate standards, building codes and guidelines. National and international IEQ standards specify indoor environmental conditions considered healthy, comfortable and productive to most occupants. Recently two new international standards were published, EN 16798-1 "Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics ", and ISO 17772-1 "Indoor environmental input parameters for the design and assessment of energy performance of buildings". Both are very similar and accompanied by a Part-2, which is a guideline. The present talk will review and critically compares the requirements for IEQ parameters for non-residential and residential buildings across international standards such as ISO, EN and ASHRAE and national standards of China, India, Singapore and Australia with emphasis on indoor thermal comfort and ventilation for indoor air quality.

The critical analysis of IEQ standards demonstrates the similarities between the numerical ranges of categories across standards. This can be the because the regional standards are influenced by the international standards, that are based on the same research conducted in the past mostly in the US and Europe. Therefore, regional differences due to factors such as climate, building typology, demographics, and culture are not be directly addressed. Most of the standards provide recommendations for various IEQ parameters by focusing on perception of IEQ by occupants rather than productivity and wellness as quantitative criteria.

Effective Energy Transition: An Adaptive Architecture View for Sustainable Long-term Management

OVIDIU NORAN
PhD.Eng
Institute for Integrated and Intelligent Systems, Centre for Enterprise Architecture Research and Management
Griffith University, AUSTRALIA

Climate change, population growth, changing energy consumption patterns and the emergence of feasible renewable energy sources has prompted governments worldwide to set targets for carbon emission reductions and consequently, energy efficiency and use of renewable energy. The transition to 'zero emissions' energy production presents significant opportunities but also caveats in relation to maintaining the balance of the 'energy triangle' aspects, namely economic, security and environmental sustainability. As the challenges ahead are beyond individual governments, a collaborative approach is imperative; however, while global climate agreements are defined and adhered to, various regions and countries find themselves in different economic, cultural and geopolitical situations which require customised approaches. Global organisations such as the World Economic Forum have worked towards enabling worldwide communication and readiness tools to guide local energy transition decision-enough transition is likely to take significant time, enough for new and disruptive technologies to emerge; therefore, it is not advisable to design a purely technical solution that would not be viable in the long run. However, in view of past project failures stemming from the lack of adequate strategic guidance for the parties involved, it would be helpful to build on- and complement the helpful, albeit high-level artefacts developed by various global organisations with strategic plans satisfying and abiding by principles that maximise the chances of success in view of the expected extensive length of such transitions. Importantly however, in this case strategic planning must follow a method that is transferable between geographical regions and their maturity levels in respect to the local 'energy triangle'. This address will describe challenges and highlights of planning such a strategy, possibly including transition impact on stakeholders, guiding principles for the solution architecture and a dynamic business model describing how governments could organise a Portfolio establishing the energy transition programme and its projects.

Decarbonising the built environment: does it make us healthier and happier?

CĂTĂLINA TURCU
Prof. Assoc. PhD. Arch
Sustainable Development and Urban Planning, The Bartlett, University College London, UK

The built environment can contribute significantly to climate change mitigation. Buildings account for 30% of primary energy consumed as well as 30% of OECD greenhouse gas emissions, which have continually increased since the 1960s. At the same time, the built environment has an important bearing on human health and well-being outcomes. It aims to provide safe, secure and comfortable shelter for human habitation and daily activities; plays an important role in public health; and is central to addressing poverty, equity and affordability issues, which are closely related to physical and mental health and well-being.

This public lecture claims that, first and despite synergies, decarbonisation and health and well-being policy in the built environment are currently pursued separately; and, second, they are both likely to focus on the building scale. A twofold argument is then made: aligning these two policy areas can contribute to achieving mutual benefits and reducing trade-offs; and a comprehensive built environment perspective is needed which also considers the wider scale of neighbourhoods and cities. Several current built environment policy initiatives and performance measurements are referenced throughout in order to highlight synergies for alignment, trade-offs mitigation and ways forward.

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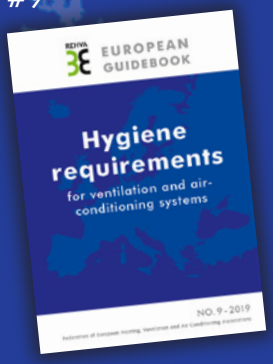

Hygiene requirements for ventilation and air-conditioning systems

Completely Revised 2nd Edition

This Guidebook specifies hygiene requirements from an interdisciplinary perspective, taking into account constructional, technical and organisational factors in the fields of planning, manufacture, execution, operation and maintenance of ventilation and air-conditioning systems and air-handling units. These requirements primarily serve to protect human health.

#27

HVAC Commissioning Process

This Guidebook describes the HVAC Commissioning Process compatible with the routines in the building sector almost everywhere around the world. This is the first work that both describes the process in a very hands-on manner and details the commissioning activities for various types of systems, complete with theoretical background, guidance & checklists.

#28

NZEB Design Strategies for Residential Buildings in Mediterranean Regions - Part 1

The aim of this guidebook is to develop a basic framework of a design guideline for planners, designers and engineers involved in the passive/architectural design of buildings and the selection process of the HVAC systems to deliver the most appropriate and cost-effective solutions for NZEB in Mediterranean climates. This guidebook is based on national experiences and the set of principles that drive the design approach for NZEB accounting for the specific climate.

#29

Quality Management for Buildings

This guidebook gives a brief overview on quality management services Technical Monitoring (TMon) and Commissioning (Cx) to building owners, developers and tenants. Avoiding technical details, it shows the tremendous economic potential, gives insights on the most important technical aspects and provides hands-on advice for application in projects.

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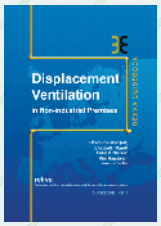

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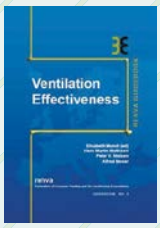

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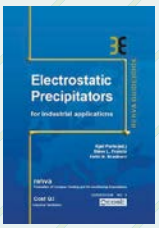

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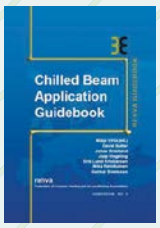

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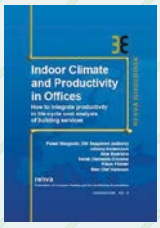

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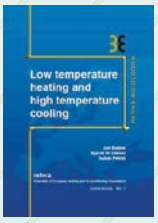

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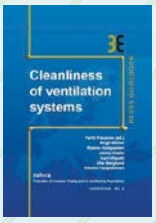

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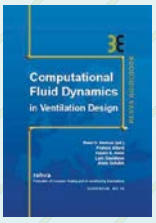

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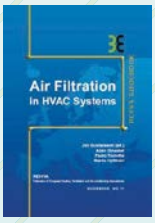

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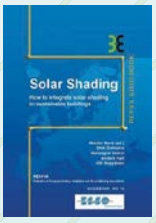

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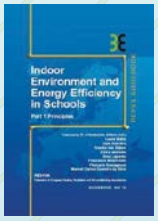

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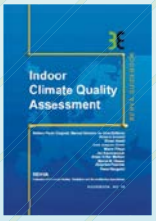

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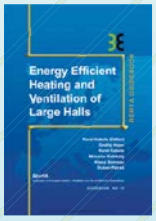

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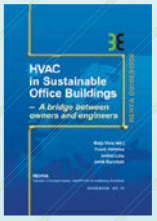
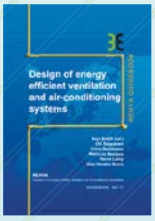


No.16: HVAC IN SUSTAINABLE OFFICE BUILDINGS



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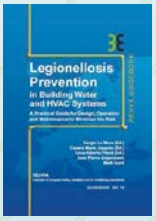

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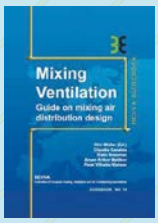
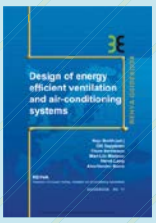


No.19: MIXING VENTILATION

No.20: ADVANCED SYSTEM DESIGN AND OPERATION OF GEOTABS BUILDINGS

No.21: ACTIVE AND PASSIVE BEAM APPLICATION DESIGN GUIDE



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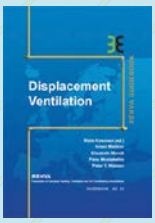

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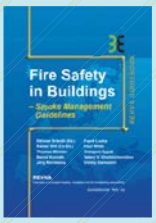

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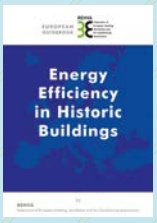
No.25: RESIDENTIAL HEAT RECOVERY VENTILATION



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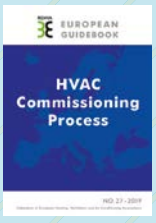

No.27: HVAC COMMISSIONING PROCESS (REHVA-ISHRAE)

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