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Special August Issue

Results of REHVA Annual Meeting and Clima 2013 Conference

REHVA New president and board members

All about indoor environment and performance

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Venue of the Conference and REHVA Dinners.

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Successful Clima 2013 Conference

OLLI SEPPÄNEN, Professor, Editor-in-chief

Clima 2013 World Conference organized in Prague was a success. 656 out of 702 accepted papers were presented at the conference. The papers were reviewed by the members of the scientific committee and other international experts. A total of 230 reviewers participated in the review process of the proposed papers. The papers were presented to 955 participants from 60 countries in several sessions with long and short presentations and posters. The sessions were chaired by 162 experts.

The most common topic of the papers was Energy Efficiency of Heating, Ventilating and Cooling of Buildings (23%). An almost equal number of presentations dealt with Good Indoor Environment (22%). It is an excellent sign that the experts see energy efficiency and good indoor environment as equally important. The importance of healthy indoor air was also recognized in the European Commission´s 'The Air 2013' Campaign. Politicians are paying more and more attention to healthy indoor environment – action plans are still missing but policy documents are under discussion. Indoor Environment is not only a question of the health of building occupants but also a question of productivity and performance of the occupants. These effects are well summarized in an article in this issue.

In addition to the normal technical sessions, REHVA organized 25 workshops parallel to the technical sessions; in addition, three seminars were held during the conference and some training sessions before the conference.

REHVA annual meeting took place just before the Clima Conference with the normal agenda. The new president, Professor **Karel Kabele** from the Czech Republic, was installed and two new members were elected to the Board – **Frank Hovorka** from France and **Manuel Carlos Gameiro da Silva** from Portugal. Their interviews, published in this issue, show that in the near future REHVA will focus on the same issues as before but will lay more emphasis on cooperation with its members, other organisations and the building industry. These activities include increasing the number of events, technical reports and perhaps position papers, which would be important independent sources of reliable information on topical issues for decision makers. Education and training will also get more attention during the coming years. REHVA will continue to develop educational material and encourage students to join REHVA activities through its members. The article by the winner of the student competition in Prague in 2013 shows the high quality of the thesis work and the relevance of the topics of theses for all EU member states.

REHVA Committees met again during the annual meeting. The results of the committees and REHVA Task Forces were reviewed and made available to the members; among these are three new REHVA Guidebooks on Mixing Air Distribution, Geotabs (Use of Ground Heat Storage with Heat Pumps), and Prevention of Legionellosis in Water Systems. These are available at the REHVA website. In addition, a report on Net Zero Energy Buildings was published. The report started a discussion on how to define renewable energy sources while evaluating building energy performance, with a focus on how to define and accept the 'near-by' use of renewables in the net energy balance.

All the papers presented in the Clima2013 Conference, totaling 6882 pages, will soon be available in various formats. The papers will serve as a reliable source of information for energy efficient buildings for years to come. The workshop summaries will be available soon as a REHVA report.

At the end of the closing session, the next Conference Clima 2016 was announced: Aalborg, Denmark, May 22-25, 2016. ■

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Effects of indoor environment on performance

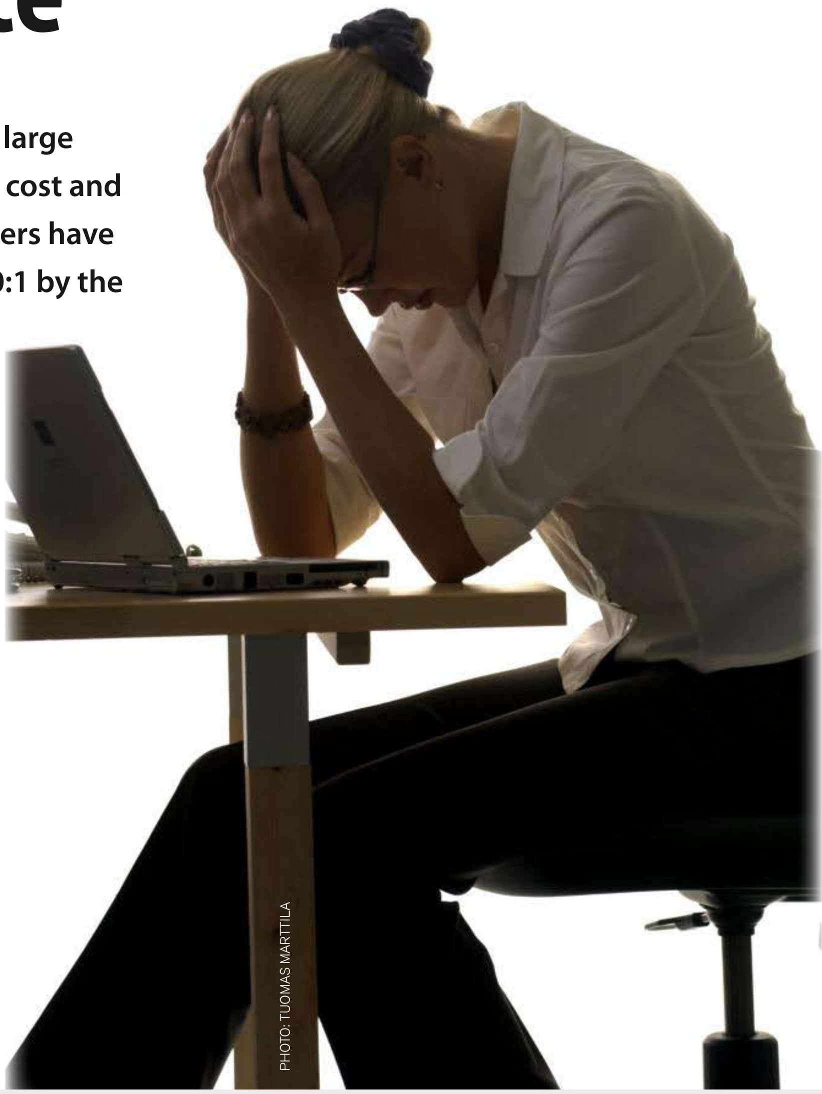

PHOTO: TUOMAS MARTTILA

Thermal and air quality control account for a large proportion of any commercial building's first cost and subsequent operating costs, so HVAC engineers have learnt to argue that they are outweighed 100:1 by the economic value of their positive effects on occupant performance, any positive effects on health and comfort being cited as additional benefits.

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Engineers are used to having to act on incomplete evidence, but if they are wise they like to have this evidence reviewed for them by specialists in any field that is outside their own experience and training. As experienced researchers in this particular field, we are often asked to give our best estimate of how and to what extent performance is affected by different aspects of indoor climate, so we now offer this very brief summary of our personal opinions, in the form of answers to 40 frequently asked questions (FAQs). Our answers are based on the results of the behavioral experiments that have been conducted to date. We offer no opinions on the long-term health effects of indoor environmental quality. We provide some references to where the relevant findings and a discussion of them may be found, but there is not enough space for all such references. We also list some questions we cannot answer as topics for future research in this area.

Relevance

Q1 Why should we be interested in thermal and air quality effects on performance?

There are four main reasons:

1) It is the added value of occupant performance that pays for indoor environmental quality (Fisk et al., 2011);
2) Performance is affected in the short-term by the combined effects of all indoor environmental factors, while subjective and physiological responses are usually selected because they are a function of one specific factor;
3) It turns out that thermal and air quality effects on performance can be observed even when there are no observable effects on comfort or on health-related symptom intensity (Wargocki et al.; 2004; Wyon, 2004; Wargocki and Wyon, 2006); and
4) The primary purpose of factory, office and school buildings is to provide an optimal indoor environment for work and for learning to work.

Effects

Q2 What effects do raised temperatures and poor air quality have on performance?

We have found that they usually reduce the rate of working, with little or no effect on accuracy (Wyon, 2004; Wargocki and Wyon, 2006).

Q3 Why is that?

In our experience, because people tend to reduce their rate of work until they are again able to achieve an acceptable error rate.

Q4 What aspects of mental work are affected?

In general, tasks that require concentration (clear thinking and symbolic manipulation), memory and original thought (Wyon, 2004; Tham and Willem, 2005; Lan et al., 2011).

Q5 Are all kinds of performance affected to the same extent?

Most mental work involves concentration and is thus likely to be similarly affected.

Q6 What are the exceptions?

Excessive concentration can impair recognition memory and creative thinking, so as moderate warmth leads to lowered arousal it can paradoxically improve the performance of work that includes such tasks.

Q7 Does low relative humidity (RH) affect performance?

Not always, although levels below 15% RH were found to impair visual acuity and the performance of tasks requiring continuous acquisition of visual data, which are both crucial in process control, driving, piloting an airplane and work with PCs (Wyon et al., 2006).

Mechanisms

Q8 How do raised temperatures affect performance?

Raised temperatures have been found to increase end-tidal CO_2 ($ETCO_2$ is an indicator of mild "acidosis", which is an increase in the concentration of CO_2 in the blood) and to decrease oxygen saturation in blood (SpO_2), both of which are likely to be detrimental for mental work (Lan et al., 2011).

Q9 How does poor air quality affect performance?

Poor air quality may lead to mild acidosis, exactly as raised temperature does, because it has been found to reduce CO_2 emission from occupants (Bako-Biro et al., 2005). If so, this may be why both factors have such similar effects. Satish et al. (2012) have recently shown that increasing the ambient CO_2 concentration artificially can decrease performance, suggesting that ambient CO_2 may have to be regarded as a pollutant instead of as an indicator of low outdoor air supply rate.

Magnitude

Q10 What is the magnitude of the negative effects of the indoor environment on performance?

For adults, up to 5% in the laboratory (Wyon, 2004), up to 10% in the field (Wargocki et al., 2004). For schoolchildren, over 20% (Wargocki and Wyon, 2006).

Q11 Is work in transportation environments similarly affected?

It would seem so, as driver vigilance was found to be reduced by up to 30% by warmth in field intervention experiments lasting only 1 h (Wyon et al., 1996).

Q12 What are the estimated costs of allowing poor IEQ to reduce performance?

As staff costs per unit of floor area exceed operating costs by 100:1, the effects observed are seldom negligible (Fisk et al., 2011).

Q13 Surely children are less affected than adults because they are young and healthy?

We have found that their performance is more affected, not less, and believe that this is because children in school are by definition doing work that is new to them, while adult workers are usually very familiar with the work they do and thus are better able to cope with environmental effects that make their work more difficult.

Q14 Is factory work likely to be less affected by thermal and IAQ effects than office work?

We believe not, as most workers in modern factories have to interact with computers, just as office workers do.

Methodology

Q15 Does laboratory research really predict what happens in practice?

Many field studies have found that the negative effects of poor working conditions are greater in real workplaces than would have been predicted from laboratory experiments (Wargocki et al., 2004; Tham and Willem, 2005). This may be because laboratory experiments use paid subjects, who tend to exert more effort than they would routinely in the course of a necessarily brief laboratory exposure to poor IEQ.

Q16 Why do some laboratory experiments show no effects on performance?

If subjects are highly motivated they can sometimes maintain performance during short exposures to poor indoor environmental quality. Negative effects on fatigue may then be found instead. Additionally, some studies may simply have missed the subtle changes in performance that are caused by slightly sub-optimal indoor environmental conditions.

Q17 Do performance tests really predict productivity?

Logically, yes, and, although environmental effects on component skills have yet to be validated as predictors of overall productivity, call-centre results use "bottom-line" measures of the call volume achieved in practice (Wargocki et al., 2004; Tham and Willem, 2005), and schoolwork is what children do in school (Wargocki and Wyon, 2006; Haverinen-Shaughnessy et al., 2010; Bako-Biro et al., 2012).

Q18 Do field intervention experiments predict what happens in practice?

Yes. Field intervention experiments examine directly what does happen in practice, often over periods of several weeks or even months. Tests of year-end educational attainment have been found to support predictions based on short-term intervention experiments in classrooms (Wargocki and Wyon, 2006; Haverinen-Shaughnessy et al., 2010).

Q19 Can experiments of limited duration predict what happens in practice?

It depends on the length of exposure. Most continuous work is in fact performed in periods lasting less than 5 hours, followed by a break, and even laboratory experiments may include 5-hour exposures.

Q20 Does a decrease in the performance of schoolwork indicate reduced learning?

Not proven. But surely schoolwork is assumed by teachers to promote learning? Test scores used by teachers and regulators to observe progress in learning have been found to correlate with spot measurements of ventilation (Haverinen-Shaughnessy et al., 2010).

Q21 Are research findings on performance from Northern Europe valid in warmer climates?

Yes. Very similar results were obtained when the same experiments were repeated in Singapore (Tham and Willem, 2005).

Indicators

Q22 What seems to be the most reliable indicator of indoor air quality effects on productivity?

Until we know which pollutants are causing the negative effects on people, the outdoor air supply rate per person seems to be the most reliable indicator (Seppänen et al., 2006).

Q23 Can indoor air quality as assessed by visitors predict performance?

It has been experimentally shown that it does (Wyon, 2004), except in the case of pollutants with no odor.

Q24 Can subjective assessments of indoor air quality by occupants be used to predict performance effects?

No. Sensory habituation ensures that increasingly poor air quality may be underestimated, except by visitors (Wyon, 2004).

Q25 Can occupants reliably assess their own productivity?

So far there is no reliable evidence that they can. Self-estimated productivity may simply indicate the effort they are aware of exerting (Wyon, 2004), and/or wishful thinking and a desire to placate management.

Q26 What is the most reliable indicator of thermal effects on performance?

Air temperature is not a reliable indicator in any absolute sense, because performance is a function of the heat balance of the body (which is affected by clothing, metabolic rate, air velocity, etc.), but in a given work situation it is a very useful basis for comparison. In the cold, manual dexterity is progressively impaired as the body actively reduces finger temperature to conserve heat, and in slightly warm conditions, mental performance has been found to decrease when finger temperatures approach their maximum value of about 36C and sweating must be initiated to maintain the body's heat balance. Finger temperatures in the 30-34C range are therefore a reliable indicator that thermal conditions are optimal for most kinds of performance.

Q27 Do occupants' assessments of thermal discomfort predict effects on performance?

Not always, because they may be able to avoid discomfort by working less. This implies that the adaptive model of thermal comfort should NOT be used in isolation to justify energy conservation measures, because that could lead to conditions that cause sub-optimal performance and productivity (Lan et al., 2011).

Q28 Can we use sick building syndrome symptoms to predict effects on productivity?

Yes, in theory, because they do co-vary. But the data is still too meager to create a robust relationship (Tham and Willem, 2005).

Q29 Is absenteeism a useful indicator of effects on productivity?

Poor ventilation does increase absenteeism (Milton et al, 2000), but so do many other factors.

Mitigation

Q30 Is there a simple way to avoid indoor air quality effects on performance?

Generations of experienced teachers ensured that children spent brief but regular periods in fresher air, i.e. outdoors, even in cold weather. Although this strategy does not seem to have been validated experimentally, our view is that it might work just as well for adults as for children.

Q31 Can the presence of windows that can be opened provide this effect?

No, because they will not be opened spontaneously unless it is also warm and because opening windows will often be seen as a waste of heating or cooling energy.

Q32 Can personalized ventilation providing fresh and cool air directly to the breathing zone be used for this purpose?

Yes, to the extent that users are aware that ambient conditions are sub-optimal.

Q33 Does increased outdoor airflow always improve performance?

No. It can even have the reverse effect if it passes through particulate filters that are full of dust (Wargocki et al., 2004).

Q34 Does airborne dust affect performance?

There is no evidence that it does, even though dust is expected to have negative effects on chronic health problems. Short-term effects of poor air quality on the performance of school work remained after airborne dust had been removed, so the negative effects observed were attributed to gas-phase air pollutants (Wargocki et al., 2008).

Q35 Can we allow indoor temperatures to drift upwards, to conserve energy in buildings?

No, because negative effects on performance will increase progressively, even if some subjective habituation takes place (Kolarik et al., 2009).

Q36 Are thermal effects on performance a function of air temperature only?

No. They are a function of the heat balance of the body.

Q37 Does this mean that it may be possible to maintain performance at raised temperatures?

Anything that increases heat loss from the body makes raised air temperature more tolerable.

Q38 What about physiological acclimatization to heat?

Physiological acclimatization to heat requires hard physical exertion well beyond what is necessary for the performance of office work.

Going forward

Q39 What are the most commercially important questions for future research?

We have identified the following 10 high priority research topics:

1) Are the combined effects of temperature and indoor air quality additive?
2) How does performance vary with self-estimated performance?
3) Which component skills are affected by indoor temperature and air quality effects?

4) Is high-level work involving decision-making and creative thinking similarly affected?
5) Are leisure activities negatively affected by poor indoor environmental quality?
6) Is sleep affected by temperature and IAQ and if so does this affect next-day performance?
7) What is the economic impact of all these effects on different kinds of productivity?
8) What is the most cost-effective way to reduce the negative effects of poor IEQ?
9) How can energy be conserved without affecting performance?
10) How do energy certification schemes affect productivity?

Q40 Which underlying mechanisms are worth investigating?

We believe that that the following 4 topics should be addressed by future research:

1) Do thermal and indoor air quality effects on acidosis decrease performance?
2) Is the acidosis caused by shallow breathing or by decreased gas exchange in the lungs?
3) Which gas-phase indoor air pollutants have this effect, and can it be prevented?
4) Are any other mechanisms involved?

ACKNOWLEDGMENTS

The preparation of this paper was supported by the research funds of the International Centre for Indoor Environment and Energy.

REFERENCES

The references are in the web version of the article at www.rehva.eu ■

Nearby use of renewable energy sources – an alternative for on-site production

Definition of nearby renewable energy production was lively discussed during CLIMA 2013 congress in Prague. nZEB workshop at CLIMA 2013 revealed that the only available, somewhat complete nearby definition is the REHVA definition, published in REHVA REPORT NO 4, some specification is also available in draft overarching EPBD standard prEN15603:2013.

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CEN definition

"Nearby" is addressed in EPBD recast stating that a very significant amount of energy used in nZEB buildings has to come from renewable sources produced on site or nearby. In prEN 15603:2013 "nearby" is defined as an energy source which can be used only at local or district level and requires specific equipment for the assessed building or building unit to be connected to it (e.g. district heating or cooling), **Figure 1**. Allocation to the building is not defined through the contractual and ownership questions, but just by the connection (cable or pipework). The possibility to use different primary energy factors than these of distant production is mentioned but not further specified.

REHVA definition

REHVA definition, which is 100% technology neutral, allows also to utilize a public grid, and puts more focus to allocation to the building, **Figure 2**. Nearby production is defined as thermal energy, or electricity which is distributed through a specific or public network (located outside the building site). It is distinguished that for example for district heat (which is by the definition nearby production) two cases exists. If just connected to district heating network as a common client (fulfills prEN15603:2013 requirement of the physical connection), the primary energy factor of the district heating network mix has to be used. In such a case there is no difference to "distant", i.e. district heat is just considered as any other delivered energy carrier. (This is also a problem of prEN15603:2013 specification, where the difference between nearby and distant is not clearly de-

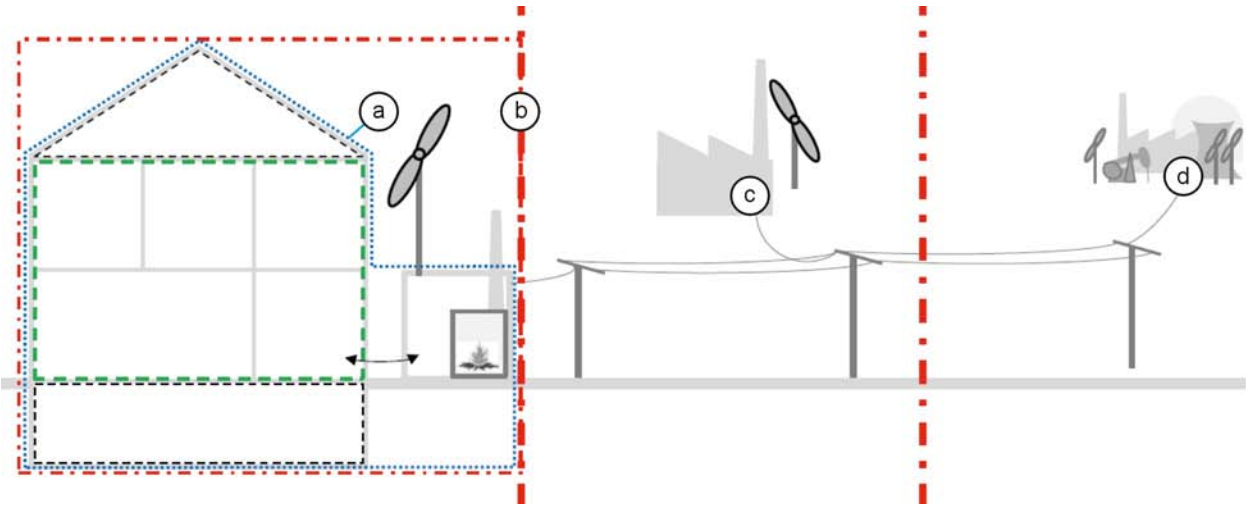

Figure 1. prEN15603:2013 defines energy balance of a building (a), on site perimeter (b), nearby (c) and distant energy production (d).

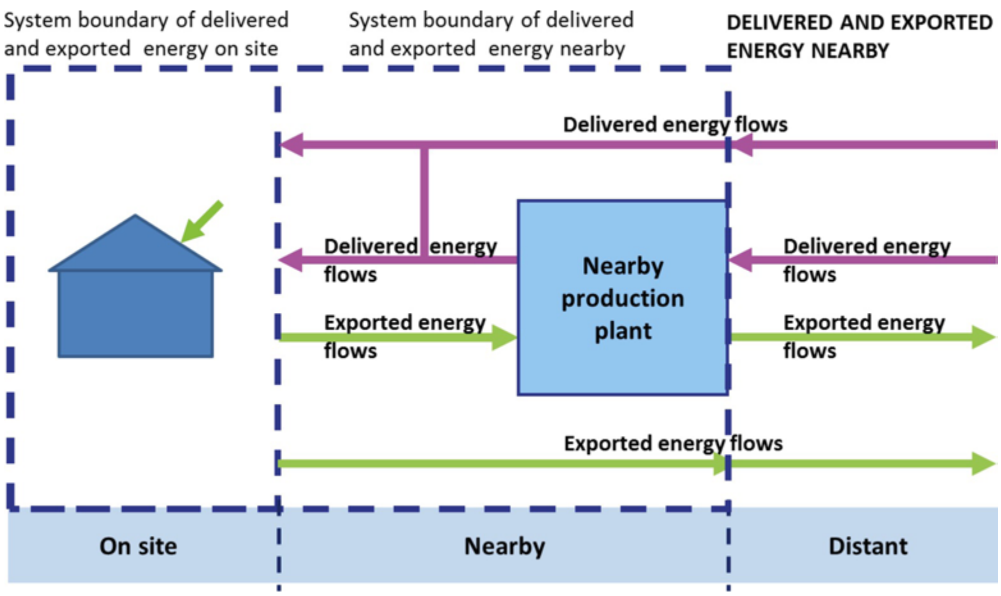

Figure 2. REHVA definition provides for nearby production invested by the building owner an equal treatment compared to on site production. There are no technology limitations, a public grid or district heating or cooling networks can be also used to connect a new renewable energy capacity to the building and to utilize with a primary energy factor related to this new capacity.

fined.) Another, the actual nearby case, is to link contractually the new district heat plant capacity, invested by the building owner (a share of a new plant or a modernized existing one with a new renewable fuel), to the building. In such a case, the primary energy factor of a new plant or modernized existing one can be used, and this can be much lower compared to the district heating network mix. The same principle applies for any kind of nearby production in REHVA definition. Another good example is the share of a wind farm – a building owner can invest and utilize corresponding wind electricity with low primary energy factor.

Extended "near by renewable" definition needed for large buildings

Strongest need for nearby production was seen in larger developments or high rise buildings. When speaking about nZEB houses, on site solutions are easy to use. But in larger buildings, on site solutions may be less efficient (at least on energy system level) and more expensive compared to nearby ones. Therefore developers and construction companies need tools, definitions and regulations to consider nearby solutions. If cannot be utilized in energy performance certificates and compliance assessment, nearby solutions will not be competitive. Wider importance of nearby solutions was seen as to provide a real addition to renewable energy production capacity and it was generally recognized that "nearby" needs more regulatory effort compared to on site solutions.

To utilize REHVA nearby definition, corresponding regulatory framework is needed. It must be possible to allocate the new capacity to the building for a long term, which could be a service lifetime of the plant, needed also to be defined nationally. Otherwise there will be a risk of green wash renewable energy products, which may not be based on new renewable energy capacity, i.e. not making a real addition to renewable energy production.

Flexible definition will increase the use of renewables

It is important to notice, that two described nearby options (a common client vs. investment to new capacity) have basically no differences regarding the maintenance and operation of the plants. In any case, whatever nearby plant will need an operator as out of site and serving many buildings. Operation and maintenance cost is usually included in the energy price, as it is today for district heat or grid electricity. Because "nearby" energy may be more expensive than that the district heating mix, there are duties for both sides. The client has to commit to buy renewable energy and the provider to produce and maintain the plant.

Until national regulations can catch up the nearby possibility launched by EPBD, the only way for developers and construction companies seems to buy the renewable energy certificates from energy companies and require to delete these after the contract is done – then this capacity is allocated to the building for a contract period and the building owner has to pay in addition to the investment for renewable energy to energy company. Indeed, such nearby renewable energy, invested by the building owner, cannot be utilized in the primary energy indicator calculation, until not included in the regulation. ■

References: See the complete list of references of the article in the html-version at **www.rehva.eu** -> REHVA Journal

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REHVA Workshops at CLIMA 2013

- Energy efficient, smart and healthy buildings

CLIMA 2013 Congress, was organised by REHVA Czech member STP in Prague under leadership of Prof. Karel Kabele, president. Theme of the congress was: "Energy Efficient, Smart and Healthy Buildings". The "Clima World Congresses" are the official conferences of REHVA, organised every third year by one of REHVA Member Associations.

As a part of the conference REHVA organised 25 Technical Workshops. The objective of the workshops was to provide an opportunity for two-way communication between the speakers and their audiences on the selected subjects. REHVA gave the floor to its supporters (AHRI; Belimo; Camfil; Caisse des Dépots; ES-SO; Eurovent Certification; Grundfos; Icade; Rhoss; Swegon; Uponor); sister organizations (CCHVAC; SHASE; ICIEE); related EU-projects (IDES-EDU; iSERV; 3Encult); and different REHVA taskforces from REHVA's technical and research committee. The REHVA Task Forces will further use the workshop results to develop European guidelines for improving the energy efficiency and indoor environment of buildings.

The workshops offered a platform for the skilled professional participants to enhance and update their technical knowledge, share their experiences and views, and reflect about the advancement of energy efficient HVAC technologies for buildings, including indoor environment, cost optimization, not only looking to optimal design criteria but also taking occupant behaviour into account, and intelligent management techniques. During the workshops, each participant was able to speak up their opinions and give a direct feedback, new ideas and another point of view to the workshop chairman about the workshop topic. For many WS-attendees it was 'refreshing' to be informed with practical knowledge for the engineer. In September, a report with a summary of most of the workshops will be published. The report include the workshops presentation and a summary of the discussions. It will be available on REHVA Guidebooks' Shop at www.rehva.eu.

VAV system with genuinely demand-controlled fans

"Ventilation systems that deliver increased comfort while consume less energy"

– wishful thinking or reality?

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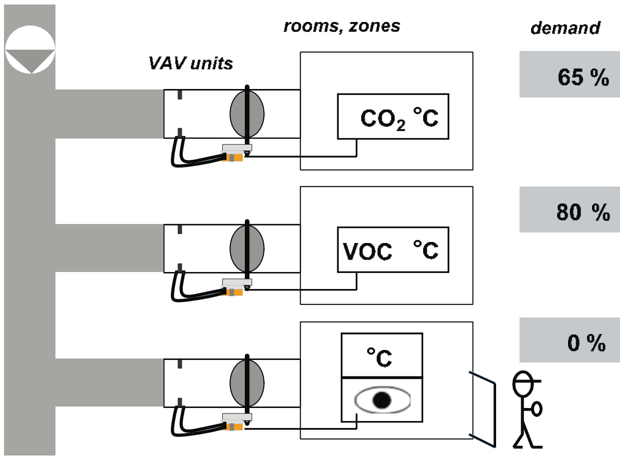
This article explains the disadvantages of duct pressure control in variable-volume ventilation systems and shows how they can be replaced with forward-looking, demand-controlled systems that comply with EN 15232, Class A*.

Demand-controlled ventilation (DCV) - benefits

Much has already been written about the benefits and possibilities of DCV systems. This technology measures the conditions in the room and calculates the amount of energy actually required. To do this, it uses sensors and control devices for CO_2, VOC, temperature, light and so on. The required volume of air is supplied to the room by precise volumetric flow controllers - a technology known as variable air volume (VAV).

If we look at the average consumption of typical room zones **Figure 1**, we can see that these are mostly operated at part load. The best efficiency point, the maximum flow rate, is only rarely needed.



Required air flow rate - time ratio over a one year periode

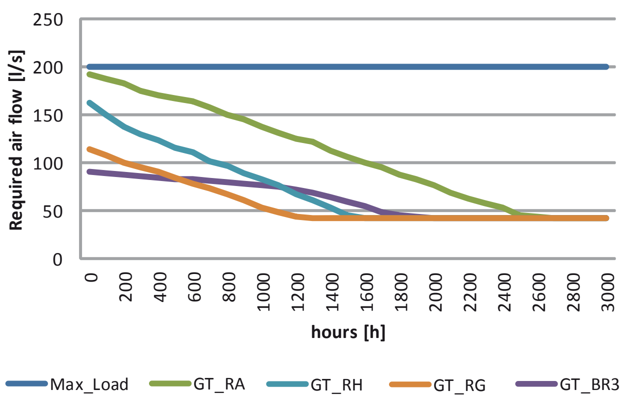


Figure 1. Most of the time the room units DCV system are working at part load.

Fan control

Efficient fan control is a vital part of a DCV system. To regulate fan output, frequency converter-controlled fans are increasingly being joined by EC fans. To adapt the fan power made available to the ventilation system, the DCV system must gauge the ventilation system's requirements and set a suitable set point. This is the weak point of traditional duct pressure control systems

* Energy efficiency class A in EN 15232 (Energy performance of buildings) stands for highly energy-efficient building automation and technical building management..

Figure 2 and the strength of the pressure feedback Fan Optimiser system **Figure 3**.

Duct pressure control

The setpoint *K* for duct pressure control **Figure 2.** corresponds to duct pressure *P1*, the pressure required to move the maximum air volume *V1* through the air duct system. The actual pressure is measured in the air duct, ideally at the most unsuitable point in the ductwork. Question: Where is the most unsuitable point in a variable-volume ventilation system? The answer is that it moves around the duct system according to the ventilation system's current load distribution. So it is only possible for the pressure sensor to be incorrectly positioned; it is usually installed immediately downstream of the fan.

The main drawback of this method is that the fan is controlled on an open loop basis. The volumetric flow V2 required at any given moment, is not used to calculate the set point as there is no feedback from the volumetric flow controllers available. The duct pressure and VAV boxes are operated independently of each other. If the volumetric flow is reduced from *V1* to *V2*, the pressure in the air duct system rises in line with the fan's characteristic curve. The pressure control system then brings the duct pressure back down to point *K*, the full load level; the correct, reduced set point *R* is unknown. The downstream VAV boxes are forced to eliminate the surplus duct pressure *P1-P2* by throttling the dampers. In practice, systems of this type sometimes contain VAV dampers throttled by up to 10% – see damper diagram **Figure 4**.

The result: excessive noise and unnecessarily high pressure losses in the air duct system, leading to excessive energy consumption by the fans.

Another disadvantage of pressure control is that every change in use and every adjustment to volumetric flow

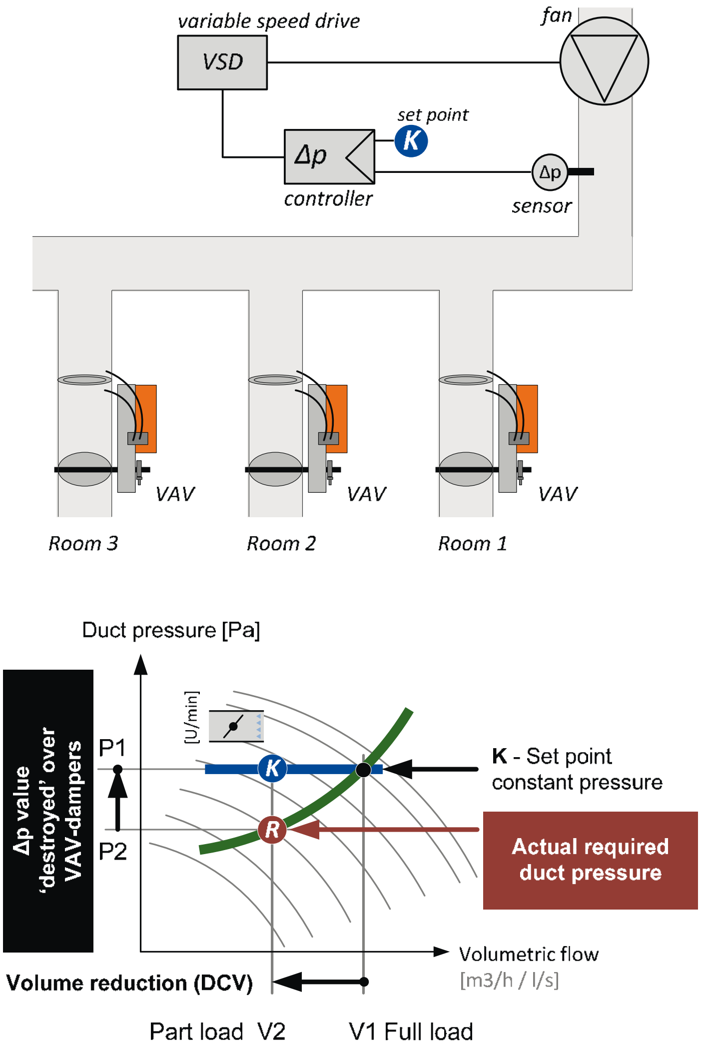


Figure 2. Duct pressure controlled VAV system: Open loop control.

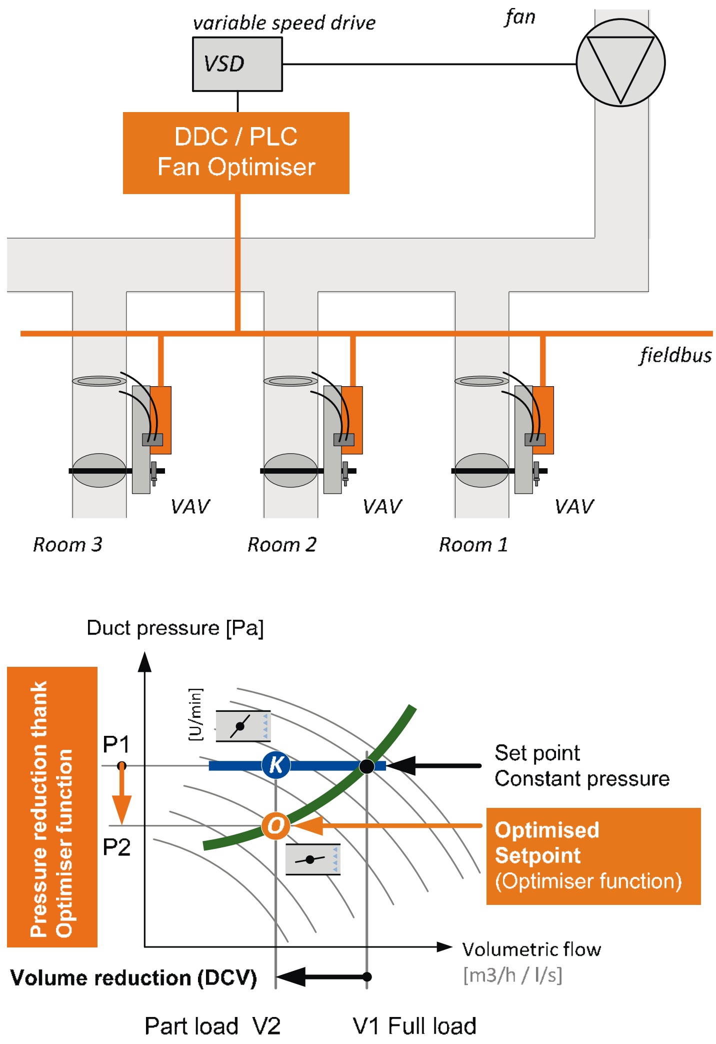


Figure 3. Pressure feedback, Fan Optimiser-controlled VAV system: Closed loop control.

requires a manual correction of the *duct pressure set point* parameter, which in practice usually does not happen – and this has consequences too.

Fan Optimiser – the pressure feedback volumetric flow control system

In a pressure feedback volumetric flow control system **Figure 3** the damper positions of the VAV-Compact controllers are gathered via a field bus (MP-Bus, LONWORKS®, Modbus, KNX etc.) and used as the trigger for energy-efficient control of the fans. The damper positions are evaluated by the Fan Optimiser function and the fans are brought down to the optimum set point *O* until most of the dampers are in the optimum operating range **Figure 4**.

Dampers close - falling demand / pressure too high, dampers open - rising demand/pressure too low: the fan is powered up or down accordingly following the ventilation system's characteristic curve (optimised set point *O*).

The result: less noise and reduced pressure losses in the air duct system, leading to considerably reduced energy consumption by the fans.

Damper diagram

The efficiency of both methods can be seen in the damper diagram **Figure 4**.

In the Fan Optimiser system, the lowered duct pressure *P2* takes strain off the system and helps to extend the lifetime of the actuators through the reduced number of part-cycles.

Further advantages:

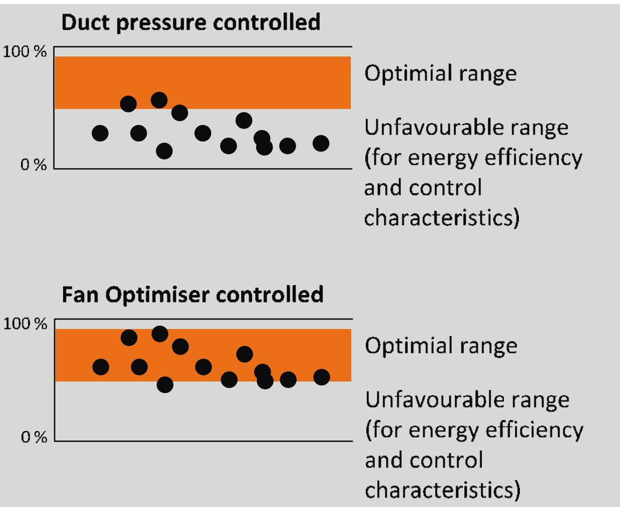


Figure 4. Damper positions: Duct pressure controlled versus Fan Optimiser controlled.

- A Fan Optimiser system automatically finds the required operating point at any given time, so there is no need for time-consuming balancing work of the duct pressure system.
- With Fan Optimiser technology, duct pressure controlled systems require no reserve Δp additions (such as compensation for filter contamination etc.).
- Changed system configurations due to a change of use etc. are detected automatically by the Fan Optimiser and taken into account in operation.
- Undersized systems will work as long as the required set volume *O* is less than the available volumetric flow. This is not generally the case with duct pressure controlled systems.

System design

Pressure feedback Fan Optimiser systems **Figure 3** can be designed in two ways:

a) DDC / programmable controllers: Bus master devices with custom-programmed Fan Optimiser application

b) Fan Optimiser hardware: Device with preconfigured, ready-to-use Fan Optimiser function, e.g. COU24-A-MP

In both variants the VAV-Compact controllers are integrated into the control system with a field bus (MP-Bus, LONWORKS®, Modbus, KNX etc.) and the Fan Optimiser function uses the damper positions to calculate the set point for the air supply.

If the system is configured as a bus system, or if a bus system is already installed, there are essentially no additional hardware costs. The duct pressure control equipment and laborious sensor positioning are not required for solutions a) and b).

Potential savings - Case study

The volumetric flow and its transport are determining factors for the energy consumption of the fans. The rules of proportionality form the foundation:

- Rule 2 describes the pressure reduction P1► P2: The pressure increase changes as the square of the volumetric flow ratio.
- Rule 3 describes the volume reduction V1► V2: The power consumption changes with the volumetric flow ratio.

Table 1 shows the result of a comparative measurement in an office building. A system integrator programmed the Fan Optimiser function into a DDC controller. The installed VAV-Compact controllers are connected to the

Table 1. Case study in office building: Duct pressure controlled versus Fan Optimiser system.

Control type	Fan	Duct pressure @ last VAV	VAV unit damper position	Var. speed drive frequency	Fan current	Consumption
- Duct pressure controlled	Supply fan	295 Pa	31…39 %	30.6 Hz	9.30 A	2,60 kWh
	Exhaust fan	250 Pa	21…43 %	28.7 Hz	9.21 A	2,47 kWh
					Fan Σ	**5,07 kWh**
- Fan Optimiser system	Supply fan	45 Pa	50…90 %	20.6 Hz	6.70 A	1,07 kWh
	Exhaust fan	20 Pa	47…90 %	18.6 Hz	5.87 A	0,77 kWh
					Fan Σ	**1,84 kWh**
Savings @ actual part load condition (!)						**-3,23 kWh (–64%)**

DDC controller by the integrated MP-Bus interface **Figure 3**. In addition to the Fan Optimiser function, the system also has conventional duct pressure control for taking comparative measurements. Either control function can be selected in order to compare the two strategies under identical operating conditions.

The measured difference on the chosen day was an impressive 64% saving. This result applies only to the specific time and conditions in place on the date in question (occupancy, refrigeration load etc.) Over the course of a year the savings would probably amount to between 20% and 50%, depending on the system and the part-load conditions (weather, internal loads, occupancy and so on).

If we calculate the savings over a year, for instance in a hospital or an apartment block with 24-hour operation 365 days a year, it is clear than the investment pays for itself very quickly. This is especially true in a planned or existing bus system which already has the necessary infrastructure.

Field of application

- Variable-volume ventilation systems for hospitals, offices, hotels, administrative and industrial buildings, etc.
- Variable-volume systems for controlled apartment ventilation. Fan Optimiser systems have already been used successfully in many such applications.

Benefits of a Fan Optimiser system

- Designed for the future – *EN 15232, Class A* compliant solution
- Open system – all CAV/VAV control functions are possible with CO_2, VOC, temperature, presence sensors etc.
- High level of comfort – no reduction in comfort or control quality
- Error compensation – compensates for some design errors
- No reserves necessary – thanks to automatic compensation (filter contamination etc.)
- Easy commissioning – the Fan Optimiser finds its own operating point
- Closed loop – integrated system from room demand to air supply
- Energy-optimised – reduced pressure loss in duct system
- Reduced noise – thanks to lower duct pressure
- Change of use possible – no adjustments required as long as total volume of air is sufficient
- Longer actuator lifetime – thanks to reduced duct pressure
- Short payback time – thanks to low fan operating costs
- Environmentally friendly – reduced energy consumption and CO_2

Conclusion

DCV systems are good news for zone-by-zone demand-controlled energy supply. To operate the whole variable-volume ventilation system efficiently, the fans also need to be fully integrated in the DCV system. The complete integrated system solution for this is the pressure feedback Fan Optimiser. From room level to air supply, it works on the principle of *only as much as necessary – not as much as possible!* ■

Comparative study of HVAC systems in hospitals: chilled beams and fan coils

The present study describes the methodology used for the determination of carbon emissions from HVAC systems in order to assess possible options for greener systems. Simple tools were developed and applied for this purpose [1] and a case study was performed on an inpatient ward of an hospital building located in Faro, Portugal, being considered fan coils and chilled beams as terminal units.

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The analyzed terminal units are part of an HVAC centralized air-to-water system composed of a chiller and gas boiler for cold and hot water production, an Air Handling Unit (AHU) and electric pumps for the hydraulic circuits.

HVAC Systems

Fan coils (FC) - compact high performance heat transfer units, consisting of a fan, return air filter, water coils and a condensate drain pan. Horizontal concealed units were considered, installed in false ceilings, supplied with 100% fresh air through an AHU.

Chilled beams (CB) - Active CB [2], which are the object of this work, are induction units linked to 100% fresh air circuit by an AHU and to the hydraulic system by water coils. Due to higher cooling water temperatures than the conventional 7/12ºC there is no need for condensate drain pan nor return air-filter, since the cooling process is not followed by dehumidification or condensation.

Given the terminal unit location (**Figures 1 and 2**) and its air diffusion conditions, it was admitted a ventilation efficiency of 100% for CB and 80% for FC.

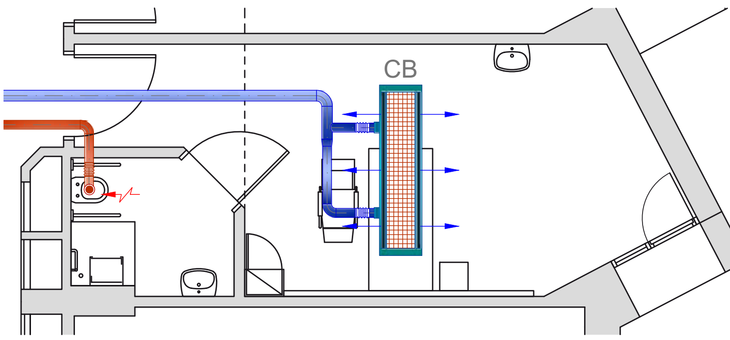

Figure 1. Chilled beam location in hospital bedroom.

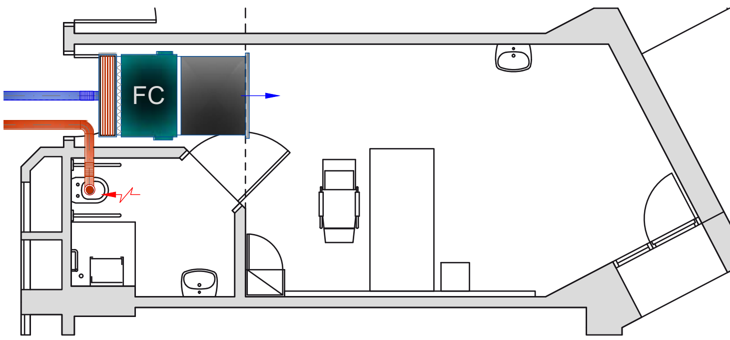

Figure 2. Fan coil location in hospital bedroom.

Methodology

Annual thermal needs - The method used for calculating thermal needs was based on thermal load and annual energy balance methods, adapted from former Portuguese Decree-Law No.40/90, with the introduction of some parameters from former Portuguese Decree-Law No.118/98 and adjustments regarding the Portuguese Decree-Law No.79/2006, in order to meet the latest regulation requirements. Some parameters were also introduced to estimate the actual operation of the HVAC system.

This solution was adopted, rather than a detailed computer simulation, since it's intended to develop an expedite tool for predicting energy consumption, allowing a simple way to compare two systems, in order to obtain gross comparable values.

Degree-day and humidity-day - To determine the annual thermal needs it's necessary to consider a set of climatic data representative of the building's location, being used for this purpose the database of *Solterm* Portuguese software. Determination of temperature annual evolution was based on Degree-Day concept. Since this concept only allows to estimate sensible needs arising from the difference of temperatures, a new concept is introduced, **Humidity-Day**, in order to estimate latent needs arising from the difference of absolute humidity - particularly because the compared units, namely CB, require humidity control. It was assumed that, generally, latent needs in the cooling period are due to dehumidification and in the heating period due to humidification.

Electrical and gas consumption – Energy consumption of HVAC equipment was calculated taking into account data provided by suppliers.

Carbon emissions – Life cycle assessment methodology was used for calculating HVAC systems carbon emissions, considering the following stages:

1. Manufacturing of equipment;
2. Transportation of equipment;
3. Energy consumed during operation;
4. Maintenance activities;
5. Waste end-of-life disposal.

The calculation methodology adopted in this work, in particular emission factors, were based on the manuals provided by ADEME, referring to the *Bilan Carbone* method [3] [4], while still subject to some adjustments to the national context.

Results

The current study was carried out for a set of 106 terminal units, 4 circulation pumps and 1 AHU, over a 30 years life cycle, for each HVAC system.

Annual thermal needs - From the results, shown in **Figures 3 and 4**, the following items should be emphasized:

- The temperature difference guaranteed by the CB-AHU in the cooling period (T_{ins} = 15°C), higher than the temperature difference in the FC-AHU (T_{ins} = 22°C), implies that the energy carried by primary air in the CB system is higher, which represents a decrease of the local sensible needs, approximately 60% of the FC units thermal needs. Overall, sensible cooling needs of both systems are nearly identical, with a relative difference of 4%;
- Since CB units are unable to remove latent load, the CB-AHU must ensure additional dehumidification, contributing not only to fresh air latent load, but also to internal latent load. Thus, CB-AHU requires about two times more energy for dehumidification than FC-AHU;
- During the heating period, local needs are not important, showing a residual value of 4% on global needs, which may be a consequence of net heat gain from solar radiation, but mainly due to net internal loads, significant in such areas with permanent occupation.

Overall, global cooling needs difference of both systems is not significant, representing about 1%.

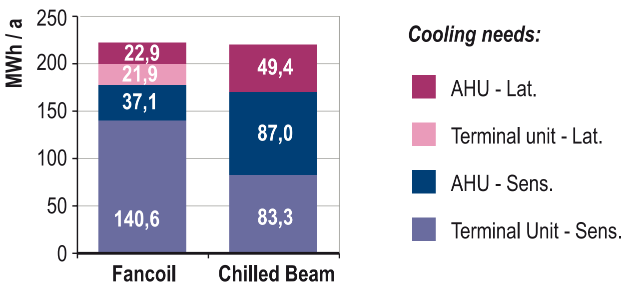

Figure 3. Cooling annual needs (MWh/year).

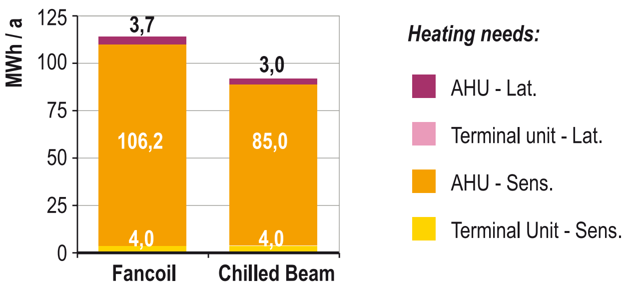

Figure 4. Heating annual needs (MWh/year).

Heating needs are significantly lower in the CB system, with a relative difference of about 19% - since the fundamental weight lies in the AHU sensible needs, it's not surprising that the relative difference between the two HVAC systems corresponds roughly to the difference between the fresh-air flows, and their considered ventilation efficiencies.

Energy consumption – Given the obtained results, shown in **Figures 5 and 6**, the following comments should be highlighted:

- In the overall balance, the annual cooling needs are approximately equal for both systems which represents identical electrical consumption for the chiller, with a relative difference of about 1%;

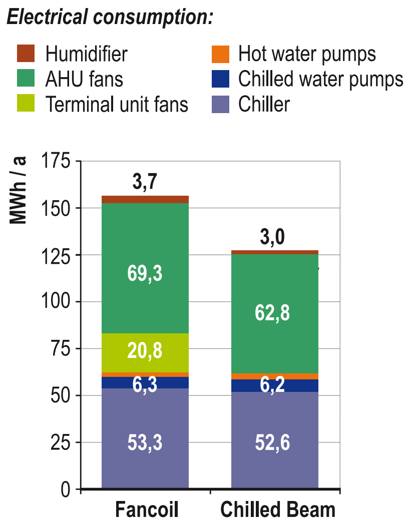

Figure 5. Electrical annual consumption (MWh/year).

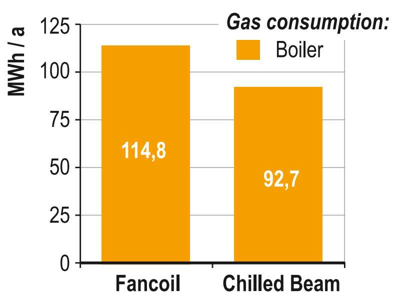

Figure 6. Gas annual consumption (MWh/year).

- CB application helps to reduce ventilation consumption by 30%, since the absence of motors in the CB units contributes significantly to its decline. With regard to AHU fans, despite the CB-AHU fresh-air flow represents 80% of the FC-AHU fresh-air flow, its electrical consumption are approximately equal, which is mainly due to the additional pressure loss of about 125 Pa in CB units.

Overall electrical consumption represents a relative difference of 18.5%.

Regarding boiler gas consumption, the relative difference between the CB system over the FC system is about 19%, a direct consequence of its heating needs.

Carbon emissions - Estimated emissions over a 30 years period are 879.0 ± 14% ton C_{eq} for the FC system and 707.0 ± 13% ton C_{eq} for the CB system. Looking at the proportions of the analyzed categories shown in **Figure 7**, it's clear that the main factor for emissions lies in the energy consumed during operation, corresponding to electricity and gas consumption, affecting about 95% of global emissions.

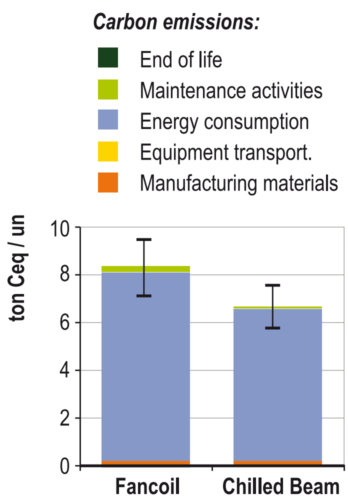

Figure 7. Global carbon emissions ($tonC_{eq}/un$).

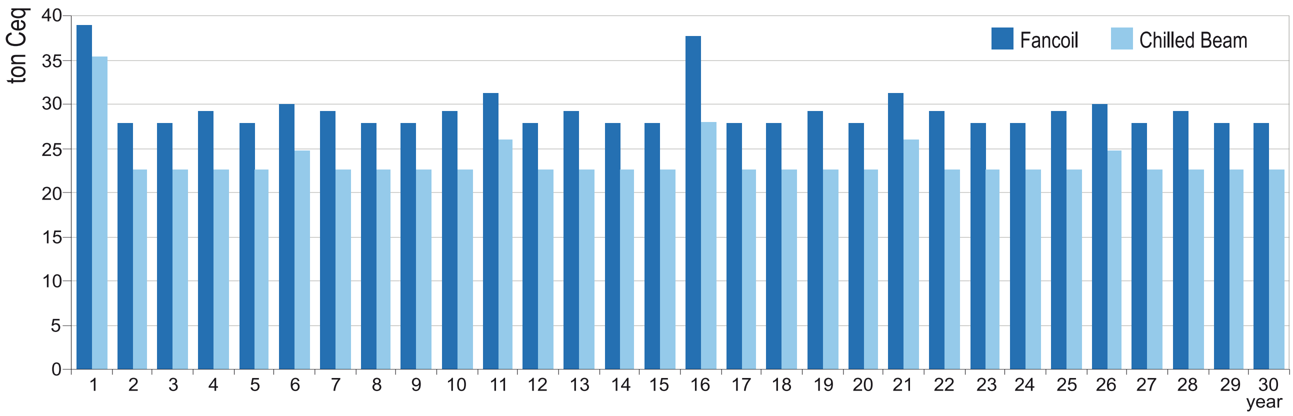

Figure 8. Distribution of carbon emissions in a 30 years period (ton C_{eq}).

The average annual carbon emissions distribution of both systems, shown in **Figure 8**, allows the following comments:

- Carbon emissions peaks for both systems occurs on the 1st and 16th year, when new HVAC equipment installation takes place, in particular, FC units and AHU, which have a 15 years average lifetime. CB manufacturing and transportation only contributes in the 1st year due to its 30 years average lifetime;
- In general, CB system carbon emissions have less fluctuation during the analysed period, which is due to less frequent maintenance operations, and so it's verified that the most important contribution takes place on the 6th, 11th, 21st and 26th year, when AHU motors and coils are replaced. Regarding the FC system, in addition to the mentioned maintenance operations, additional motors rewinding operation every 3 years and return-air filter replacement every 5 years contributes also to its carbon emissions.

Comments and conclusions

Using the developed tools for estimating energy consumption and carbon emissions, it can be concluded that:

Final energy consumption - CB system operation provides an annual reduction in energy consumption, 18.5% in electricity and 19.3% in gas, when compared to the FC system.

Carbon Emissions - In a 30 years life cycle the reduction of carbon emissions is about 20%, when opting for CB instead of FC, featuring per terminal unit, 8.3 ± 14% ton C_{eq}/ unit against 6.7 ± 13% ton C_{eq}/ unit. The main factor for emissions lies in the energy consumed during operation, affecting about 95% of global emissions.

Also worth noting is the concept of humidity-day that proves to be both effective and simple to use.

The results of this study reinforce the advantages of using CB in hospitals and contribute for their possible application in Portuguese hospitals, which were recently allowed to be considered by national health recommendations. ■

Acknowledgements

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A method to analyse the performance of residential ventilation systems

The article describes the concept of recommendations of ventilation systems for residential buildings developed by Polish National Energy Conservation Agency and Warsaw University of Technology. The evaluations are based on computer simulations.


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The system of recommendations uses two types of virtual reference buildings: 8 story multi-family building and 2 story single family building. Reference buildings are equipped with 2 reference ventilation systems: natural (passive stack ventilation) and mechanical extract ventilation (central fan). The reference primary energy use is an average value for two reference ventilation systems. Investigated ventilation systems, depending on percentage of reference primary energy use, get an energy class from A1 to D. Recommended system has to provide at least 30% of energy savings and at the same time has to ensure that during occupation required ventilation rate is supplied.

The Concept of Ventilation Systems Assessment

The National Energy Conservation Agency (NAPE) and Warsaw University of Technology (WUT) developed system of recommendations of ventilation systems based on evaluation of annual primary energy use (including auxiliary energy use) and air quality (with ventilation rates as a investigated parameter). The system is based on results of computer simulations performed for virtual reference building in reference weather conditions. The concept can be applied for different types of buildings, however - at the moment – the scheme presents sufficient maturity only for residential buildings.

NAPE scheme uses two types of residential reference buildings: multi apartment building and single family house. The plans were prepared as a compilation of most typical solutions observed in buildings designed or modernized during last 20 years with technical support of NAPE.

NAPE recommendation scheme for residential buildings is based on a comparison of the annual primary energy consumption (heating and auxiliary energy associated with ventilation) and the air volume (minimal, maximal and average value for outdoor air temperatures below +12 °C) for three scenarios (**Figure 1**):

- reference building with reference passive stacked ventilation,
- reference building with reference mechanical extract ventilation,
- reference building with analysed ventilation system.

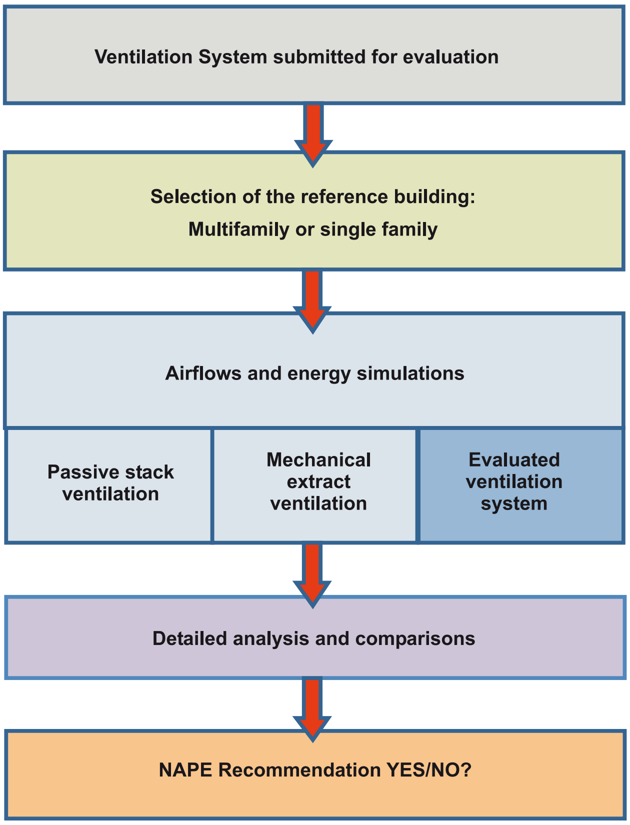

Figure 1. Schematic view of the NAPE recommendation scheme.

The reference primary energy use is an average value for two reference ventilation systems. Investigated ventilation systems, depending on percentage of reference primary energy use, get an energy class from A1 to D:

A1	0–30%
A2	30–50%
B1	50–70%
B2	70–90%
C	90–110%
D	>110%

Recommended system has to provide at least 30% of energy savings and at the same time has to ensure that during occupation required ventilation rate is supplied.

The multi-family NAPE reference building has the total volume of V_e = 5865 m³, surface of envelope A_e=2028.5 m² (shape ratio A_e/V_e = 0.35) and usable area A_f = 1634 m². Heat is supplied from town district heating network.

The single-family NAPE reference building has the total volume of V_e = 550.5 m³, surface of envelope A_e=432.7m² (shape ratio A_e/V_e = 0.79) and usable area A_f = 149.8 m². Heat is generated in combi gas boiler (efficiency 90%).

In both buildings two variants of the reference ventilation are considered:

- passive stack ventilation (windows with air vents and ventilation ducts located in kitchens, toilets, bathrooms and lockers etc.)
- mechanical extract ventilation with constant air volume (location of air supply and exhaust as above).

The calculations of the energy consumption and the ventilation rates are performed using hourly weather data for Warsaw.

Simulations of Airflows in Buildings

Calculations of airflows are carried out with application of a quasi-dynamic multi-zone model (CONTAM 3.0 [1]). Opportunities of CONTAM version 3 and higher are quite broad, so the software can be used to model many types of natural, hybrid and mechanical ventilation including demand controlled systems.

Changes of total air flow obtained for a multi-family building with 2 reference ventilation systems are shown in the **Figure 2**.

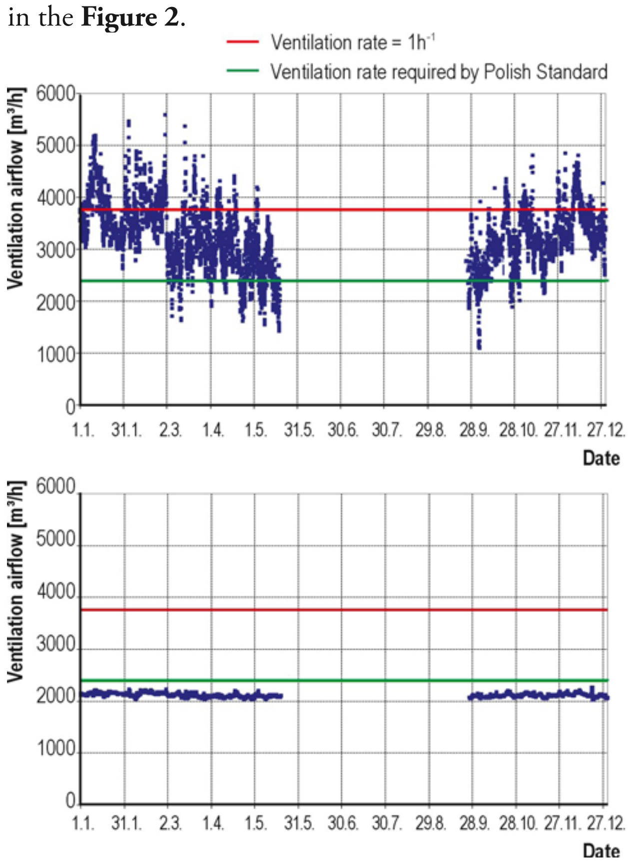

Figure 2. Changes of total air flow obtained for a multi-family building equipped with reference ventilation systems: passive stack ventilation (top) and mechanical extract (down)

Simulations of Annual Energy Use

For energy analysis of whole buildings, the recommendation scheme uses model 6R1C+AHU [3], which is modified version of simple hourly method 5R1C described in EN ISO-FDIS 13790 [2]. Total consumption of heat and electricity is converted into primary energy using energy waging factors and for NAPE reference buildings the following results were obtained: multi-family building 132 889 kWh/year (81.31 kWh/(m²year)) in case of passive stack ventilation and 106 681 kWh/year (65.27 kWh/(m²year)) in case of mechanical extract ventilation. Without any ventilation the reference building would hypothetically use ~48 000 kWh/year (29.37 kWh/(m²year)). The results of the primary energy use and ventilation intensity plotted on a two dimensional graph creates a background which is the basis for the assessment of other ventilation systems.

Example of Recommendation

The example presents the analysis of performance of humidity based demand controlled hybrid ventilation [4]. Air vents used in that system has variable characteristics influenced by relative humidity. For given pressure drop air flow is proportional to relative humidity (in range 30...70%). Characteristics of exhaust grills also depend on relative humidity. Additionally exhaust grills mounted in bathrooms and toilets are equipped with presence sensors that force opening of a control damper when users are in a space (delay for switching off is 20 min). Exhaust fans mounted on a roof above collecting ducts are equipped with pressure sensors and can reduce fan speed when needed.

In CONTAM environment the building together with analysed ventilation system has been idealized as 127 zones and 884 flow paths. Additionally in case of humidity based demand controlled hybrid ventilation systems the model takes into account controls (in analysed case humidity influences characteristics of air vents, exhaust grills and exhaust fans).

Figure 3 presents ventilation rate for whole building during the heating period in case of humidity based demand controlled hybrid ventilation. Average air volume is ~40%

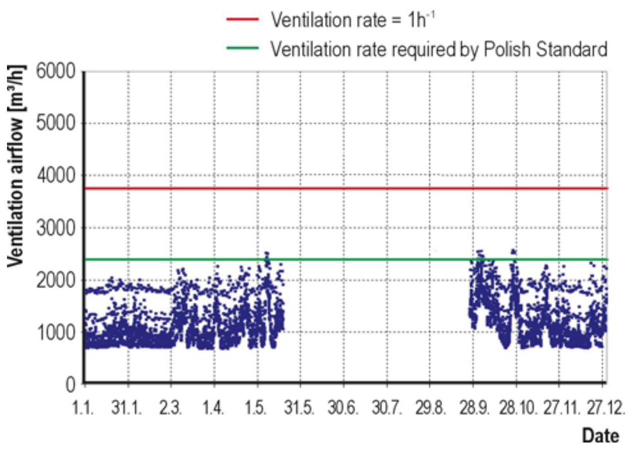

Figure 3. Ventilation rate for whole building during the heating period for humidity based demand controlled hybrid ventilation.

of maximum value that is approximately equal required ventilation rate. This indicates that analysed system is capable to provide required ventilation rates on demand.

Some ventilation systems (e.g. passive stack ventilation) work with huge differences in ventilation rates not only over time but also between similar flats located at different floors. Therefore before recommendation detailed analysis of airflows is performed. **Table 1** presents comparison of air ventilation rates for small studio M2 (66.5 m²) for 8 floor and ground floor. Simulation indicated that humidity based DCV hybrid system works with substantial differences in ventilation rate over time but without important differences between floors.

The comparison of primary energy use for reference multi-family building equipped with three different ventilation systems (two reference and one under evaluation) proved that utilization of humidity based DCV hybrid system leads to substantial energy savings. Reference energy consumption for comparisons is an average obtained for two reference ventilation systems 119 785 kWh/year (73.29 kWh/(m²year)). Primary energy use of reference building with analysed ventilation system is 79 712 kWh/year (48.78 kWh/(m²year)). This indicates the savings of ~33%. Taking into account just the energy for ventilation savings are much higher

Table 1. Summary of airflows analysis for humidity based demand controlled ventilation.

Ventilation rate, m³/h	M2 8 floor: Humidity based hybrid ventilation	M2 8 floor: Mechanical Ventilation (ref)	M2 8 floor: Passive stack ventilation (ref)	M2 ground floor: Humidity based hybrid ventilation	M2 ground floor: Mechanical Ventilation (ref)	M2 ground floor: Passive stack ventilation (ref)
Average	36	68	88	37	75	167
Min	21	65	28	22	68	41
Max	90	78	289	90	86	270
Stnd. Dev.	14.7	1.6	36.1	14.9	2.7	30.3

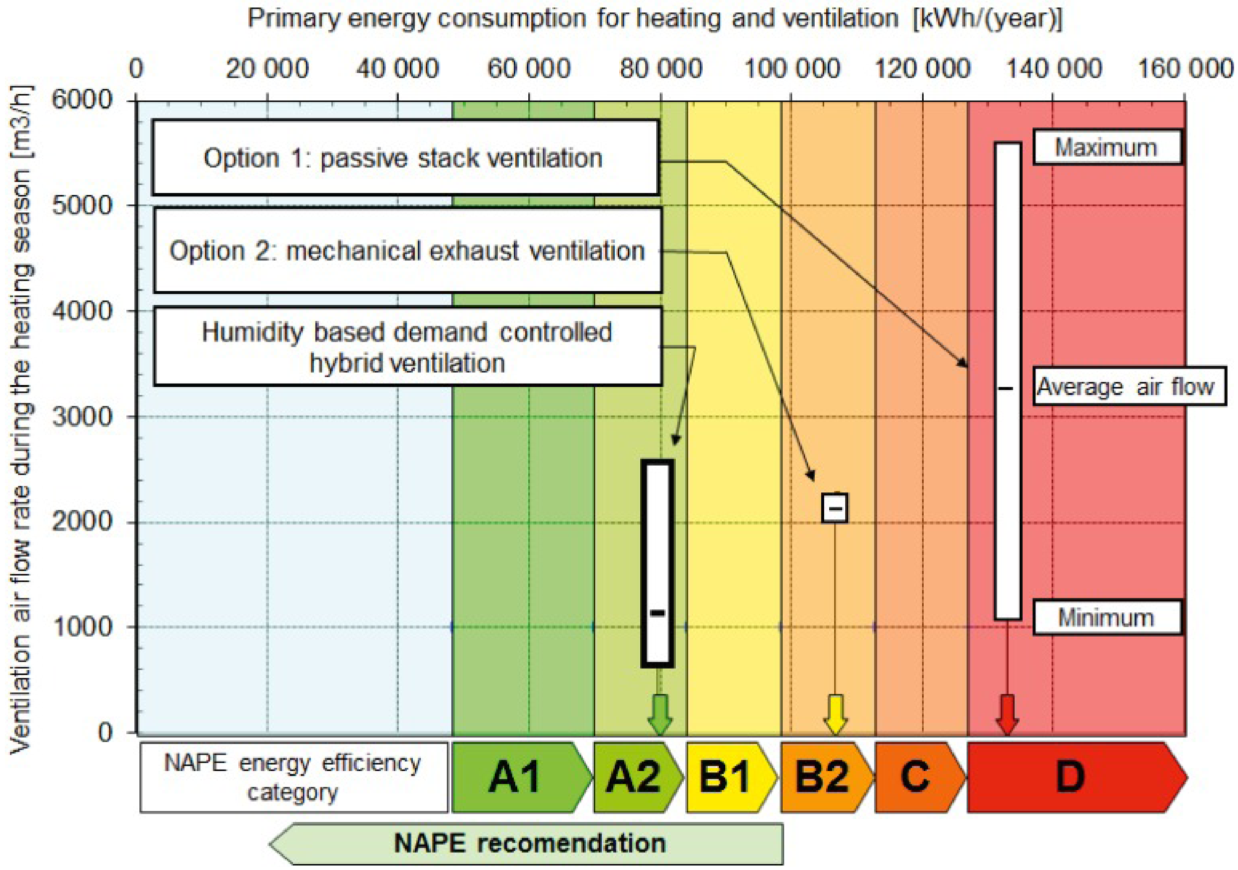

Figure 4. Reference levels of primary energy use and reference air flows with the recommended direction of modernization.

and reach ~55%. As the result of presented analysis the system got energy class A2 (**Figure 4**).

Conclusions

The described method for determining the energy efficiency of ventilation systems for residential buildings is characterized by the simplicity of the calculation, while allowing for consideration:

- auxiliary electricity consumption for fans and pumps,
- airflow changes due to temperature and wind speed fluctuations,
- airflow changes resulting from the control of ventilation components,
- reduction of heat consumption due to use of heat recovery (including the necessary reduction of heat recovery efficiency in case of frost built-up in heat exchanger or during transition periods),
- indoor air quality level created by evaluated ventilation systems. ■

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Ecodesign regulations for Solid fuel boilers and Local space heaters approaching the final steps

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The Ecodesign Framework Directive 2009/125/EC establishes a framework for setting ecodesign requirements for energy-related products. It is a key instrument of EU policy for improving the energy efficiency and other aspects of the environmental performance of products. The Eco-design directive does not set binding requirements on products by itself: it provides a framework (rules and criteria) for setting such requirements through implementing measures. For products intended to consumer use, binding rules for energy labelling are usually prepared in parallel with ecodesign regulations. Some main principles and a few processes of preparation have been introduced earlier in the REHVA Journal [1]. This article gives some news on "hot topics" relevant to HVAC, plus brief notes on a few new studies.

The preparation of the implementing measures is a long process - the preparatory work in the "Lots" and other phases are introduced in more detail on REHVA EU Regulations webpages, at http://www.rehva.eu/index.php?id=79 , and summarized in the following figure also available at REHVA's Ecodesign webpage. The duration of the steps is typically a little more than planned, because delays appear for several reasons (workload, difficulties to find consensus, co-ordination of two or more "lots") and sometimes the whole process of preparation is put on hold for some time.

Boilers and local space heaters – soon to be all covered by regulations?

After a very long – more than 8 years from the beginning – process of preparation, the Ecodesign regulation for gaseous and liquid fuel boilers has been finally approved - see a complete introduction to the new requirements in [2]. For solid fuel boilers, the preparations started in 2009, and after some delays the work has now proceeded towards the final steps. In parallel, also local space heaters (using either liquid, gaseous or solid fuels) have been subject to ecodesign studies, and now it should finally be possible to look at all types of boilers and heaters "in one picture". However, as the new versions of proposed regulations contain some changes to the ones prepared for the Consultation Forum in autumn 2012 - even in the scope and main definitions, it is still too early to predict the final contents or dates of publication of the coming regulations.

Solid fuel boilers (Lot 15)

In May 2013, three documents were circulated to Member States for comments and will be finalized taking into account the received comments. These documents are still subject to change, and the revised versions will be sent for comments approximately one month prior to the Regulatory Committee meeting, foreseen to be held in September 2013.

The documents include a Working Document on a Draft Commission Regulation

- with regard to ecodesign requirements for solid fuel boilers, and
- with regard to the energy labelling of solid fuel boilers and packages of solid fuel boiler, supplementary heater, temperature control and solar device
- …and a third document, a draft communication from the commission on a transitional test method for solid fuel boilers.

The proposed regulation establishes ecodesign requirements for the placing on the market and/or putting into service of solid fuel boilers with a rated heat output ≤ 1 000 kW, including those integrated in packages of solid fuel boilers, supplementary heater, temperature control and solar device. The energy labelling regulation gives some more detailed descriptions about the product definition, but also the proposed ecodesign regulation gives a list of products not included in the scope, for example (list not exhaustive) boilers generating heat only for the purpose of providing hot drinking or sanitary water, or boilers for heating and distributing gaseous heat transfer media such as vapour or air, or solid fuel cogeneration boilers with a maximum electrical capacity of 50 kW or above

After the Consultation Forum, there are a few significant changes in the proposed regulation. First of all, the upper limit of rated heat output has been extended from 500 kW to 1 000 kW, bringing some new manufacturers within the scope. Also there are less product types excluded from the scope now. For example, Cogeneration space heaters were previously excluded from the scope, and now it is proposed to exclude "solid fuel cogeneration boilers with a maximum electrical capacity of 50 kW or above".

There are also changes in the definitions, for example an addition to the "solid fuel boiler" definition:

> *"has a heat loss to the space it is located in of no more than 6% of rated heat output";*

Some requirements have changed, as well as the schedule – instead of step by step tightening requirements, now all main requirements would enter into force four years after publishing of the regulation. The current proposal gives the main requirements as follows:

> *(a) Solid fuel boilers shall comply with the following requirements from [date to be inserted: four years after the entry into force of the Regulation]:*
>
> – *seasonal space heating energy efficiency shall not be less than 77%;*
>
> – *seasonal space heating emissions of organic gaseous compounds shall not be higher than 10 mg/m³;*
>
> – *seasonal space heating emissions of carbon monoxide shall not be higher than 300 mg/m³;*
>
> – *seasonal space heating emissions of nitrogen oxides, expressed in nitrogen dioxide, shall not be higher than 200 mg/m³;*
>
> *These requirements shall be met for the preferential fuel and for any other suitable fuel of the solid fuel boiler.*

Local space heaters (Lot 20)

"Local space heater" is defined as follows:

> *'local space heater' means a space heating device that*
>
> *a) emits heat by direct heat transfer or by direct heat transfer in combination with heat transfer to a fluid, in order to reach and maintain a certain level of human thermal comfort within an enclosed space in which the product is situated, possibly combined with a heat output to other spaces; and*
>
> *b) is equipped with one or more heat generators that convert electricity or gaseous, liquid or solid fuels directly into heat, through use of the Joule effect or combustion of fuels respectively.*

Also for these products, three working documents were sent for comments in late May 2013 – with very much similar structure as the ones for solid fuel boilers. The draft ecodesign regulation establishes ecodesign requirements for the placing on the market and/or putting into service of domestic local space heaters with a nominal heat output equal or below 50 kW and commercial local space heaters with a nominal heat output equal or below 70 kW. It is worth noticing that the draft energy labelling regulation covers only heaters up to 50 kW, and it does not use definitions domestic and commercial. Examples of products not included in the scope:

- local space heaters using a vapour compression cycle or sorption cycle for the generation of heat (either driven by electric compressors or fuel);
- local space heaters that are specified for the combustion of non-woody biomass only;
- local space heaters specified for other purposes than indoor space heating to achieve a certain thermal comfort of human beings;
- local space heaters that are specified for outdoor use only

As in the case of solid fuel boilers, also here changes have been made in the proposals, including the scope and the list of excluded products. It is also very crucial for manufacturers to observe that requirements in draft regulation would enter into force in one stage with very stringent requirements for energy efficiency and emissions. As a new requirement limit values for NOx emission has been proposed.

Because of the many changes, it would now be important for both Member States and individual manufacturers, as well as manufacturers' organizations to study the current proposals carefully. The list of National contact points in charge of the implementation of the Ecodesign Directive 2009/125/EC can be found at EC homepage*. ■

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1 Railio, Jorma: Ecodesign of energy related products – time for industry to wake up. REHVA Journal. Vol 50, issue 1/2013, pages 54-55.

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* http://ec.europa.eu/enterprise/policies/sustainable-business/documents/eco-design/national-contacts/implementation/index_en.htm

Status of new CEN EPB Standards

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European initiatives developing a coherent set of standards needed to describe the Energy Performance of Buildings: the development of the set of EPB standards

This initiative is originated by the publication of an European Directive 2010/31/EU recasting the Directive 2002/91/EC on energy performance of buildings ([recast] EPBD) which promotes the improvement of the energy performance of buildings within the European Union, taking into account all types of energy uses (heating, lighting, cooling, air conditioning, ventilation) and outdoor climatic and local conditions, as well as indoor climate requirements and cost effectiveness. This initiative is described in Mandate 480, given by the European authorities to CEN.

It is expected that the use of these standards will increase the accessibility, transparency and objectivity of the energy performance assessment by facilitating the comparison of best practices and supporting the internal market for construction products. This development is based on an earlier developed set of EPB standards that has been published in 2007-2008. This earlier (2007-2008) set of 42 EPB standards consists of 30 EN (European) and 11 ISO (EN-ISO) standards.

The current initiative (2012-2015) is to review and revisit this set of (2007-2008) EPB-standards and reformulate and add standards so that they become on the one hand unambiguous and compatible, and on the other hand a clear and explicit overview of the choices, boundary conditions and input data that need to be defined at national or regional level.

The EPB-project work will lead to a second generation set of the EPB standards, more usable as direct reference in national legislation and leading to a high transparency in national choices.

Phase 1 (circa 2012-2013):

The development of **basic principles** and **detailed technical rules** providing the necessary clear guidance for the standards writers and an **overarching standard** providing a continuous but modular structure, preceding:

prCENTS 16628: Technical Specification (TS): Basic Principles for the set of energy performance of buildings related standards

A Technical Specification with basic principles will provide guidance on the required quality, accuracy, usability and consistency of each standard and the rationalisation of different options given in the standards, providing a balance between the accuracy and level of detail, on one hand, and the simplicity and availability of input data, on the other. The basic principles and rules will also comprise rules and formats for the separation of harmonised procedures and choices and input at national or regional level.

Consequently it addresses topics such as:

- a common format for each EPB standard, including a systematic, hierarchic and procedural description of options, input/output variables and relations with other standards;
- a clear separation of the procedures, options and data to be provided at national or regional level;
- a common structure of easily accessible and comparable national annexes to each standard, containing the national or regional options, boundary conditions and input data;
- an informative technical report, accompanying each standard, according to a common structure, comprising at least the results of internal validation tests, examples and background information;
- a clear and comprehensive field of application (scope);
- ensuring that all procedures are software proof and unambiguous;
- ensuring that the standards will be concise and complete, that can be easily referenced in legislation;
- rationalisation of different options given in the standards, each option aiming at specific applications with respect to availability of input data and impact on the energy performance.

The basic principles are intended as basis (the "**why**") for a set of **detailed technical rules** and an **over-arching standard** (the "**how**").

Status: At the last CEN TC371 meeting, the 4th of July 2013, it was decided to publish this TS for TC-Approval (TCA). This means that CEN will send this version to all National Standard Bodies, the CEN member organisations, for comments and acceptance. As soon the TS have been send out for TCA there is a 3 months period for all NSB's to react-vote.

prCENTS 16628: Technical Specification (TS): Detailed Technical Rules for the set of energy performance of buildings standards

A Technical Specification with detailed technical rules, based on the basic principles, will provide guidance for the drafting of the over-arching standard (phase 1) and the drafting of each of the set of standards under phase 2.

Status: At the last CEN TC371 meeting, the 4th of July 2013, it was decided to publish this TS for TC-Approval (TCA). This means that CEN will send this version to all National Standard Bodies, the CEN member organisations, for comments and acceptance. As soon the TS have been send out for TCA there is a 3 months period for all NSB's to react-vote.

prEN15603:2013: Over-arching standard on the energy performance of buildings

The improved set of EPB standards shall become a systematic, clear and comprehensive package. In order to ensure consistency among EPB standards and user-friendliness, a continuous but modular overall structure is needed, covering all standards related to the energy performance of buildings, providing the overall framework.

This over-arching standard on the integrated energy performance of buildings re-uses the main elements of EN 15603:2008 (Overall energy use and definition of energy rating) and core elements of other key EPD standards, including common definitions, terms and symbols, offering a systematic, clear and comprehensive, continuous but modular structure. Consequently, its scope is significantly wider than the scope of EN 15603:2008.

Status: The prEN15603 is available and currently at Public Enquiry. Public Enquiry (PE) will close by October 2013. When considering this prEN for comments the draft prCENTR 15615 should be kept aside, this draft is currently available as working draft within CEN TC371.

prCENTR 15615: The Accompanying Technical Report to prEN15603:2013

Given the number of topics to be dealt with, the over-arching standard prEN15603 results in a rather voluminous and complex document, including many equations linking together energy related parameters, on-site energy production, the use of renewable vs. fossil energy, energy export, links to inspection, product properties, etc.

The complexity of the building energy performance calculation requires a good documentation and justification of the procedures. Informative text is required but is separated from actual procedures, to avoid confusion and unpractical heavy documents. All the informative documentation and justification, including worked examples will be laid down in an accompanying separate Technical Report.

Status: At the last CEN TC371 meeting, the 4th of July 2013, it was decided to publish this TR for TC-Approval (TCA). This means that CEN will send this version to all National Standard Bodies, the CEN member organisations, for comments and acceptance. As soon the TR have been send out for TCA there is a 3 months period for all NSB's to react-vote.

Phase 2: The preparation/revision of the whole set of standards on the energy performance of buildings

Phase 2 will focus on the improvement and expansion of the current set of CEN-EPB standards on the basis of the findings (see also results CENSE project and reports of CAP-EDMC-LC reports) and set of requirements developed in Phase 1 (the Over-Arching standards, the connected TR, the two Technical Specifications and several supporting tools, like templates, checklists and the software tool).

The actual revision of the standards will be carried out under the responsibility of the relevant CEN/TC's on the basis of the clear set of common principles and rules and priorities (the OAS+TR and two TS's).

The issues to be covered in the work include the following:

Checking the software-proof-ness of the equations given in the separate standards or parts of standards by producing an excel program and calculation example connected to each WI's. General checking of the appropriateness of the current standards in particular the application of these standards for existing buildings. More focus on models and input data which are to be suited to existing buildings. More focus on passive cooling techniques and the assessment of the energy performance of cooling systems. Possible integration of the inspection standards on systems for heating, cooling and ventilation. Where needed, expansion of the procedures to NZE-buildings by way of renewable sources of energy, and procedures for energy producing buildings, with consideration given to alternative systems; Integrated approach for calculating minimum performance requirements for technical building systems and building envelope.

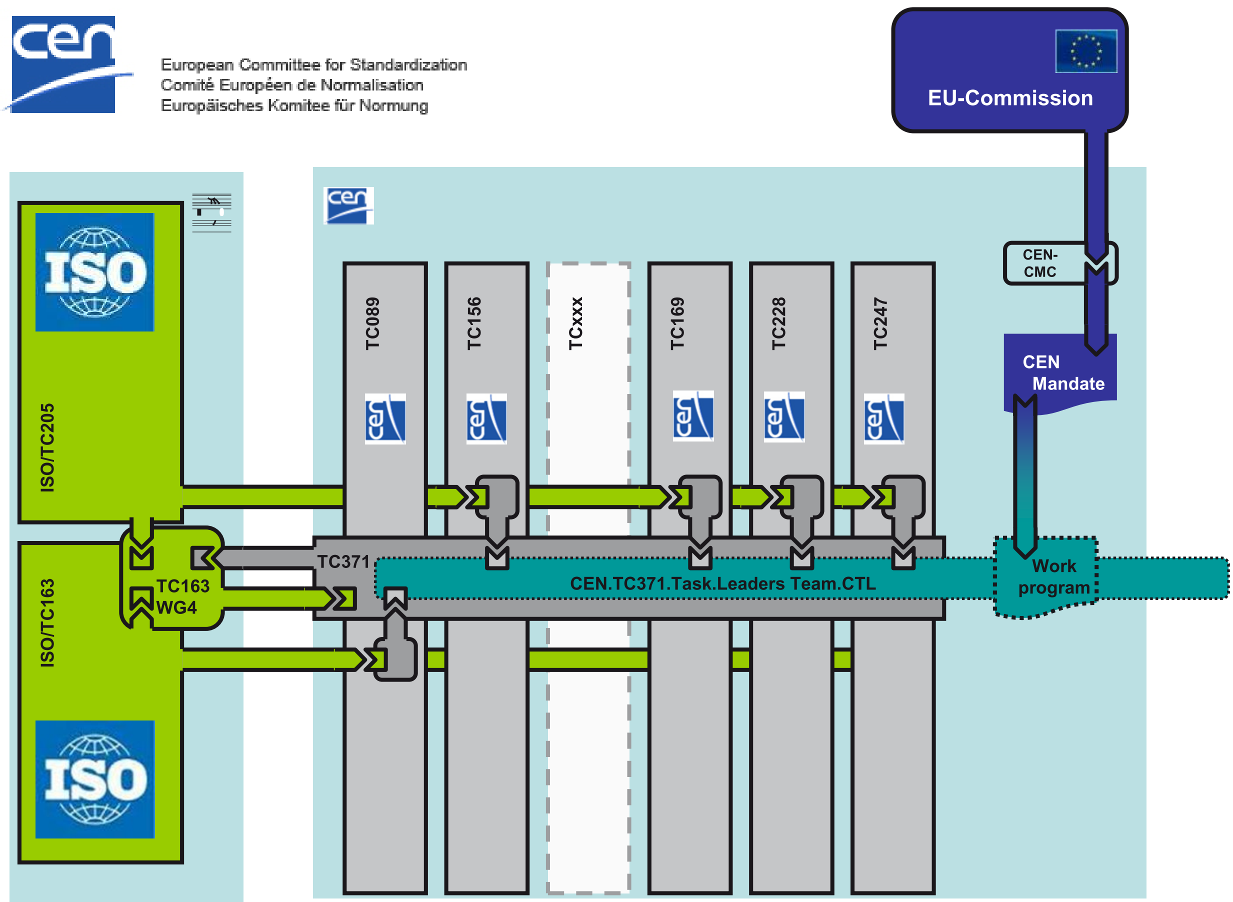
Work Program of Phase 2

- About 100 Work Items (WI): Resulting in about 50 standards or parts thereof and about 50 TR's connected to these standards
- Some of these WI's may still be merged and some of the TR's may cover more parts of a standard or more standards. This may shorten the list but not the work
- Starting this summer, all WI's have to be registered by the 5 TC's before October 2013
- The first TC-Working Group drafts have to be ready by December 2013, it is expected to reach and possibly finish the enquiry stage of most or, if possible, all EPB-standards before the end of 2014. We should keep in mind that many of the standards will not fundamentally change. ■

Central coordination within CEN team of Task Leaders/experts under CEN TC 371

CEN TC 371 organises this central coordination team in cooperation with the other relevant CEN TC's.

- CEN TC 89, Thermal performance of buildings and building components: CT-leader: Dick van Dijk
- CEN TC 228, Heating systems in buildings: CT-leader: Johann Zirngibl
- CEN TC 156, Ventilation for buildings: CT-leader: Gerhard Zweifel
- CEN TC 247, Controls for mechanical building services: CT-leader: Dan Napar
- CEN TC 169, Light and lighting: CT-Leader Sohéil Moghtader & Jan de Boer



European Commission has given a mandate to CEN to revise several EPBD related standard administrated by TC 371 and five other CEN technical committees.

Impoving the energy efficiency by coupling of a heat pump and hybrid PV-T panels

The concern about climate change has lead European Union and national governments to take some measures (EPBD Directive, RES Directive…) in order to reduce the impact the building sector has on the global contribution of greenhouse gas emissions.

As a consequence of such regulations, maximum values of primary energy use (kWhPE/m²) are then allowed when a new building is being constructed or largely renovated and a minimum share of RES should be used.

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Architects and building engineers have to find solutions to build efficient buildings. As an example, for the French case (Réglementation Thermique RT2012), a value of 50 kWhPE/m²/year (for heating, cooling, DHW, lighting and auxiliaries) is the average target for every new building as from 1st January 2013. A minimum of 5 kWhPE/m²/year of RES has also to be considered for individual residential buildings.

Future versions of these regulations will be even stricter and the fact that buildings will have to become energy providers (net or positive energy buildings) probably by 2020 is already in discussion.

Heat pumps and PV panels are two types of equipment that may represent interesting solutions for building designers. Although today they are very often installed with no interaction between the two, the objective of the project described herewith was to take advantage of each piece of equipment in order to obtain an efficient coupled system and meet the regulation requirements, thus providing a technical answer for future buildings.

Principle Objectives and Description

As described in numerous studies, a photovoltaic collector produces electricity but also thermal energy which can be recovered by air or water to heat the building. This solar component is generally described and modelled as a combination of a photovoltaic collector and an air solar collector, leading to what is commonly called a hybrid photovoltaic-thermal (PV-T) collector. It is also well known that the efficiency of a PV panel decreases with its operating temperature as well as its lifetime. As a consequence, some benefits may be obtained when the PV panel is cooled down.

The coefficient of performance of a heat pump depends strongly on the temperatures of the source and of the sink. This is particularly true for air-source heat pumps. It is possible to significantly improve the seasonal Coefficient of Performance (COP) of an air source heat pump by coupling its external unit with pre-heated air-sources integrated into or near the building.

A system has been designed and installed on a demostration builiding.

Demonstration Building Description

The developed prototype has been installed in a new building, "La Petite Maison Z.E.N (PMZ)", which is a Zero Energy Net building of 116 m², hosting offices and located in the Montagnole village, near the city of Chambéry, in the French Alps.

Figure 1. Case building : La Petite Maison Z.E.N.

It was designed to have a yearly overall consumption lower than 50 kWh/m², for all uses. To reach such levels of performance, both the building design and the equipment have to be very efficient.

Not complex architecturally speaking, the building is compact. On the north face, the window area is fitted with triple glazing. For the South and East faces, with larger window areas, passive solar gains are favoured with double glazing windows.

To reduce solar gains in summer, an architectural mask in the south facade has been created by the eaves.

The building structure is made from a wood frame of 145 mm. It is insulated with 140 mm of wood wool between the frame, plus 60 mm of fiber wood in the exterior in order to prevent hermal bridges.

To limit the ventilation losses, a mechanical ventilation system with a 90% heat recovery efficiency exchanger has been installed.

Fan coil units equipped with fans driven by EC motors are used as low inertia emitters for heating and cooling.

System Description

Photovoltaic Collector

The south-oriented roof (70 m²) is fully covered with photovoltaic modules divided into 2 parts:

- 7.2 kWp of thin film CIGS modules on the roof itself.
- 1 kWp of see-through micromorph modules integrated in the roof of the patio (10 m²).

Thanks to the air flow, the module temperature should rarely be higher than 60°C.

System and Water Loop Description

Ambient air is pumped and circulates under the PV panels thanks to the fans incorporated into the air handling unit. Before being rejected outside the building, it crosses the coil where heat is extracted and directed to the evaporator of the water to water heat pump through the brine circuit (**Figure 2**).

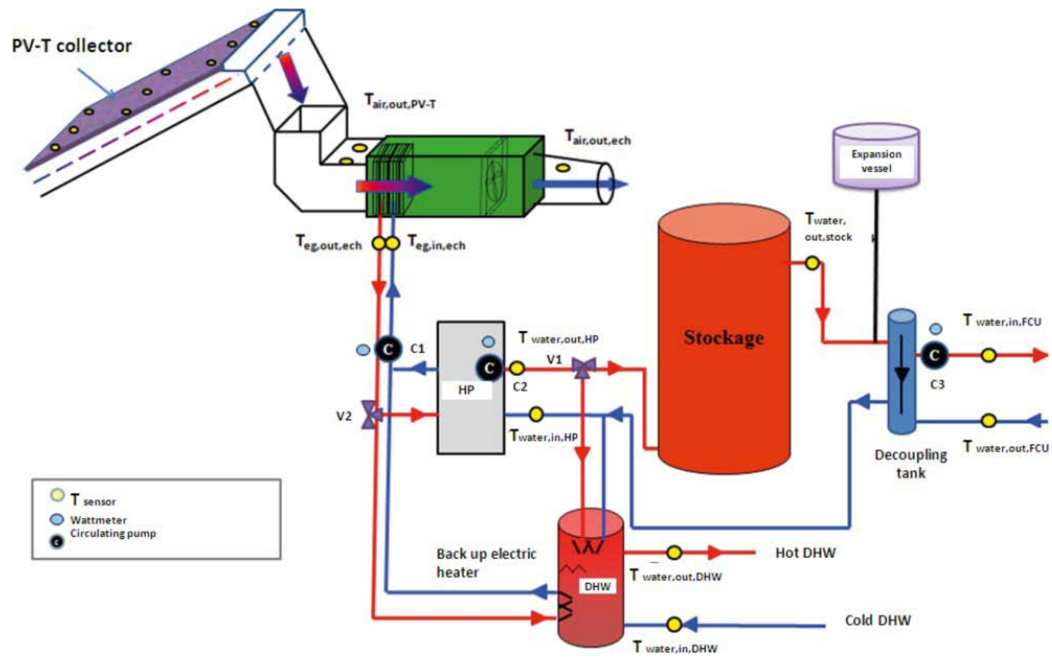

Figure 2. Detailed diagram of the air and hydraulic circuit.

On the secondary side of the heat pump, thanks to a motorized three way valve, heat can either be dispatched on the main loop composed of a large storage tank connected to the decoupling tank that feeds the fan coil units or on the DHW tank.

If the temperature of the extracted air is high enough, the heated brine can be sent directly to the serpentine of the DHW tank by bypassing the heat pump with a motorized three way valve. The system is reversible and can produce cold water in summertime.

Modelling of the system

The models of the different components of the system are coupled and integrated into a building simulation tool.

PV-T collector

The production of electricity by photovoltaic modules is calculated with the 1-diode model, assuming the collector is grid-connected.

In the case of a ventilated air gap, a model has been developed to calculate the thermal efficiency of the PV-T collector. This model assumes steady-state conditions and a one-dimensional conduction heat transfer perpendicular to the collector surface.

Heat pump

The heat pump model is based on a steady-state empirical model and considers full load and part load conditions.

In order to validate and define more accurately some parameters of the heat pump model, some steady state tests have been performed on a semi-virtual test bench.

Domestic Hot Water Tank

The model is derived from type 340 from the TRNSYS library. In this model, it is assumed that the stratified hot water tank is divided into horizontal, thermally uniform water layers.

Coupling and implementation into a dynamic thermal simulation tool

The demonstration building has been modelled and simulated thanks to a thermal simulation tool of multi-zone buildings named COMFIE: it allows heating and cooling loads, as well as temperature profiles in different zones, to be evaluated.

The hourly outputs of the resulting simulation tool are for instance the absorbed energy and the COP of the heat pump. These results, once integrated over one year, will give the efficiency of the whole system. Other variables (hourly mean temperatures or electricity produced by the PV-T collector for instance) can also help to assess its performance.

Monitoring system

The monitoring system aims at comparing the numerical model with real measurements as well as highlighting the performance of the demonstrator.

Data is logged every minute by the monitoring system. Meteorological data recorded on site are the ambient temperature and the relative humidity. Each component of the system is monitored.

Comparison between modelling results and in situ test results

Figure 3 gives the comparison between the model and the monitoring results in terms of the outlet air temperature of the PV-T collector, for 3 days of the first week of November 2011.

The figure shows a good concordance between the tuned model and the experiment. Nevertheless, we can note some discrepancy during the night, because the radiation heat exchange between the PV collector and the sky is not accurately taken into account in clear sky conditions.

Figure 4 gives the comparison between the model and the experiment for the coefficient of performance of the heat pump for one day in February 2012 (more precisely from 12 pm to 4 pm). The figure shows a good concordance between the model and the experiment.

Modelling of Annual Performances

It was shown that the modelling of the system is very close to the monitoring results measured in real operating conditions. It thus enables us to validate the complete model and to perform an all year round simulation of the complete installation, including the calculation of the building needs. The demonstration system has been simulated as well as a reference system composed of an on/off air-to-water heat pump and of an unventilated PV roof having the same size as the one installed on the demonstration building. No coupling exists between the air/water heat pump and the PV roof and there is no water storage, as in the reference case. The heating system as well as the building are identical for both cases of simulation. The coupling improves the PV production by around 10% and decreases the heat pump electricity consumption by around 20%. The net benefit is of around +10% for the coupled case (see **Figure 5**).

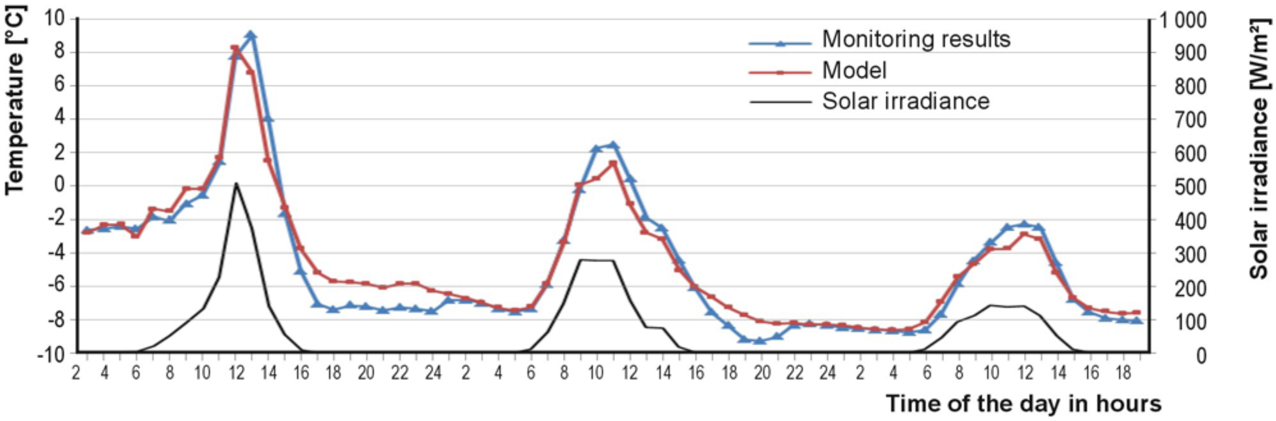

Figure 3. Outlet air temperature of the PV-T collector.

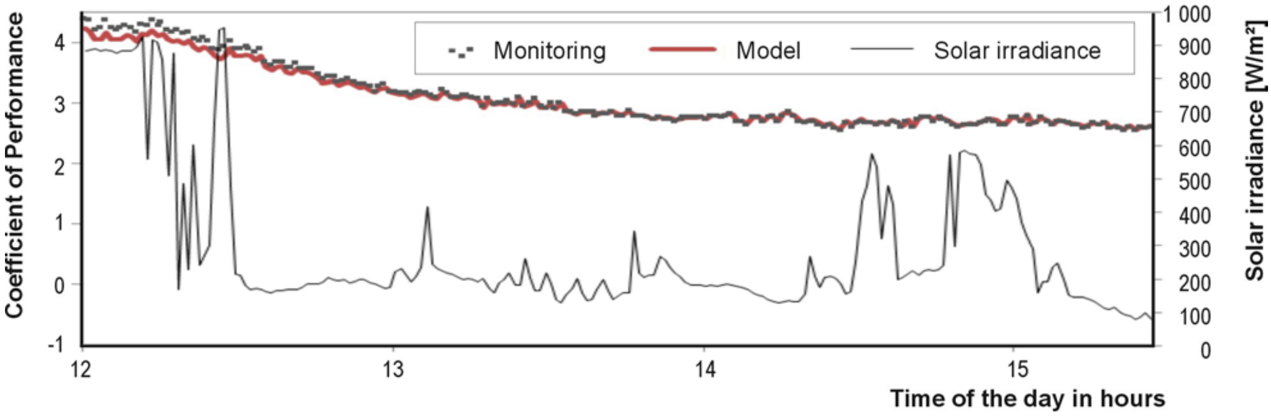

Figure 4. COP of the heat pump.

Conclusions and Perspectives

A system coupling a PV-T roof to a heat pump has been designed and installed in a demonstration building. It has been operating since the autumn of 2011, as has its controlling system. It is able to heat, cool and produce DHW (either with the heat pump or by direct solar heating).

Its modelling has been performed, showing that such coupling benefits the efficiency of the heat pump as well as the PV panels electricity production, as was expected at beginning of the project. The results of the experiments show that some improvements may be made on the system (Air Handling Unit coil design, control of the system…).

Some studies and experiments on larger building are planned to be done. ■

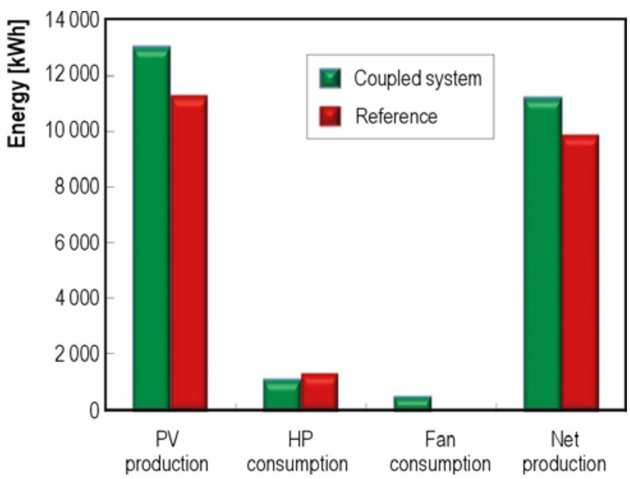

Figure 5. COP of the heat pump.

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Heat recovery ventilation with closed-loop ground heat exchange

Ventilation of modern residential buildings is often combined with additional technologies to bring fresh air into the building in the most comfortable and energy efficient way. As such, balanced ventilation with heat recovery can be combined with ground heat exchange.

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Because the ground temperature reacts slower than the air temperature, often the ground can be used to preheat the incoming outdoor air in winter, and precool the incoming outdoor air in summer. In this article, the results will be shown how balanced ventilation with closed-loop ground heat exchange performs in practice, in a residential building in Nijeveen, The Netherlands.

Two types of ground heat exchange

Two variations of ground heat exchange systems exist. First, an open system where outdoor air is led through pipes in the ground, before entering the building and going through the heat recovery unit. For a detailed description of this open system, refer to [1].

Second, a closed system (see **Figure 1**) where outdoor air is led through an air-liquid heat exchanger before entering the heat recovery unit. The liquid is a glycol-water mixture that is flowing through a tube. Most part of the tube is horizontally installed in the ground (ground collector) where the liquid picks up the heat (or cold) from the ground [2,3].

Closed-loop ground heat exchange is preferred, because it is easier to install, and less prone to damage because of natural settling of the ground or digging into the ground after installation. The closed-loop system also avoids potential microbial growth problems. Last, closed-loop ground heat exchange needs less area as it can be installed in a meandering pattern.

Figure 1. Representation of the ventilation system. Green: outdoor air; Red: supply air; Yellow: extract air; Brown: exhaust air; Grey: the ground collector with glycol-water mixture.

Explanation of the technology

Balanced ventilation with heat recovery and ground heat exchange is explained using **Figure 2**. The horizontal axis shows the outdoor temperature. The black line is the desired indoor temperature. For heat recovery ventilation, the green line represents the supply temperature of the fresh air that enters bedrooms and living room via supply air grilles.

In winter, the necessary heating to bring the incoming fresh air to the desired temperature (red arrows) is low. The avoided heating when compared without heat recovery is shown by the grey arrows. This saves costs for heating the internal climate. Ground heat is used when possible to keep the heat recovery unit free of condensation and ice so that the mass balance is maintained.

Under certain conditions, the bypass is opened automatically to prevent too high supply air temperatures. Now, the fresh air enters the rooms without energy exchange. The green line follows the dashed black line. This is called free cooling as the supply air temperature is below the indoor air temperature (blue arrows).

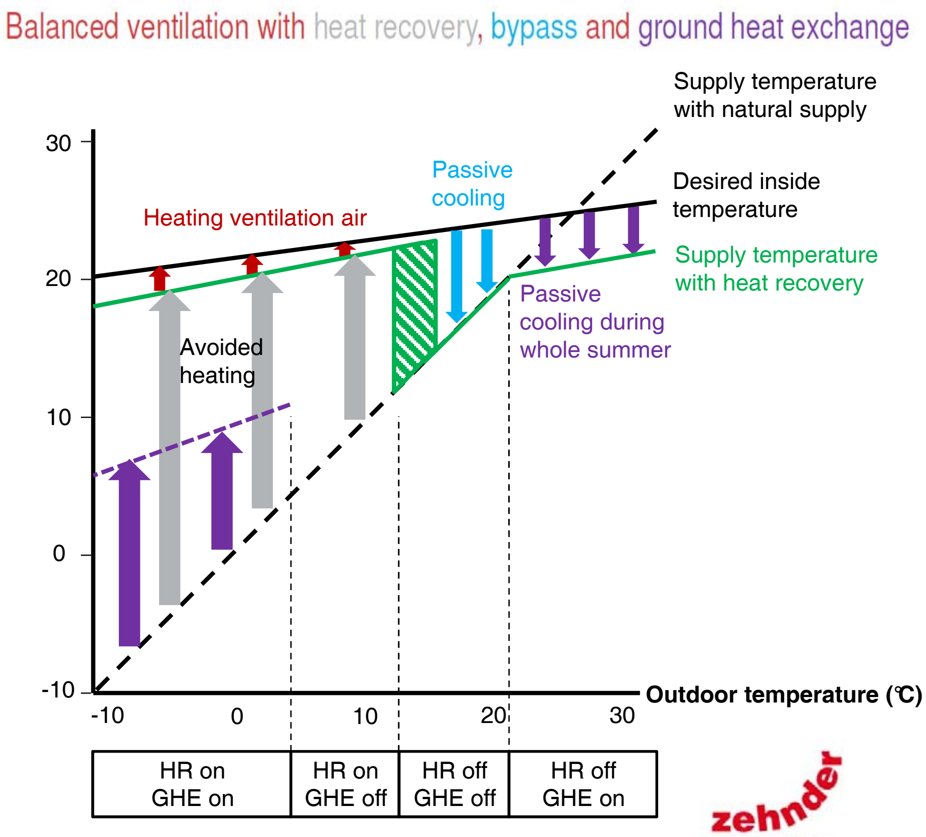


Figure 2. Schematic principle of balanced ventilation with heat recovery (HR) and ground heat exchange (GHE).

In summer, the ground temperature is lower than the outdoor air, and even lower than the indoor temperature. Thanks to the ground heat exchange, free cooling is therefore available throughout the summer and this raises the comfort level in every room of the house (purple arrows).

Ground heat exchange is not used for outdoor temperatures between 7°C and 23°C, but these values can be changed according to the location.

The monitored house

In Nijeveen (The Netherlands), the ventilation of a residential building has been monitored for a full year. For the monitoring period, the heat recovery ventilation had a fixed amount of fresh air of 220 m³/h. The closed loop ground heat exchange consists of the unit ComfoFond-L (positioned next to a heat recovery unit) and the ground collector. In this project the ground collector is a 100 m long polyethylene tube with an outer/inner diameter of 25/17 mm. The collector is installed at a depth of 1.20 m in the ground and filled with a glycol-water mixture. The collector tube is going from the unit in the attic straight down to the basement floor. At the front door of the house it is entering the ground and runs around the house to the backyard. In the backyard it makes a few turns and goes back along the same side of the house and up to the attic again. It is advisable to respect a minimal tube spacing of 60 cm, but in this project the distance is 30 cm in some segments.

Ground heat exchange is automatically switched on/off by a pump in the ComfoFond-L unit. In this project, the pump is running for outdoor temperatures below 7°C and above 16°C. The fresh air is distributed throughout the house by round metal ducts branching off to the various rooms. Stale air is returning from kitchen, toilets and bathroom to the heat recovery unit again before being exhausted to the outside.

Flow rates, temperatures and settings of the ventilation system have been collected with an interval of 1 minute, and afterwards 1 hour averages are calculated to give statistical results for July 2011 until August 2012. In spring 2012, some data is missing because of hardware problems with the monitoring equipment.

Ventilation with ground heat exchange in practice

In **Figure 3**, the ground temperature at 1.20 m depth and the outdoor air temperature are shown. The dampening effect of the ground is visible. At this depth, the ground temperature varies between 5 and 16°C for outdoor air temperatures between –15 and 35°C.

There are four possible states for this ventilation system (see also **Figure 2**), depending on whether heat recovery (HR) is used and/or ground heat exchange (GHE) is used. **Figure 4** shows that in the cold season heat recovery is used, with ground heat exchange whenever the outdoor air was below 7°C (mostly at night, and during cold days). In the warm season heat recovery is not used (ventilation with bypass open), and for outdoor air temperature higher than 16°C the ground cools the fresh air even further (afternoons and warm nights). In this project with the mild Dutch sea climate, ground heat exchange is used during 55% of the monitored time.

The preheating and precooling effect of the ground heat exchange is shown in **Figure 5a**. For outdoor temperatures lower than 7°C, the fresh air is preheated by the ground. For outdoor temperatures higher than 16°C, the fresh air is precooled by the ground.

Optimal performance would be that the air temperature is preheated in winter to 5°C (minimal ground temperature) and precooled in summer to 16°C (maximal ground temperature). In this project the air temperature is minimally 0°C and maximally 21°C. Detailed analysis has shown that the performance of the ground heat exchange could be improved with better positioning of the ground collector. The collector should be laid out more evenly in the ground, respecting a minimum distance between two tubes of 60 cm.

After the heat recovery unit, the fresh air is increased in temperature when the heat recovery is on (see **Figure 5b**). Even with outdoor temperatures as cold as –13°C, the fresh air is brought to the living rooms at a comfortable 17°C. This reflects the huge energy saving capacity, as the heat demand for ventilation is decreased enormously. In fact, the average heat recovery efficiency is measured as 92% over the entire heat recovery season.

If the heat recovery is off, the ground heat exchange helps to keep the fresh air temperature low, so that the supply temperature is always lower than the indoor temperature. This means free cooling for the whole warm season, and not only during cool summer nights. The free cooling helps to keep the cooling load of the house low in summer, in the same way as proper shading equipment.

Energy saving

The performance of the ventilation system in terms of energy is given in **Table 1**. The seasonal performance index SPF is calculated as the energy gain divided by the energy consumption, both inside and outside the heat recovery season.

Table 1. Annual energy benefit of heat recovery ventilation and seasonal performance factors.

	Energy gain	Electrical consumption	Seasonal Performance Factor SPF
Avoided heating load	3 899 kWh	593 kWh	7
Free cooling load	950 kWh	408 kWh	2

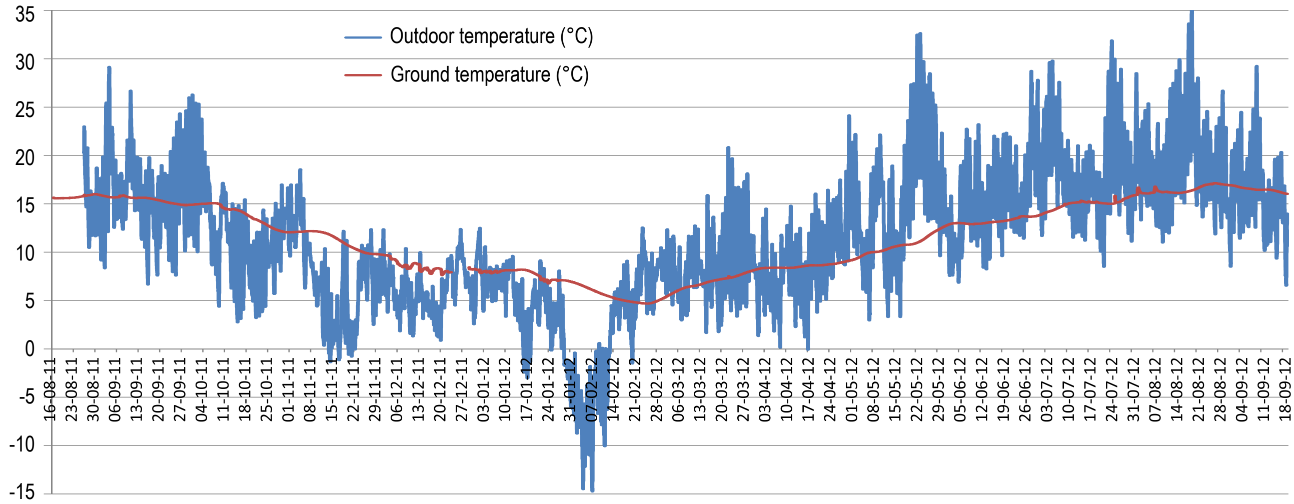


Figure 3. Ground temperature (1.20 m depth) and outdoor air temperature.

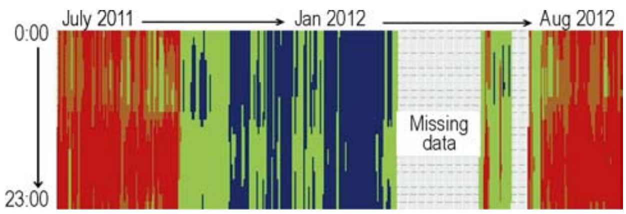


Figure 4. State diagram. Blue: HR on, GHE on; Green: HR on, GHE off; Orange: HR off, GHE off; Red: HR off, GHE on.

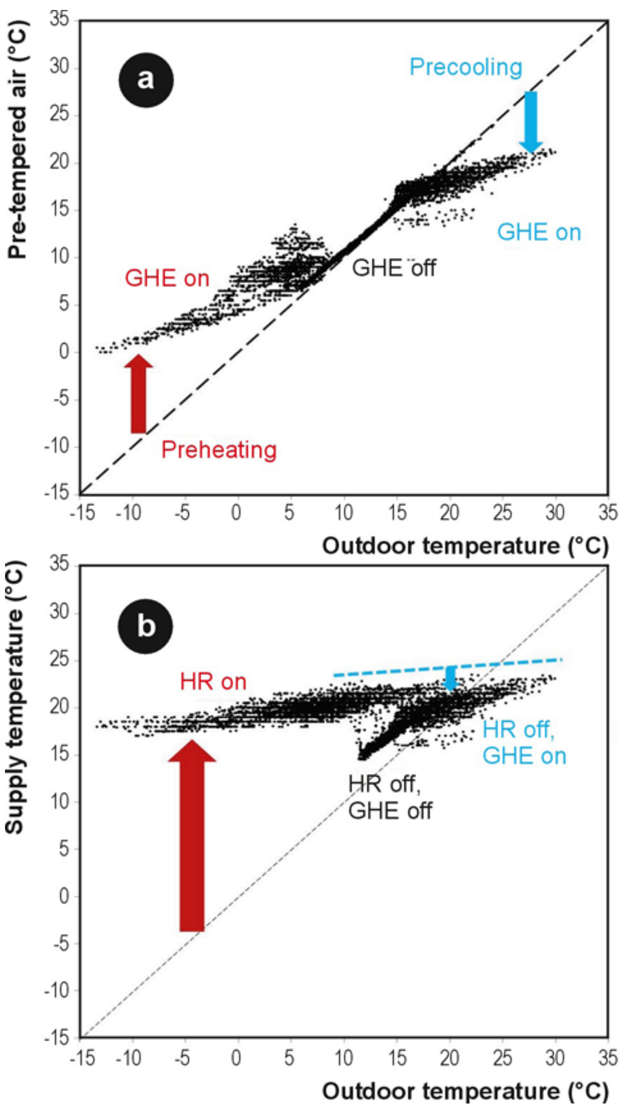


Figure 5. a) Air temperature after ground heat exchange and b) supply temperature as a function of outdoor air temperature.

The energy saving of the heat recovery is calculated in terms of avoided heating. The reference situation is that fresh air comes in at the same temperature as the outdoor air. The avoided heating thanks to heat recovery is calculated using the difference between supply air and outdoor air and the actual air flow rate. This saving is achieved using electrical energy by the fans of the heat recovery unit and the pump of the ComfoFond-L ground heat exchanger in the heat recovery season.

With heat recovery off, the free cooling for the house is calculated using the difference between indoor temperature and supply temperature and the actual flow rate. This free cooling is again achieved using electrical energy by the fans of the heat recovery unit and the pump of the ComfoFond-L ground heat exchanger outside the heat recovery season.

For this monitored installation, the values of the SPF inside en outside heat recovery season of 7 and 2 respectively are quite low compared to the reported 17 and 8 in [1]. This is because the fans and the pump take more energy. The first due to from resistance in the air distribution system and the second due to a higher pump speed setting than necessary.

Conclusions

The combination of a balanced ventilation unit with heat recovery and ground heat exchange can provide ventilation which is both energy efficient and comfortable.

In the cold season, the ground heat exchange in combination with heat recovery ensures that fresh air is brought into the rooms in a stable and comfortable way, whilst keeping the heating demand for ventilation low. In the warm season, the ground heat exchange ensures free cooling for the whole summer (not only cool summer nights), keeping the cooling load of the house low. Along with proper shading measures in the house, the ventilation system with ground heat exchange also prevents overheating of the house. ■

References

[1] Cremers B.E. 2012. Long term monitoring of residential heat recovery ventilation with ground heat exchange, REHVA Journal, August 2012, 41–46.

[2] Vollebregt, R. 2011. Koelen zonder energiegebruik door zomernachtventilatie (in Dutch), Verwarming & Ventilatie, May 2011, 268–271.

[3] Stege, C. ter 2012. Geen bevriezing of oververhitting bij ventileren met aardwarmte (in Dutch), Gawalo, November 2012, 14–17.

This article is based on the paper published in the proceedings of the Clima 2013 Conference.

MicroShade™ provides daylight and view out in the new Confederation of Danish Industry' building in Copenhagen

The Confederation of Danish Industries' main HQ has been rebuilt and extended over the past two years. An important element of the new building is a large atrium right at the center of the building – glazed with MicroShade™ to provide a great view out, comfortable daylight and a well balanced indoor climate.

HELLE FOLDBJERG RASMUSSEN
PhotoSolar A/S. E-mail: hfr@photosolar.dk

The Headquarters of the Confederation of Danish Industries ("DI") is situated right in the center of Copenhagen at the Town Hall Square, and overlooking the famous Tivoli Gardens at the rear. The building dates back to 1979 and over the past two years it has been completely rebuilt, modernised and extended.

A prominent feature of the new building is a large glazed atrium in the center. It rises to the 7th floor level, and contains a conference facility, spacious lobby and bridges which inter-connect the offices placed in the two wings of the building.

The function of the atrium

The main function of the atrium is to provide daylight to the core of the building and at the same time provide a well balanced indoor climate in order for the atrium to be used for conferences and meetings. The allowed temperature variation of the atrium in the summer is in the range from 22 to 27°C, and in the winter between 22 and 25°C. Temperatures above 26°C are accepted for 100 hours yearly, and temperatures above 27°C must be limited to 25 hours yearly. In addition, it was important to the client that the building was designed to be as energy effective as possible, and that this was reflected in the choice of materials and technologies used in the building.

The facade area of the atrium is 1 700 m² of which 1 500 m² constitute the roof and the remaining 200 m² the southwest gable. The roof is facing southeast and features 7 segments that tilt between 0 and 46°. Because of the orientation and tilt of the roof, heat gain from

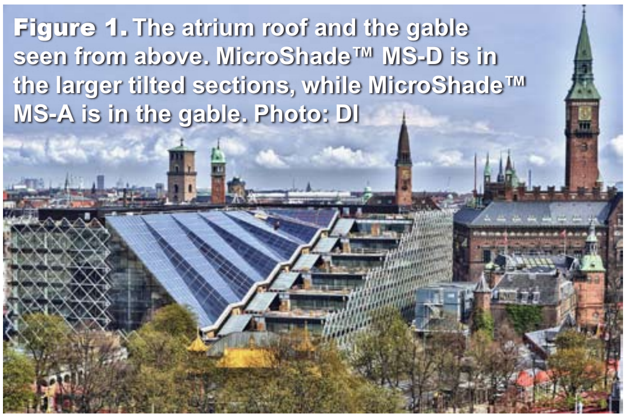


Figure 1. The atrium roof and the gable seen from above. MicroShade™ MS-D is in the larger tilted sections, while MicroShade™ MS-A is in the gable. Photo: DI

the direct sun is a major issue in the summer period. Controlling solar heat gain in the atrium without compromising daylight levels therefore became an important challenge. It was soon recognized that a very efficient solar shading had to be implemented for the atrium roof and gable.

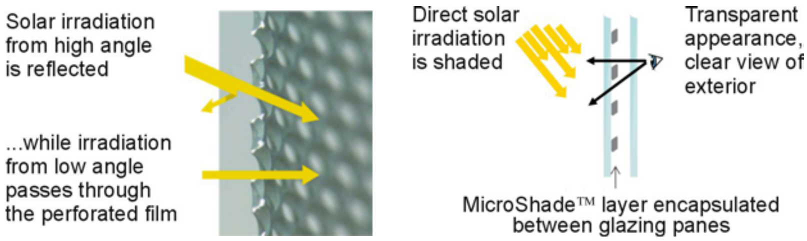
Figure 2 shows a model of the atrium. Most of the triangular surfaces of the glazed roof (No. 3, 5, 7, 9 and 11) were to be fitted with semi-transparent photovoltaics embedded in glazing. However, the light transmission on these surfaces was reduced by 94%. On the remainding surfaces No. 1, 2, 4, 6, 8, 10, 12 and the gable No. 13 a solution had to be found which would provide the required level of daylight combined with high performance solar protection.

Conventional solar shading inadequate

The initial envisaged solution for the shading contained a combination of screen printed glass and movable interior screens. The exterior screen print was designed to vary between 0 and 75% density such that the surfaces with the largest tilt had the most dense print. The movable interior screens featured an aluminum coating to reflect the heat to the outside, but the optical transparency of the screen was less that 10%.

The screen print on the glass will reduce the heat flow to the building, but the specified temperatures in the atrium only could be achieved by extensive use of the

The MicroShade™ technology is a progressive solar shading technology designed to achieve a shading performance on a level with exterior shading solutions. The progressive effect of the MicroShade™ ensures that most shading is provided when most needed. MicroShade™ is a passive element which does not require any maintenance, service or operation during use.



MicroShade™ glazing provides a reduction of the solar heat gain up to 90%, while maintaining visually transparency. The light transmittance is close to 50% for 2 layer MicroShade™ glazing.

supplementary interior screens. The disadvantages of using the interior screens were the reduction in daylight below acceptable levels and blocking the view to the outside. This combined solution was therefore rejected by the design team.

New technology: MicroShade™

As an alternative to the initial solution, MicroShade™ glazing was investigated.

MicroShade™ is a new generation of modern, energy efficient facade and roof glazing for new and refurbished buildings.

MicroShade™ solar shading consists of a patented microscopic lamella structure built into the glazing. The microscopic lamellas are angled to provide a shading of the direct solar irradiation falling onto the window while allowing light from other angles through the glazing. The advantage of these microscopic lamellas is that they are invisible to the human eye even at close distance, and hence allow a free view through the glazing at typical viewing angles. The microscopic lamellas are made of metal and are built into the product during the production of the MicroShade™ glazing. As the shading device is integrated in the glazing and contains no moving parts it requires no service and is not sensitive to the exterior climate.

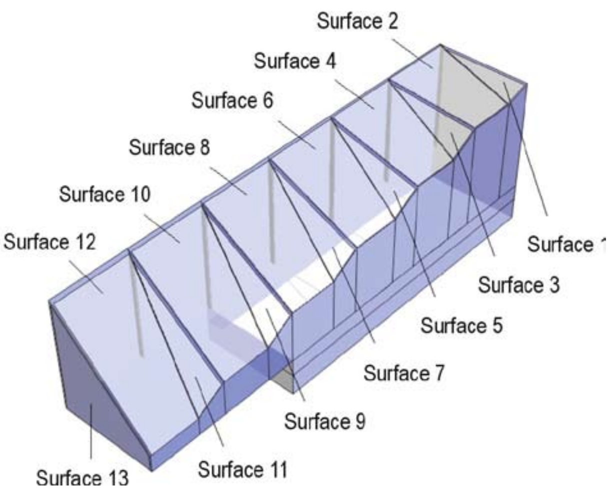


Figure 2. Model of the atrium with indication of the surfaces. Source: Rambøll

Adaptation of the MicroShade™ solution

Before the decision was taken to use MicroShade™ glazing, a series of calculations and simulations were made to compare the thermal and optical performance of different scenarios and shading solutions. Initial calculations of the solar heat gain in the atrium revealed that glazing fitted with MicroShade™ type MS-A would lead to an unacceptable heat gain on a selection of the surfaces in the atrium roof compared to the initial solution consisting of screen print in combination with interior movable screens.

As a consequence, PhotoSolar A/S, the Danish company which develops and produces MicroShade™, manufactured a new version of MicroShade™ named MS-D. The MS-D differs from the MS-A by having a steeper tilt of the microscopic lamellas. Accordingly, the shading efficiency of the MS-D is higher than that of the MS-A, and the product is better suited to the atrium roof of the DI building. The tilt of the microscopic lamellas of the MS-D was optimized to provide the same energy balance as the initial shading solution with screen print and movable screens.

Figure 3 shows a comparison of the total solar transmittance through the different solutions – screen print in combination with movable shades, MicroShade™ MS-A and MicroShade™ MS-D.

After that, detailed CFD simulations of temperature and air currents in the atrium were conducted in order to ensure the solution would live up to the indoor cli-

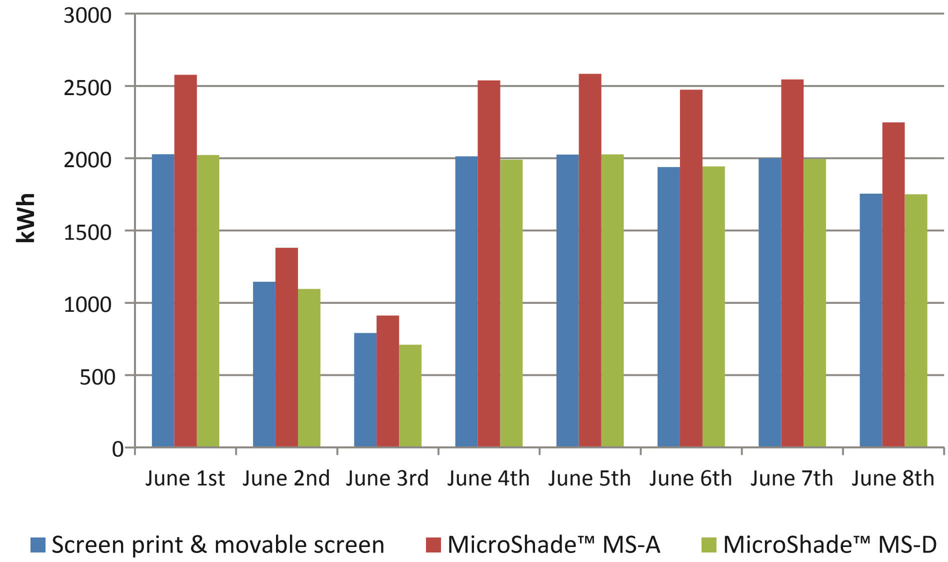


Figure 3. Total solar transmittance on selected summerdays for the original solution with screen print and movable shades, the traditional MicroShade™ MS-A and the modified MicroShade™ MS-D.

mate requirements from the tender material. The simulations showed that the modified MicroShade™ MS-D solution performed just as well as the original solution with screen print and movable shades.

View Out

A simple mock-up with a MicroShade™ glazing was made in order to test the view out through a MicroShade™ glazing. The mock-up could be adjusted to the different view angles, which exists in the atrium roof. Furthermore DI visited a MicroShade™ roof installation in Germany too see an installation of the product. In this way the client got a first-hand experience of the MicroShade™ glazing before the solution was finally decided.

There was a great satisfaction with the MicroShade™ glazing, and this together with the calculations lead to the final choise of MicroShade™ as the solar shading solution for the atrium.

The final solution

The final solution in the atrium roof became MicroShade™ MS-A Vertical in surfaced no. 1 and in the gable MicroShade™ MS-A was used. In the remaining surfaces (no. 2, 4, 6, 8, 10 and 12) the modified MicroShade™ MS-D was used.

It is not possible to tell the difference between the different types of MicroShade™ with the naked eye and thereby the entire atrium facade ended up appearing homogenous.

The MicroShade™ glazing was delivered by Glassolutions Scandinavia in the autumn of 2011 and in January 2012 the atrium roof was finished. Even though some of the interior works still remain before the building is ready for commissioning in May 2013, it already now looks very promising for the large atrium. ■

Table 1. Technical properties of MicroShade™ solar shading for four standard types.

Type	Description	Tilt of micro-lamellas	g-value [1]	Light transmittance [2]
Standard				
MS-A	For facade and roof application	16°	0.10–0.33	0.49
MS-D	For facade and roof application	23°	0.10–0.30	0.43
MS-RS	For roof application	0°	0.09–0.28	0.49
MS-RW	For roof application	40°	0.09–0.28	0.32

[1] The g-value varies with the position of the sun and depends on the glazingtype, tilt and orientation.

[2] The light transmittance normal to the surface according to EN 410. The light transmittance varies with angle of incident.

Effects of intermittent air velocity on thermal and draught perception

– *A field study in a school environment*

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"Air velocity has significant effects on thermal comfort and air quality."

Figure 1. High velocity terminals installed in a class room.

Table 1. Intermittent velocity profiles at different room temperatures. H 5 and L 15 correspond to five minutes of high velocity followed by 15 minutes of low velocity, which will be repeated as long as the temperature remain unchanged.

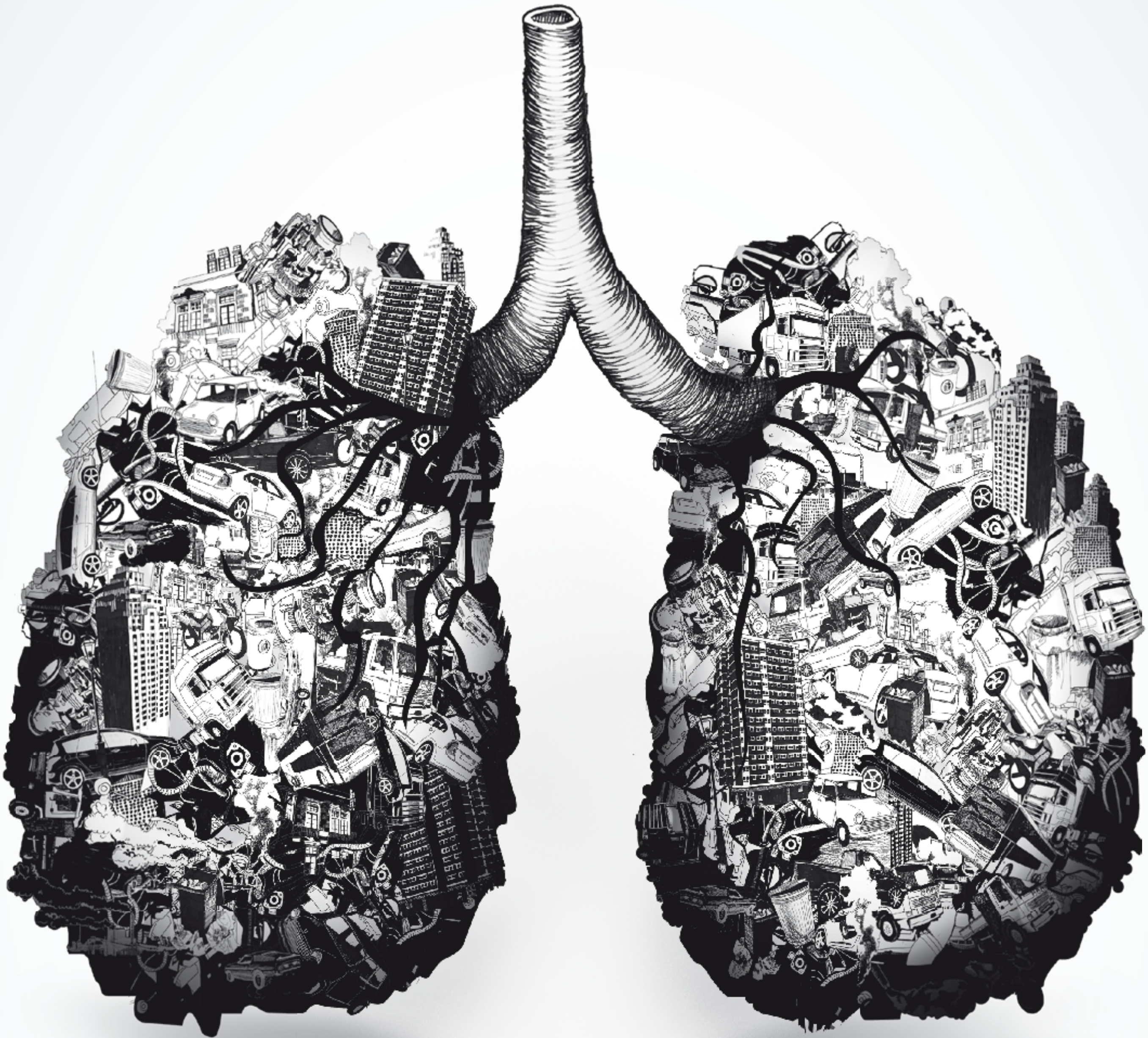
Temperature [°C]	**Velocity profile [min]**
below 22	Constant low velocity
22-23	H 5 L 20
23-24	H 5 L 15
24-25	H 5 L 10
25-26	H 5 L 8
26-27	H 5 L 6
27-28	H 5 L 4
above 28	Constant high velocity

Air movements in an indoor space may be experienced in very different ways. For persons feeling cool, air movements tend to be perceived as draught, whilst feeling warm air movements may provide a desired cooling effect. In the transition zone it therefore seems difficult to use constant air velocity as a tool for cooling without creating draught.

One possible way is to use intermittent air velocity instead of constant velocity. Intermittent air velocity, or velocity variations (**Table 1**), consists of high velocity pulses, strong enough to offer occupants the desired cooling effect but with a limited duration, in order to avoid draught. This new method was implemented in a high school in Sweden. One classroom where equipped with a ventilation system which could produce velocity variations in the occupied zone. This was realized by letting the supply air enter the room either through high velocity terminals (**Figure 1**) placed in four rows straight above the occupants, or through standard low velocity diffusers. During the high velocity period the ventilation system produced a downward air jet with a mean speed of 0.4 m/s, measured straight below the terminals at head level of a sitting person. The intermittent velocity changes or velocity profile, periods of high respectively low velocity (**Table 1**), were controlled by the room temperature. Two classrooms, which were placed beside each other and considered as having approximately identical climate conditions beside the velocity, were used to collect data. Evaluation was done during spring (April) and autumn (September).

The analysis did show significant effects of velocity condition on thermal comfort and air quality. People exposed to velocity variation perceived the air as cooler and fresher compared with those exposed to constant low velocity and very few classified the air movement as draught. A further conclusion is that even the pupils who were exposed to velocity variation wanted slightly more air movements. ■

This Research note is based on the paper submitted to International Journal of Ventilation.



News

Indoor Air Quality Session at EU´s Green Week 2013

REPORT BY MYRIAM TRYJEFACZKA – CAMFIL GROUP SUSTAINABILITY MANAGER, MYRIAM.TRYJEFACZKA@CAMFIL.FR

This year's Green Week, the biggest annual conference on European environmental policy, was dedicated to Air Quality, as 2013 has been designated European Year of Air. A comprehensive review of EU air policy is scheduled to take place in fall 2013.

The session on Indoor Air Quality, which addressed the main causes and health impacts of poor indoor air quality and possible solutions, was chaired by **Mr Charles Price**, from the European Commission's Directorate General for Health and Consumers DG SANCO. **Ms Catherine Stihler MEP** spoke about citizens' concerns about air quality in buildings. A number of research projects were also presented, including HealthVent which aims to develop health-based ventilation guidelines for Europe, Promoting Actions for Healthy Indoor Air (IAIAQ) and EPHECT, which focuses on consumer products.

Speakers of the IAQ session from left: **Pawel Wargocki**, Danish Technical University DTU – (HealthVent Project), **Catherine Stihler**, Member of the European Parliament, UK, **Charles Price**, Directorate General for Health & Consumers DG SANCO, European Commission, **Marianne Stranger**, Air Quality Measurements, Environmental Risk & Health Unit, VITO NV (EPHECT Project), **Myriam Tryjefaczka** Camfil Sustainability Manager, and **Matti Jantunen**, (IAIAQ project).

The panellists of the session stressed on the tangible benefits of tackling indoor air pollution in terms of public health, productivity and energy efficiency given that the indoor environment, where Europeans spend approx. 85-90% of their time, can be up to 50 times more polluted than outdoors. They also pointed out that to reduce exposure of people to air pollution indoors, source emission control should be a primary measure. It should be supplemented with ventilation systems for supplying air that have an adequate design and maintenance. Ventilation and air filtration technologies are available to create healthy and energy efficient indoor environments and should be further developed with innovative solutions.

"2013 is the EU Year of Air and therefore an opportunity to create a better environment for EU citizens, not only outdoors, but also indoors."

IAQ session speakers called EU Commission for

- the inclusion of the indoor air quality dimension into the upcoming Commission's communication on the review of the EU air quality strategy,
- integration of indoor air quality aspects and accounting for the associated environmental, health, social and economic impacts in the potential review of the Ambient Air Directive.
- addressing indoor air quality research needs in the Horizon 2020 Framework Programme.

Pawel Wargocki pointed out that there is a need for the integration of indoor air quality in maintenance and operation procedures including outdoor air, building and air system and regular indoor air quality auditing in the future recast of Energy Performance Buildings Directive (EPBD) and in the revision of ventilation regulations.

As a conclusion of the panel discussion, Experts, Mrs Stihler, and Camfil, joined their voices in encouraging the European Commission to launch the debate on the future EU framework on indoor air quality with a Green Paper.

Presentations of the session can be downloaded from Speakers and presentation section - June 5th session 4.1 on Green Week 2013 website http://greenweek2013.eu

More information:

HealthVent: http://www.healthvent.byg.dtu.dk/
HealthVent report will be published fall 2013.

European Collaborative Action on Urban Air, Indoor Environment and Human Health (2013). Guidelines for health-based ventilation in Europe. Ispra, European Commission, Joint Research Centre, Institute for Health and Human Protection, Physical and Chemical Exposure Unit (Report No. 30)., in preparation.

REHVA was the leader of WP5 of HealthVent project. See the report at www.rehva.eu

Ephect https://sites.vito.be/sites/ephect/Pages/home.aspx
IAIAQ http://ec.europa.eu/health/healthy_environments/docs/env_iaiaq.pdf
Camfil http://www.camfil.com

Eurovent certification and Certita merged

Paris, July 15th, 2013 - CERTITA and EUROVENT CERTIFICATION Company, leading product certification companies in the field of heating, ventilation, air conditioning and refrigeration (HVAC-R), have successfully completed the merger of their certification activities within a new corporation named **Eurovent Certita Certification**.

From July 1st, 2013, all merged certification activities are operated by this new entity having its head office at Paris La Défense. The firm is headed by a Management Board on which sits the President Erick Melquiond and the Managing Director François-Xavier Ball.

The combined company becomes a major European certification body in the field of HVAC-R, operating 35 certification programs and generating about € 9 million in turnover. As a result of the merging, Eurovent Certita Certification is now providing voluntary third part certification services on the full range of HVAC-R products, whatever their final use, either in residential domestic buildings or in industrial facilities for instance. Eurovent Certita Certification is offering various certification schemes tailored to the needs of manufacturers and stakeholders on their specific markets. It focuses on certifying product performance as well as data needed to implement regulations. The main quality marks currently proposed are the marks "Eurovent certified performance", NF, CSTBat, and the European Keymark.

The recognition of these well- known brands will be further enhanced by the merging and the combined company will optimize their granting through its one-stop shop for certification.

On a market ever more demanding in terms of energy performances and environmental challenges, Eurovent Certita Certification is fit for supplying certified data at a European level and providing the needed confidence on the playing field.

Certification schemes proposed for both domestic & industrial facilities:

Thermodynamics: Heat pumps, air conditioners, liquid chilling packages, VRF, rooftop, …

Comfort appliances: Radiators, fan coils, solar collectors and heaters, heating appliances using liquid or solid fuels, mobile liquid fuel heaters, chilled beams …

Cooling & refrigeration: Cooling and heating coils, cooling towers, heat exchangers, milk coolers, condensing units, compressors, refrigerated display cabinet...

Ventilation: Mechanical ventilation, air handling units, fans, flue pipes, filters, heat recovery. ■

More information:
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ASHRAE President 2013-14

The new president for 2013-14 is **William P. Bahnfleth**, Ph.D., P.E., Fellow ASHRAE, ASME Fellow, a professor of Architectural Engineering and director of the Indoor Environment Center at The Pennsylvania State University, University Park, Pensylvania.

As ASHRAE's president, Bahnfleth chairs the Society's Board of Directors and Executive Committee. Bahnfleth's Presidential Theme, "Shaping the Next," focuses on embracing our responsibility to "Our World" – fellow humans and the earth, to make buildings safe, healthy, productive, comfortable environments in harmony with nature. To do this, he believes we must develop "Ourselves" – the human resource of the professional community, and transform "Our Work" – what we do, how we do it, and who we do it with, by becoming more global in outlook, broader in scope, and more collaborative in approach.

Mr Bahnfleth attended as president-elect the REHVA´s Clima World Coference in Prague, and made an excellent key note speech stressing the importance to develop technology to achieve both good Indoor Environment and Energy Efficiency.

International Energy Agency promotes Ventilative Cooling

Ventilative cooling refers to the use of natural or mechanical ventilation strategies to cool indoor spaces. This effective use of outside air reduces the energy consumption of cooling systems while maintaining thermal comfort. The most common technique is the use of increased ventilation airflow rates and night ventilation, but other technologies may be considered as well. Ventilative cooling is relevant in a wide range of buildings and may even be critical to realize renovated or new NZEB.

The Executive Committee of the IEA accepted the formation of a new IEA Annex on Ventilative Cooling at their last meeting in November 2012. This new Annex 62 is given a one year preparation phase which, if successful , will continue in a four year working and reporting phase from 2014 – 17. During the preparation phase two workshops will be arranged to define and focus the Annex's objectives, feasibility, methodology, and deliverables in detail. The 1st Annex 62 Preparation Meeting was held March 21 – 22 in the BBRI offices, Brussels, Belgium and **the 2nd Preparation meeting will be held in Athens, September 23-24, 2013**.

In order to address the cooling challenges of buildings the research focus of the annex will be on development of design methods and compliance tools related to predicting, evaluating and eliminating the cooling need and the risk of overheating in buildings and to develop new attractive energy efficient ventilative cooling solutions. Annex 62 will be divided in three subtasks. Subtask A "Methods and Tools" will analyse, develop and evaluate suitable design methods and tools for prediction of cooling need, ventilative cooling performance and risk of overheating in buildings. The subtask will also give guidelines for integration of ventilative cooling in energy performance calculation methods.

7th EU Environment Action Programme

The text of the 7th EU Environment Action Programme has been agreed upon by the Council and the European Parliament The European Parliament will vote on the programme in October.

The programme is a clear step forward in protecting not only the environment but also in promoting the health and quality of life of Europe's citizens. It is a programme for action to 2020, which sets 9 priority areas: 3 thematic priorities and then an enabling framework including 6 priorities. Measures for health protection are defined in priority objective 3 "to safeguard EU citizens from environment-related pressures and risks to health and wellbeing".

Protecting vulnerable groups runs as a thread through the different measures discussed under priority objective 3, for example for indoor air or chemicals (see details below).

For the first time, the programme gives due weight to improving the **quality of the indoor air**. First, the goal is now set to improve indoor air by 2020; second, it is also included in the measures that need to be taken ("developing and implementing measures to combat air pollution at the source, taking into account differences between source of indoor and outdoor air pollution"); third, it is included in the strategy that is established for a non-toxic environment, which has to be set up by 2018 ("developing by 2018 an EU strategy for a non-toxic environment, building on horizontal measures by 2015 which include inter alia promoting non-toxic material cycles and reducing indoor exposure to harmful substances") and fourth, it is now clearly included when the air pollution problem is defined. Given that the Commission proposal did not at all mention indoor air, this outcome is really good, and will allow us to push the Commission for a Green Paper/EU strategy.

The 7th EAP sets the goal that by 2020 **outdoor air quality** has significantly improved, moving closer to WHO recommended levels. The WHO guidelines are now included, but they were not in the initial proposal.

The text of the programme is now available *.

* http://www.europarl.europa.eu/meetdocs/2009_2014/documents/envi/dv/envi20130710_7th_eap_2012-0337-cod_/envi20130710_7th_eap_2012-0337-cod_en.pdf.

News

ISHVAC 2013

– 8th International Symposium on Heating, Ventilation and Air Conditioning

October 19-21, 2013, Xi'an, China

The conference series was initiated in Tsinghua University in 1991. It has been the premier international HVAC conference initiated in China and has played a significant role in the development of HVAC and indoor environment research and industry in China.

The conference mainly concerns the issues on: Sustainable building, Indoor environment, Climate and outdoor environment, Power and energy system, HVAC&R component, Modelling and simulation, Building information and management.

More information: www.ishvac2013.org

REHVA-Conference 2014

April 29, 2013, Düsseldorf, Germany

During the REHVA Annual Meeting 2014 in Duesseldorf, a conference will be held to follow up on the topics of energy-efficient, smart and healthy buildings from the last REHVA world congress in Prague.

Program and other information will be available soon at: www.vdi.de/rehva-AM-2014.

Indoor Air 2014

July 7-12, 2014, Hong Kong

Indoor air 2014 will be a promising event for those who want to learn and share the latest science and technologies for better air environment in buildings. The triennial Indoor Air conference series was started in 1978 in Copenhagen to promote the science of indoor air quality and climate, to provide a venue for presentation, collaboration and generation of new ideas related to indoor environment. Indoor Air is the official conference of the International Society for Indoor Air Quality and Climate, ISIAQ.

Indoor Air 2014 will be a

- A truly multi-disciplinary conference - A new indoor air research culture has emerged in Hong Kong after the 2003 SARS epidemics with engineers, epidemiologists and microbiologists working together.
- A conference for both developed and developing countries - As a developed economy, Hong Kong is unique as a part of the largest developing country in the world. Hong Kong provides easy access to the other major developing countries in the region while also sharing many of the indoor air challenges of developed countries
- An indoor-air-science-for-the-future conference - All local organization committee members are active scientists of indoor air or related disciplines.

More information: www.indoorair2014.org

Cold Climate HVAC 2015

October 20-23, 2015, Dalian, China

The 8th International SCANVAC Cold Climate HVAC Conference 2105 is organized by Dalian University of Technology with Tsinghua University and VTT Technical Research Centre of Finland as co-organisers. The conference topics cover:

- Sustainable building energy saving
- Zero energy building
- Heating technology and policy
- Usage of renewable energy
- Ventilation and heat recovery
- Heat pump technology

Cold Climate HVAC 2015
The 8th International Cold Climate HVAC Conference
Dalian, China

The Cold Climate 2015 conference will provide a platform for discussing building energy and environmental issues for initiating collaboration among scientists, designers, engineers, manufactures and other decision makers to achieve the eco energy efficient buildings and districts with comfortable and healthy indoor environments. And Dalian is a charming harbor city.

We are looking forward to meeting you in the Cold Climate 2015 conference in Dalian, China.

Istanbul
Climamed'13
Mediterranean
Congress of Climatization

The 7th International Mediterranean Congress of Climatization, CLIMAMED'13, will take place in Istanbul, Turkey on 3 – 4 October, 2013 at Harbiye Military Museum.

Co-organized biennially by REHVA Members AICVF (France), AICARR (Italy), APIRAC (Portugal), ATECYR (Spain) and TTMD (Turkey). CLIMAMED provides a forum to exchange knowledge and experience for designers, manufacturers, contractors, and end-users alike.

The main theme of CLIMAMED'13 is **Net Zero Energy Use in Buildings.** The Congress will cover all aspects of HVAC&R technology and focus on the use of sustainable energy in buildings by applying the latest research and technical innovations into practice.

So far CLIMAMED'13 has received 159 abstracts from 21 countries. During the congress we will be arranging oral and poster presentation sessions. There will be three invited lectures.

In addition we organized a panel titled "**nZEB Approaches in Mediterranean Countries**" where experts from five countries will share and decipher research expertise to broaden the scope of discussions.

Some of the highlights from the CLIMAMED'13 Congress

- 90 oral presentation
- 8 poster presentations
- Panel session
- Cocktail on Bosphorus, Cruise
- Climamed Gala Dinner - October 3,2013 Four Seasons Hotel Bosphorus

More information: www.climamed.org

RoomVent 2014

13th International Conference on Air Distribution in Rooms and airplanes
Sao Paolo, Brazil, from October 19 to 22, 2014

The Scandinavian Federation of Heating, Ventilating and Sanitary Engineering Associations - SCANVAC, formed by HVAC Associations in Denmark, Finland, Iceland, Norway and Sweden, initiated the series of ROOMVENT conferences several years ago.

The theme of the next confernce is "New ventilations strategies with base in active and passive technology in building and for comfort in airplane".

The Conference will offer scientists and academics, business professionals like consultants, engineers and architects together with policymakers, a platform for the exchange of scientific knowledge and technical solutions. The conference will also provide the opportunity to view the state-of-the-art technologies, to interact with others and to work together for the benefit of the indoor environment and energy performance of buildings and airplanes.

The whole organizing committee, warmly invites you ROOMVENT 2014 in Sao Paulo, Brazil.

More information: www.roomvent2014.com.br.


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The 12th REHVA World Congress – CLIMA2016

At the 11th REHVA World Congress – CLIMA2013, which was held in June 2013 in Prague, Czech Republic, it was announced that the next congress CLIMA2016 will be organised in **Aalborg, Denmark on May 22 – 25, 2016.**

The scope of the 12th REHVA World Congress, CLIMA2016 will be to offer researchers, industry, building owners, end users, consultants, engineers, architects, policy-makers, etc. a platform for the exchange of scientific knowledge and innovative technical solutions. The special theme of the 12th Congress will focus on building and HVAC system performance in practice both in relation to fulfilment of the intended design, in relation to their ability to fulfil the needs of the occupants and in relation to their interaction with the users in daily practice.

Aalborg is located in a region where focus on new energy efficient technologies for the built environment is very dominating. This includes among others a city like Frederikshavn, which has planned a 100% supply by renewable energy by 2015 and is a demonstration platform for new HVAC and energy technologies in the built environment in new and renovated constructions. The region also hosts a number of well-known companies involved in renewable energy and energy efficient technologies as Grundfos, Vestas, Danfoss, Velux, etc. Hosting the 12th REHVA World Congress in Aalborg, Denmark in 2016 will therefore also offer excellent opportunities for real life experience and demonstration of the key role HVAC systems will play in the future in the built environment.

Professor Per Heiselberg, Department of Civil Engineering, Aalborg University will be the congress president. ph@civil.aau.dk

For more information: www.clima2016.org

New president and board members of REHVA

REHVA installed a new president and elected two board members at its Annual Meeting in Prague as a part of the Clima World Conference. Professor Karel Kabele was elected as president-elect a year ago in the REHVA Annual meeting in Timisoara. His term began at the Annual meeting, and lasts until the annual meeting in 2016.

Two new board members for 2013-2016 are **Manuel Carlos Gameiro da Silva** from Portugal and **Frank Hovorka** from France. REHVA Journal had an opportunity to interview the new president and the new board members.

Ian Dobosi from Romania and **Jarek Kurnitski** from Estonia were re-elected to the board for the next three year term. The other REHVA board members, **Zoltan Magyar** from Hungary and **Stefano Corgnati** from Italy continue their terms.

Q: Professor Karel Kabele, how do you see the role of REHVA within the players of the constructions sector?

– The construction sector has undergone dramatic developments in recent years.

On the one hand, we feel a strong pressure to reduce energy consumption in buildings and reduce the impact of buildings on the environment; on the other hand, there are increasing demands on the quality of indoor environment and building management. Modern architecture also requires maximum use of natural principles (passive cooling, natural ventilation, day lighting), and all this creates an extremely inspiring environment for the development of new technologies.

REHVA, which brings together representatives of professionals from designers, consultants, developers, researchers and academics in the field of HVAC, has to address issues associated with the amount of energy savings in buildings, quality of the indoor environment and the application of modern technology.

PROF. **KAREL KABELE**
REHVA President 2013-16, is a full-time professor and head of the Department of Microenvironment and Building Services Engineering in the Faculty of Civil engineering at Czech Technical University in Prague.

The strength of REHVA is its ability to link practice with the theoretical base of experts from leading European universities, and to influence European and national regulations. REHVA represents European countries, and so its primary goal is the development of the construction market for European players.

Q: What are the most important issues REHVA should work with in the near future?

– REHVA, during the last 10 years, has significantly developed its activities, which is proven by the expanding library of REHVA Guidebooks, REHVA Journal with professional content, a number of European projects that involved REHVA, seminars for major professional events and participation of more than 900 experts from around the world at the Prague Congress CLIMA.

The task of the Federation in the near future is to build on and further develop those activities that benefit our members and industry partners. Ahead of us is a long-term REHVA strategy update on the development of cooperation with other partners outside Europe, and adapting internal structures to the needs of REHVA members.

Last but not least, it is also the development of the membership base – we would like to establish cooperation with organizations in those European countries that do not yet have a representative in REHVA.

Q: What do you want to accomplish during you term as the REHVA president?

– During my term, I would like to focus on three areas of REHVA development. The first area is the development of the membership not only by inviting representatives of the remaining European countries, but mainly through dialogue with existing members and finding their needs and expectations from membership in this prestigious organization. I wish that each individual member of our member organizations realizes that he is a member of REHVA and has the ability to take advantage of this unique community of experts to support the implementation of its projects, and the acquisition of information and contacts. This is possible only on condition of a perfectly functioning, stable professional office.

The second area I would like to focus on is the use of the potential in cooperation between our industrial partners and European legislation, practices and universities and help to identify topics of research and development.

The third area is the development of cooperation with other professional organizations, not only in Europe, and seeking mutually beneficial activities.

MANUEL CARLOS GAMEIRO DA SILVA

New REHVA Board member.

Mr. da Silva is an Associate Professor with Aggregation of Departamento de Engenharia Mecânica (DEM) at Faculdade de Ciências e Tecnologia da Universidade Coimbra (FCTUC), Universidade de Coimbra, Portugal.

Q: Mr. da Silva, how do you see the role of REHVA within the players of the constructions sector?

– REHVA has a very special position because it may act as a mediator between the active forces of the market and the political decision makers. Being recognized as an independent organization holding the knowledge about the sector, it has a very strong ability to influence its evolution. Following this trend, and keeping in mind that its power comes from its independence, will surely have the possibility to play a central role in the near future. Our mission, as regards this particular question, should be to find the best/wisest compromises between the interests of the various parts involved each time new decisions, regulations, directives, etc. are to be launched.

Q: What are the most important issues REHVA should work with in the near future?

–REHVA should continue its policy of being the meeting point of different players (e.g. company representatives, technicians, scientists, decision makers, etc.) promoting the cross fertilization of ideas and creating an innovative environment.

The investment in the relationships with sister associations of other geographical areas should continue and be encouraged. This is fundamental to promote European engineering solutions all over the world.

As regards topics of interest for REHVA activities, I envision the aspects related to the environmental certification of buildings which is relatively fuzzy in a world perspective. Also the call of attention about the need to consider the indoor environmental quality (IEQ) when analyzing the energy efficiency is a cause that REHVA should go on defending, because there is a strong risk that IEQ will be forgotten if a purely economic point of view is adopted.

The dialogue with the EU services about the implementation of Energy Policies is also an issue that deserves a strong commitment from REHVA, because this is perhaps the most fruitful mission of REHVA. Giving technical input, promoting the discussion and helping the implementation of measures is a crucial role for REHVA.

Q: What do you want to accomplish during you term at the REHVA board of directors?

– I would like:

- to structure and enlarge the offers of REHVA in the education/training sector;
- to study the possibility of having a statute that allows giving to an individual the feeling of belonging to REHVA (of course taking into account that the membership is reserved to national associations);
- to contribute to the promotion of the relationships with Latin America and Africa.
- finally, to have a positive contribution to strengthen the financial situation of REHVA.

FRANK HOVORKA

New REHVA Board member.

Mr. Hovorka is working for the 'Caisse des Depots' group in France, where he is in charge of the real estate sustainable development policy. He is also co-chair of UNEP-FI Property Working Group and chair of Sustainable Building Alliance and IISBE board member.

Q: Mr. Hovorka, How do you see the role of REHVA within the players of the constructions sector?

– I fully endorse the role of REHVA as dedicated to the improvement of health, comfort and energy efficiency in all buildings and communities. This role is today very effective through research and participation to normalization programs. The impressive success of CLIMA 2013 confirms once again the strong position of REHVA and the involvement of its members.

With the fast evolution of our industry, education and training programs will become an important issue at national and European levels with programs such as skill development, especially to achieve the EU goals of energy needs reduction through acceleration of building retrofit.

REHVA is a solid organization, not only by the age of 50s, but through the highest quality of work developed by its members at every level. The recognition by EU officials is a clear achievement of this work.

At the international level, meetings and MoUs with sister organizations are in place to now implement cooperation programs based on knowledge dissemination in order to maintain the visibility of European engineering and industry.

Q: What are the most important issues REHVA should work with in the near future?

– The structure of REHVA organization, which has an advantage from its cultural and geographical diversity, offers a great strength to organize position papers and offer more visibility to HVAC industry and research at European level.

This work, conducted with a high level of transparency with the members and the industry, is one of the key roles for REHVA in its collaboration with the European Commission directions and institutions that can be a clear differentiator with other associations represented in Brussels.

EU project participation is also an important channel for the development and visibility of REHVA.

Position papers, such as the nZEB report published in June, are very powerful tools for REHVA members in the EU.

The international cooperation is also an important development not only to maintain relations with other organizations but also to influence EU policies for external cooperation.

Q: What do you want to accomplish during you term at the REHVA board of directors?

– I would like to enhance the cooperation with other stakeholders among the building industry. It is obvious that the expertise of REHVA members could be used by other stakeholders for risk analysis, improvement of construction and retrofit quality and efficiency.

One of the key questions is how to assess quality and performance of components, then systems, then buildings according to the planned use, their location and potential access to energy.

I believe that cooperation with decision makers could be a great opportunity for REHVA. This task would be a real challenge in order to understand the needs of these stakeholders and translate their technical knowledge to other stakeholders such as investors, finance or insurance companies.

Cooperation with industry for a better understanding of service quality, system performance and lifespan, global cost translation into investment process… is a part of this process to improve the trust chain between stakeholders through a common language. ■

REHVA 2013 General Assembly

The 57th REHVA General Assembly was held on Saturday 15 June 2013 in Prague, Czech Republic. It gathered nearly 90 national representatives from 27 European countries. After a welcoming address by the host, STP President, Prof **Karel Kabele** from Czech Republic, Prof **Michael Schmidt** opened the session with a short presentation of the 2012 report.

Later afternoon, Prof. Karel Kabele was installed as the 15th REHVA president. He and the Assembly warmly thanked Michael Schmidt for his important contribution to REHVA's development during the two last years. During the GA, a new board was unanimously elected. Two Board Members saw their mandate renewed. **Bjarne W. Olesen** decided to step down due to other professional activities. Former President Michael Schmidt came at the end of his term. The meeting ended with the introduction of the newest REHVA Member, the Moldavian Association of Heating, Ventilation and Air-conditioning engineers, AIIRM.

Former president Prof **Michael Schmidt** (left) and present REHVA president 2013-16 prof **Karel Kabele**.

50th Anniversary Gala dinner

This year marked the 50th Anniversary of REHVA. To celebrate this important event, a Gala Dinner was organized on Saturday June 15th in a prestigious venue of high quality cuisine and service, the Art Nouveau Francouzska restaurant located in the Prague Municipal house. The 200 guests enjoyed a pleasant evening enriched by live piano or jazz music. During this evening the REHVA former President; Michael Schmidt related the past 50 years of REHVA. REHVA received awards from ISAQ and ASHRAE. A commemoration gift was also offered by ABOK.

On this occasion, the following members of REHVA national associations received a REHVA Award: **Mrs Lisje Schellen** (TVVL – The Netherlands) and **Mr Miroslav Urban** (STP – Czech republic) received a REHVA Young Scientist Award; **Mrs Otilia Lulkovicova** (SSTP – Slovakia) was recognized for her outstanding achievements in design and for her contribution to improve energy efficiency and the indoor environment of buildings; **Mr Miroslav Kotrbaty** (STP – Czech Republic) was recognized for his outstanding achievements in technology and for his contribution to improve energy efficiency and the indoor environment of buildings; **Mr Teet Kõiv** (EKVÜ – Estonia) and former REHVA President Prof. **Michel Schmidt** (VDI – Germany) were recognized for their outstanding achievements in science and for their contributions to improve energy efficiency and the indoor environment of buildings.

REHVA Board of directors 2013 and the secretary general from left **Jarek Kurnitski** (EKVU, Estonia), **Zoltan Magyar** (ETE, Hungary), **Stefano P. Corgnati** (AiCARR, Italy), President **Karel Kabele** (STP, Czech Republic), **Jan Aufderheijde** (Secretary General), **Iaon Silviu Dobosi** (AIIR, Romania), **Manuel Carlos Gameiro da Silva** (Ordem dos Engenheiros, Portugal).


Miroslav Urban


Otilia Lulkovicova


Lisje Schellen


Ondřej Hojer


Teet Kõiv


Jorma Railio


Risto Kosonen


REHVA 2013 General Assembly participants.

During the evening, the Organisation of National Societies of Heating, Ventilating and Air Conditioning in the Nordic countries (SCANVAC) honored two of the prominent experts, Mr **Jorma Railio** with the SCANVAC award and Dr. **Risto Kosonen** with the Rydberg Gold Medal due to his work with air distribution. ■

REHVA Student Competition

During the Clima 2013 World Congress in Prague, the REHVA student competition took place. Participants from 10 REHVA Member Countries had nominated candidates to present their bachelor or master theses for this competition. REHVA jurors from seven nations followed 15 minute presentations. The students also had to prepair a poster presentation of their work. This year's winner, **Felipe Ventura** from Portugal, was invited to present his work at the Clima 2013 conference the following day. His thesis "Carbon emissions – Comparative Study of HVAC-Systems in Hospitals" was presented during the plenary session. Prof. **Karel Kabele**, President of REHVA, expressed his appreciation of the work of all participants during the ceremony. He expressed his opinion that the scientific and professional experience gathered by participating should not be undervalued.

Next year's student competition will take place at the REHVA Annual Meeting to be held on 29th and 30th April, 2014 in Duesseldorf, Germany (Competition on 29th, Ceremony on 30th). Send nominations to REHVA (info@rehva.eu) until 1st of January, 2014. REHVA will host the young people in Duesseldorf, travel expenses should by covered by the national REHVA member.


Back row: Juris Sorokins (Latvia), Marije te Kulve (the Netherlands), Charlotte Buhl (Germany), Michal Bejček (Czech Republic), Ana-Maria Pasăre (Romania), Paul Anghel (Romania), Üllar Alev (Estonia).

Front row: Marcin Wronowski (Poland), winner of the competition Felipe Ventura (Portugal), Balázs Both (Hungary), Lucia Borisová (Slovakia), Veronika Földváry (Slovakia)

ATIC celebrates its 75th anniversary

ATIC, the Belgium national member association of REHVA celebrated their 75th anniversary on June 7 2013. The venue of the festivities was the magnificent Colonial Palace in Tervueren. ATIC presented on this occasion a new logo. After a historic overview over the past 75 years by **Mr. Mampaey**, **prof. Jiang Yi** from the Tsinghua University Beijing, presented his key note concerning nZEB.

REHVA was represented by **Mr. Jan Aufderheijde**, Secretary General. He congratulated ATIC with this milestone and handed over a plaque on behalf of REHVA. He underlined the active role ATIC played in the start-up phase of REHVA, now nearly 50 years ago. ATIC was one of the 'founding fathers' and organized several REHVA Annual Meetings and also a Clima 2000 congress. Jan Aufderheijde was pleased to see that

Mr. **Jan Aufderheijde** (right), Secretary General of REHVA congratulates ATIC with their 75 anniversary, ATIC's president, Mr. **Joris Mampaey** on left.

ATIC is broader than just HVAC, and also covers other disciplines of Building Services.

Danvak conference

Hot HVAC Topics and an XL check to promising young PhD student

Chairman of Danvak Mr. **Jørn Schultz** together with the award recipient, **Tobias Gybel Hovgaard** who received rounds of applause, a diploma and a size XL check at the conference Danvak Dagen on 10 April 2013.

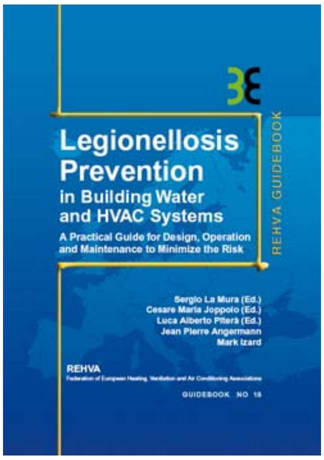
Danvak – The Danish Society of Heating, Ventilation and Air Conditioning – held its annual conference on HVAC issues on April 10, 2013. More than 150 people attended the conference, among them exhibitors, academics, professionals from the corporate and public sector, journalists and students who had all showed up to gain and learn from the latest development in the HVAC field. The conference was held at IDA Conference Centre run by The Danish Society of Engineers, IDA.

Taking a broad and cross-disciplinary approach to addressing HVAC issues in contemporary society, conference session topics, among others, included: Smart Grid, Solar Shading, Indoor Climate, the Danish Solar Decathlon Participation, Energy Service Companies (ESCO), Ventilation and Air Distribution, Daylighting Performance Assessment, Active House Specification, Energy Saving Renovation and Low Energy Buildings. The conference, moreover, offered an opportunity to learn about two new Danish standards which became operative in March 2013. The standards in question are "Heating and cooling systems in buildings" and "Ventilation for buildings – Mechanical, natural and hybrid ventilation systems".

According to tradition the Professor P.O. Fanger's Award was announced at the conference. This year the award was given to Tobias Gybel Hovgaard – an industrial Ph.d student at Technical University of Denmark - who had demonstrated excellence within the field of Smart Grid research. Tobias Gybel Hovgaard was nominated by his dissertation supervisor, Associate Professor John Bagterp Jørgensen, for his study on "Power Management for Energy Systems". This project was carried out in close collaboration with the Danish companies Danfoss and Vestas.

Sergio la Mura, Cesare Maria Joppolo, Luca Alberto Pitera, Jean Pierre Angermann & Mark Izard:

Legionellosis Prevention in Building Water and HVAC Systems – New REHVA Guidebook no 18



The Guidebook has been prepared by an European Working Group (leaded by AICARR, the Italian Air Conditioning Heating Refrigeration Association) and has been published by REHVA the European Federation of Heating, Ventilation and Air-conditioning Associations.

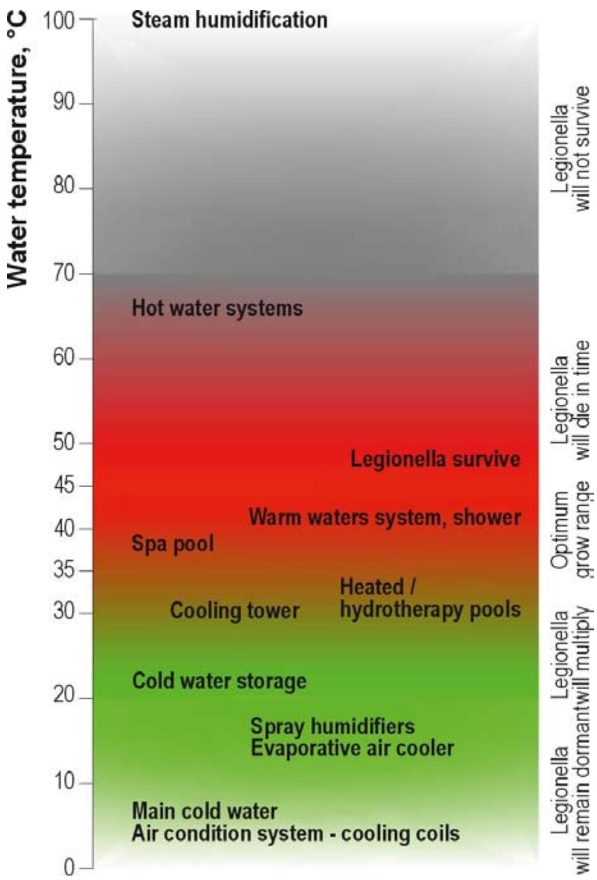
The Guidebook adopts an articulated structure for each of all building services sectors covering four aspects (i.e. introduction; how to design a new installation; how to evaluate an existing installation; how to effect corrective modifications to an existing installation. Special concern and a separate section of the book have been devoted to Operation & Maintenance (O&M) in consideration of their relevance both from a technical point of view and from a "procedure" approach. The following snapshots illustrate the technical contents of the Guidebook.

Growing conditions of *Legionella*

Presence of the bacterium *Legionella* is present in natural and artificial aquatic environments: it is to be found in springs, including hot springs, in rivers, lakes, mists/vapors, and in the soil. From these environments it reaches man-made environments such as city mains conduits and building service water installations, such as tanks, pipes, fountains and swimming pools. Legionella bacteria have been detected also in river or torrent mud, or in clay for terracotta pottery articles.

The conditions favorable to the proliferation and to the presence of the bacterium are:

- a water temperature between 20°C and 45°C, where growth of Legionellae is possible;
- service water systems with a temperature not greater than 60°C;
- acid and alkaline environments, with pH values between 2.7 and 8.3.
- stagnation conditions of the water in distribution piping networks and in storage systems;
- presence of scaling and/or sediments inside piping networks;
- presence of nutrients and shields, giving eg. by amoeba and biofilm.



Effects of temperature upon the reproductive mechanisms of the ***Legionella*** bacteria and operating ranges in some applications.

Air conditioning humidification

The influence that humidity has on human comfort has still not been precisely established. Conditions of comfort for people are to be found for humidity values between 30 and 60%.

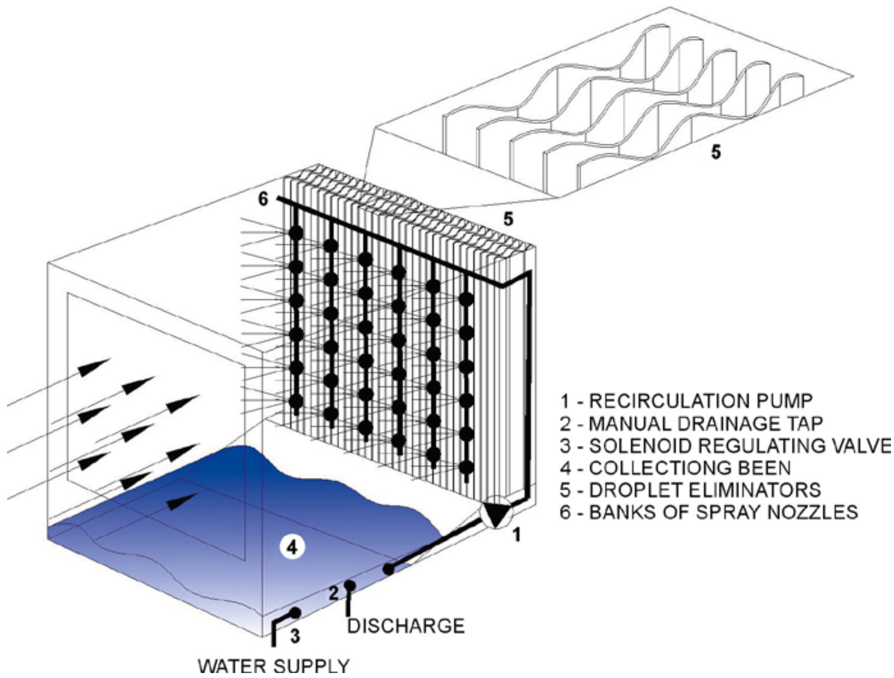
Illustration and specification of health and hygiene aspects of humidification system for:

- Adiabatic humidifier
- Steam humidifiers

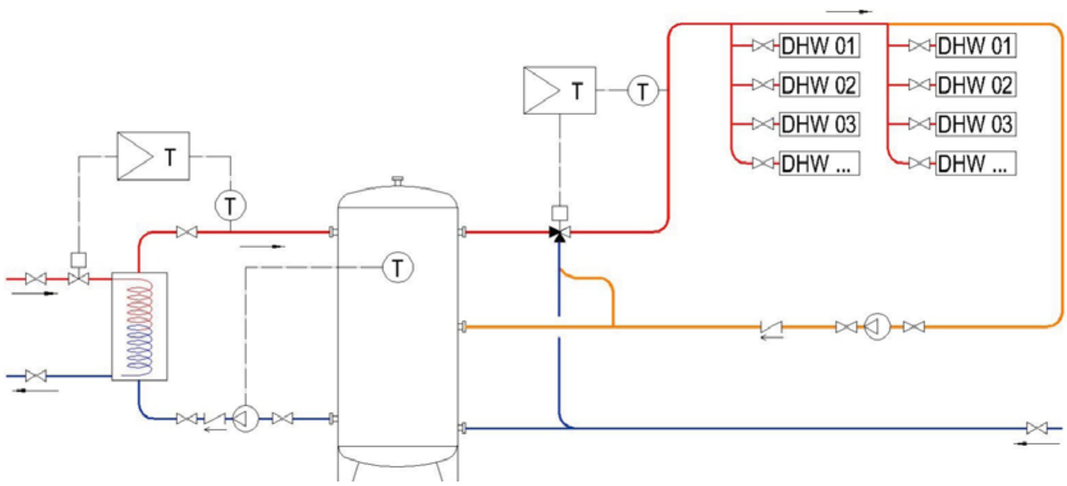
Hot and cold potable water hydraulic networks and installations

Situation with risk of proliferation occurs when water remains at rest for a long time (stagnation) at temperatures between 20° and 50°C, and particularly between 32° and 40°C.

These conditions are normally to be found in service Hot Water Systems for hygienic and washing purposes; the hot water can also become warm / lukewarm (32 – 40°C) by choice of design (mixing valve control) or through running or malfunctioning. Temperature range above 20°C can, on the other hand, also occur in Cold Water Piping Networks, which are considered to be at



Schematic drawing of an adiabatic washer inserted in an air handling unit.



Schematic drawing of sanitary hot water network with semi-instantaneous production.

temperatures below those of proliferation because they are fed by mains water or well-water (at temperatures which are usually below 15°C).

FOCUS on:

- Production of sanitary
- Hot water with storage
- Tank

And for the sanitary hot water

- Instantaneous production of sanitary hot water
- Semi-instantaneous production
- Design Expedients
- Description of water treatment techniques

Evaporative cooling towers

Evaporative cooling combines high thermal performance and good cost efficiency through low cooling temperatures which mean containment of energy and water usage. The evaporative cooling tower is an energy-efficient device of relatively simple design and operation, with many applications both for buildings HVAC systems and for industrial processes. But, errors in design or construction, or poor maintenance procedures, particularly in those installations with seasonal usage (e.g. summer air conditioning installations), can generate the conditions for proliferation and diffusion of the bacterium.

FOCUS on:

– Evaporative cooling tower operation;
– Cooling Tower Geometrical Forms and
Construction Types:

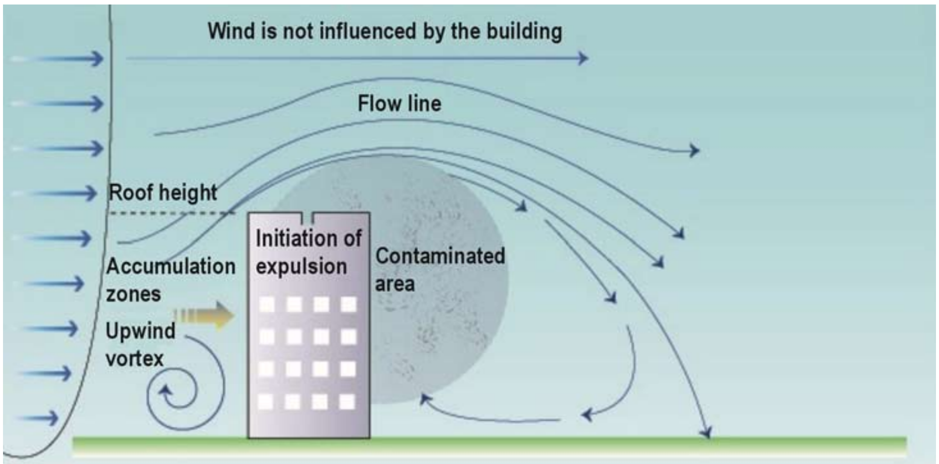
- Design evaporative cooling towers systems;
- Evaluation existing evaporative cooling towers systems
- Corrective modifications to existing installations;
- Chemical treatment of the water

Management of operation and maintenance

Good operation and maintenance are the in key role in the prevention of Legionella growth. In the end of the guidebook 25 pages is focused on principles and details for goof O&M. In order to organize successfully Operation and Maintenance management following principles are proposed and several check lists are given for each action:

- Conduct a hazard analysis;
- Identify critical control points.
- Establish critical limits for each critical control point;
- Establish a monitoring plan for critical limits at critical control points;
- Establish corrective action for each critical limit;
- Establish procedures to document all activities and results;

Establish procedures to confirm that the plan actually works under operating conditions (validation), is being implemented properly (verification) and is periodically reassessed and reviewed if necessary after a critical dysfunction. ■



Entrainment risk through windows in the downwind (negative pressure) side of a building with cooling tower over the roof.

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Simplified VAV solution with full potential...

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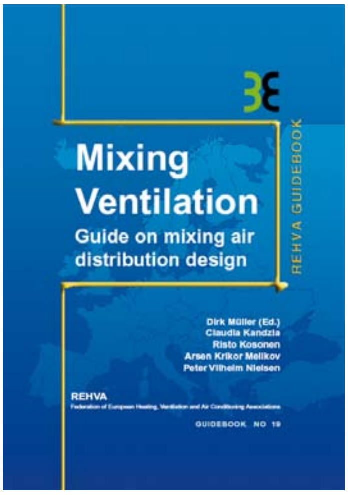
Lindab - We simplify construction...



Risto Kosonen, Halton Oy and Aalto University, Finland
Dirk Müller, Claudia Kandzia, RWTH Aachen University, Germany
Arsen K. Melikov, DTU, Department of Civil Engineering, Demark
Peter V. Nielsen, Aalborg University, Denmark

Mixing Ventilation – New REHVA Guidebook No 19

At present mixing ventilation is mostly used in practice. Although it has been applied for many years the conditions for its optimal performance in practice are not widely understood. A new REHVA design guide book is giving an overview of the nature of mixing ventilation, design methods and its evaluation under laboratory conditions and in practice.

Objectives of the guidebook

The motivation for the mixing ventilation (more correct is mixing air distribution) guide book was that existing knowledge was not structured in a simple, short and understandable way for the majority members of the HVAC community.

Although mixing ventilation has been applied for many years the conditions for its optimal performance in practice are not widely understood. The aim of the guidebook is:

- to introduce the main factors important for achieving different air distribution patterns in rooms, the airflows generated by jets or convection flows in spaces and their interaction is presented;
- to summarise human response to air movement and its importance for occupants comfort;
- to systemize the main principles and considerations used today for design of comfortable and efficient mixing air distribution;
- to outline the methods for prediction and assessment of the environment obtained with mixing ventilation.

The guidebook is addressed to a large audience of consulting engineers, contractors, facility owners, engineers who enter the field of ventilation.

Nature of mixing air distribution

The air distribution strategies in spaces can be divided into two groups, namely total volume air distribution and localized air distribution. The total volume air distribution aims to achieve uniform velocity and temperature field in the occupied zone, i.e. occupants are exposed more or less to uniform environment. The total volume air distribution principles applied in practice are: mixing air distribution and displacement air distribution.

Several boundary conditions including geometry, supply and return air openings, different sources and sinks of heat load including their strength and location, enclosure surface temperature, etc. have influence on the air distribution in spaces.

The most critical factors that effect on air distribution are defined as:

- Cooling or heating mode
- Archimedes ratio $\Delta T_o/q_o^2$ based on flow rate of air supplied to the room, q_o and temperature difference between return and supply air, ΔT_o
- The ratio between the total area of the supply openings and the wall/ceiling/floor area where the openings are located, a_o/A
- Location, high or low, of the air supply opening(s)

Both, the air distribution with mixing and the air distribution with displacement can be can be driven by either buoyancy or momentum. In **Figure 1** examples of mixing and displacement air distribution patterns resulting due to buoyancy effect and momentum effect are shown. Diffuse ceiling/floor inlet, i.e. when the air

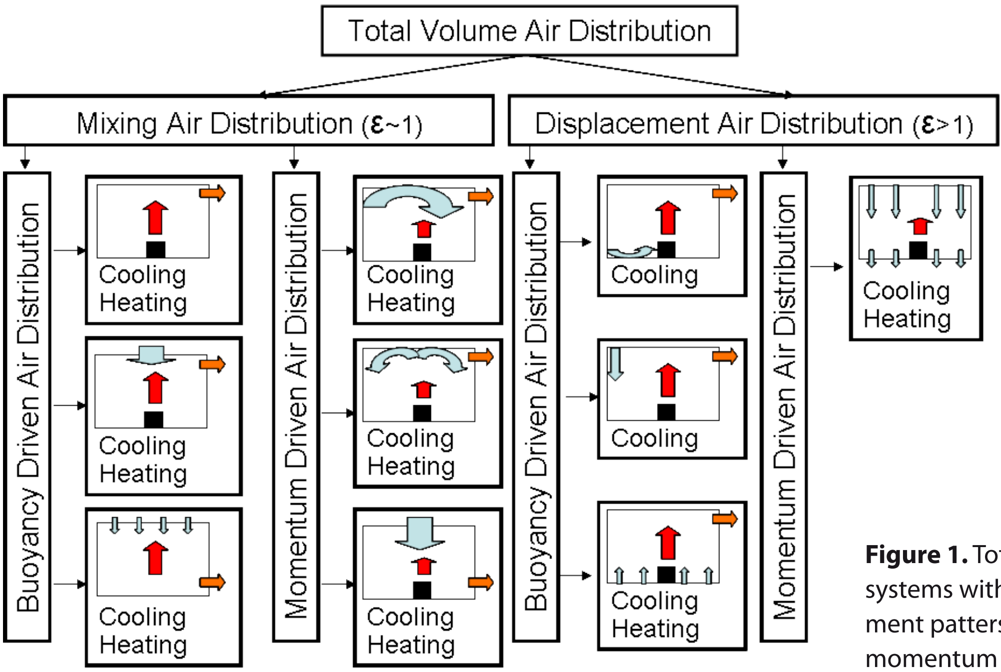


Figure 1. Total volume air distribution systems with mixing and displacement patters based on buoyancy or momentum driving forces.

is supplied over the whole area of the ceiling/floor (a_o/A = 1.0), have been rarely used for comfort ventilation in occupied public buildings, such as office rooms, etc. For typical practical applications ventilation air is supplied from air terminal devices installed either on the ceiling or the wall or the floor (a_o/A <1.0), In this case the general rule is that air distribution with mixing effect is used for cooling and heating while the air distribution with displacement effect is used mainly for cooling.

Design and evaluation of the indoor conditions

Ventilation air supplied to spaces aims to generate healthy, comfortable and work stimulating environment for occupants. Airflow with different characteristics, including air temperature, mean velocity, turbulence intensity, frequency of velocity fluctuations, flow direction, etc., can be generated which affect occupants' thermal comfort and inhaled air quality.

Selection of air distribution schemes is critical for the whole system performance with regard to its ventilation efficiency and occupants' comfort. Air distribution methods for high and low ceiling applications are presented in the guide.

Several models are available for the study of the room air distribution at different stages of the design process. Simplified models such as flow elements are easy to use at the early stage. Flow element models often describe steady state and they may form the basis of zonal models. In practice, isothermal throw length method, pen-

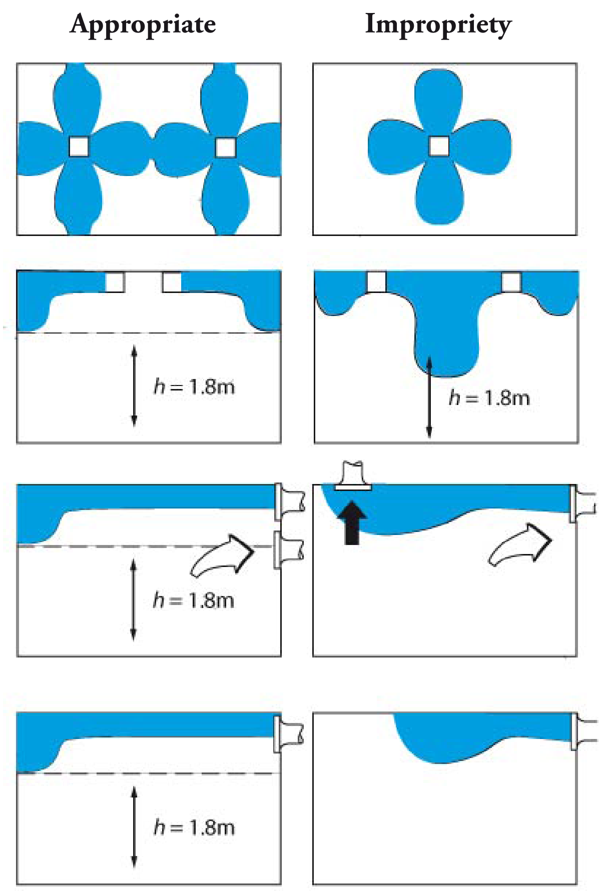


Figure 2. Air distribution should be designed to get high ventilation efficiency without draught (left) and to avoid short cirtuiting and low ventilation efficiency (right).

etration length of jet or manufactures product data of non-isothermal jets are used when air distribution is designed. At present there is no standardized method to present air velocities on the boundaries of the occupied zone.

The air movement generated in rooms has a major impact on occupants' thermal comfort and inhaled air quality. Special attention should be taken to analyse ventilation efficiency and air velocities in the occupied zone in all typical load conditions. Therefore one of the stages of indoor environment design improvement includes identification of the air distribution in room, its assessment by measurements and evaluation of its impact on occupants comfort. Typically the evaluation is performed in two stages: first, assessment is performed based on full-scale laboratory mock-ups together with Computational Fluid Dynamics (CFD) in order to describe the complex interaction of the room flows and then a field survey of air distribution and its impact on occupants is performed when the building is accomplished and occupied. During the first stage proper simulation of the strength and location of the heat sources, such as occupants, office equipment, solar radiation, etc. is important.

The importance of proper simulation of the heat source for the air distribution in rooms is demonstrated in **Figure 3**. Ventilation air is supplied at rate of 1.5 $L/s/m^2$ from chilled beam installed in a room with heat load of 50 W/m^2 generated by two occupants and heated window (on the left side of the section of the room shown in the figure. The importance of the airflow interaction for the room air distribution can be clearly seen. The air supplied from the chilled beams on the side of the window is deflected by the strong thermal plum toward the second occupant generating velocity as high as 0.25 m/s at his head region.

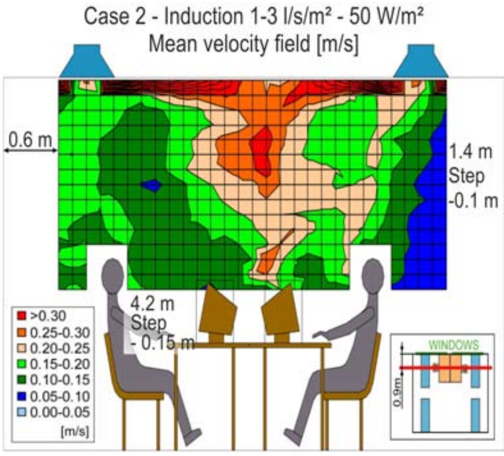


Figure 3. Contours of constant mean velocity measured in a full-scale room ventilated by chilled beams.

In mixing ventilation design guide, case studies on mixing air distribution in rooms are presented and discussed. Special attention is on the examples that depict the complex interaction between air jets and thermal plumes.

Conclusions

The new REHVA design guide gives an overview of nature of mixing ventilation and methods for its design and evaluation. Various case-studies are included as practical examples. ■

REHVA Report No 4

Definition and system boundaries for nearly zero energy buildings

Jarek Kurnitski (Ed.), Francis Allard, Derrick Braham, Dick van Dijk, Christian Feldmann, Jacquelyn Fox, Jonas Gräslund, Per Heiselberg, Frank Hovorka, Risto Kosonen, Jean Lebrun, Zoltán Magyar, Livio Mazzarella, Ivo Martinac, Vojislav Novakovic, Jorma Railio, Olli Seppänen, Igor Sartori, Johann Zirngibl, Michael Schmidt, Maija Virta, Karsten Voss, Åsa Wahlström

This REHVA Task Force, in cooperation with CEN, prepared technical definitions and energy calculation principles for nearly zero energy buildings required in the implementation of the Energy performance of buildings directive recast. This 2013 revision replaces 2011 version. These technical definitions and specifications were prepared in the level of detail to be suitable for the implementation in national building codes. The intention of the Task Force is to help the experts in the Member States to define the nearly zero energy buildings in a uniform way in national regulation.

Fanziska Bockelman, Stefan Blesser & Hanna Soldaty:

Design and operation of GEOTABS buildings – New REHVA Guidebook no 20

One of the most interesting technical solutions for energy efficient and healthy buildings is the combination of thermally activated building system (TABS), a ground heat exchanger and heat pump in between both systems (GEOTABS).

GEOTABS is an acronym for a geothermal heat pump combined with a thermally activated building system. TABS is a water based radiant (more than 50% of heat transfer by radiation) heating and cooling system using low water temperature heating and high water temperatures cooling in buildings. The energy supply and removal is through a geothermal system using a heat pump. This double function is matched by the changing function of the ground as heat sink and heat source.

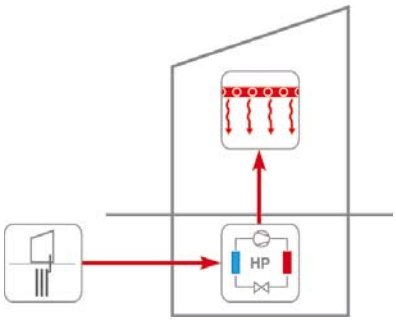


Figure 1. Heating mode with heat pump.

To obtain the required temperature for heating, a heat pump is incorporated into the system extracting heat from the ground (**Figure 1**). The low temperature of the ground in the following summer allows absorbing the heat from the building directly through the ground heat exchanger, in so called passive cooling mode (**Figure 2**). To achieve higher cooling capacity also a reversible heat pump can be integrated (**Figure 3**).

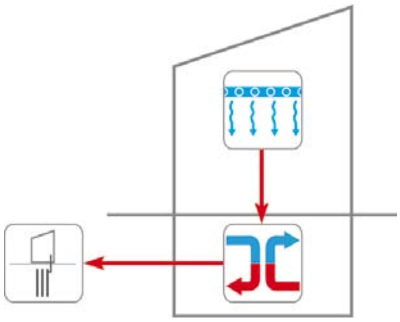


Figure 2. Passive cooling.

GEOTABS has several advantages. The radiant heating and cooling system TABS has proven to be one of the most comfortable ways to condition indoor spaces, especially multi-storey offices.

Their ability to heat and cool with medium temperatures close to room temperature makes them the perfect match for ground heat exchangers. Heat pumps work best with these low temperature differences between source and sink. This concept is further strengthened through the use of electricity as only source of energy either from the grid or produced on-site by photovoltaic system. In the building no carbon based process is needed which re-

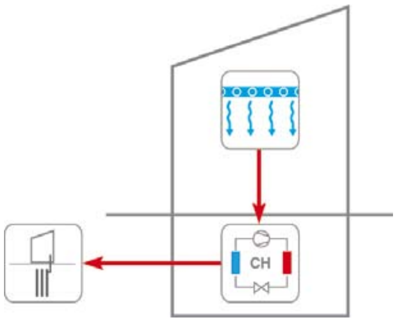
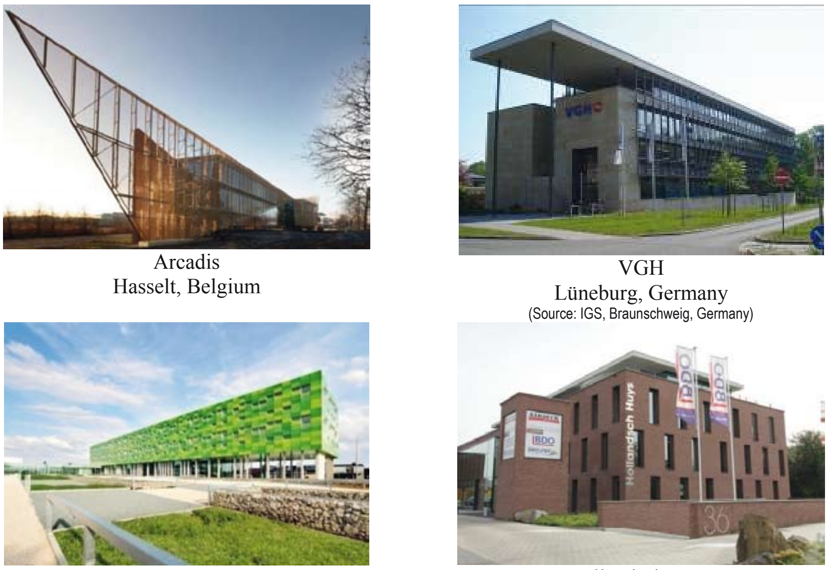


Figure 3. Active cooling.

duces emissions in cities and saves cost for supply infrastructure and space for chimneys.

Within the developing smart electric grid GEOTABS can play a central role. The electrical energy, transformed with a heat pump into thermal energy, is stored in thermally activated concrete slabs, which become buffer capacities for the smart grid. Intelligent management of the systems can help to stabilize the electricity supply systems and to match supply peaks and demand.



Arcadis
Hasselt, Belgium

VGH
Lüneburg, Germany
(Source: IGS, Braunschweig, Germany)

INFRAX West
Torhout, Belgium
(Source: CREPAIN BINST ARCHITECTURE nv, Antwerpen, Belgium)

Hollandsch Huys
Hasselt, Belgium
(Source: Houben nv, Hasselt, Begium)

Figure 4. GEOTABS Buildings: High energy efficiency, excellent indoor climate – and great architecture!

Comprehensive research on GEOTABS has been carried out over the last decades. Manufactures provide reliable products for pipes, heat pumps, circulation pumps and automation systems.

A large number of buildings has been constructed and monitored in operation, giving engineers and facility managers a deep insight into the practical operation of GEOTABS. Their efficiency often surpasses most alternative solutions like the typical combination of gas boilers and electric chillers. And especially in moderate climates that dominate most of Europe, GEOTABS is an excellent option to provide buildings with healthy and comfortable heating and cooling.

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

This book should inspire the reader to apply GEOTABS and helps to evaluate whether the system is appropriate for a specific building. It is a useful guide through early designs, building simulation, mechanical engineering, commissioning and operation towards energy efficient, comfortable and healthy buildings. ■

Clima 2013 Conference Proceedings

KAREL KABELE, MIROSLAV URBAN, KAREL SUCHÝ, MILOŠ LAIN (EDITORS)

CLIMA 2013 - 11th REHVA World Congress and the 8th International Conference on Indoor Air Quality, Ventilation and Energy Conservation in Buildings

16. - 19. 6. 2013 Prague Congress Centre, 5. kvetna 65, 140 21 Praha 4, Czech Republic

Edition: 1st Edition, June 2013 • Pages: 6882 • ISBN 978-80-260-4001-9 • Author: Different Authors • Published by: Society of Environmental Engineering (STP). REHVA member association • Novotného lávka 5, 116 68 Praha 1 , Czech Republic • www.stpcr.cz • www.rehva.eu

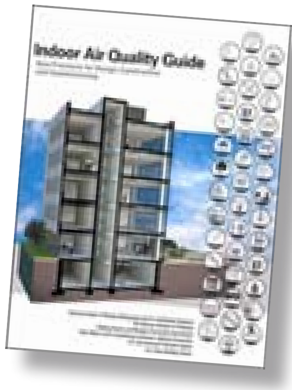
ASHRAE encourages free downloading of Indoor Air Quality Guide

To promote good indoor air quality (IAQ) in buildings, ASHRAE is making available for free a guide for achieving enhanced IAQ. The Indoor Air Quality Guide: Best Practices for Design, Construction and Commissioning provides strategies to achieve good IAQ using proven technologies and without significantly increasing costs. First published in 2009, the guide is the result of collaboration between ASHRAE, the American Institute of Architects, the Building Owners and Managers Association International, the Sheet Metal and Air Conditioning Contractors' National Association and the U.S. Green Building Council with funding provided by the U.S. Environmental Protection Agency.

The guide can be downloaded for free at www.ashrae.org/FreeIAQGuidance.

The free download is being offered in support of the presidential theme of 2013-14 ASHRAE President William P. "Bill" Bahnfleth, Ph.D., P.E., Fellow ASHRAE, ASME Fellow. His theme, "Shaping the Next," focuses, in part, on making buildings safe, healthy, productive, comfortable environments in harmony with nature.

"As we move forward in shaping the next generation of buildings and systems, good indoor air quality must be a central focus of our efforts," Bahnfleth said. "The health and comfort of buildings occupants is too important to leave IAQ as an after-thought in design, construction and operation. By making this publication available to the industry, we are providing guidance to help ensure the use of best practices for good IAQ, allowing all of us to enjoy the benefits of a better indoor environment cost-effectively."



The book describes 40 strategies for achieving critical IAQ objectives related to moisture management, ventilation, filtration and air cleaning and source control. It also highlights how design and construction teams can work together to ensure good IAQ strategies are incorporated from initial design through project completion.

The book also contains

- Hundreds of internal and external links to resources for the design, construction, and commissioning of buildings with excellent indoor air quality.
- Access to an incredible variety of in-depth information by topic to help you design, construct and operate buildings using best practices for indoor air quality.
- Best practices for all aspects of IAQ building design, commissioning and construction, including designing for maintainability.
- Tools and material for demonstrating the value of IAQ to clients.

IEA Heat Pump Centre Newsletter

Heat pump efficiency in real conditions in focus

In technical product development in any field, one needs to track performance of the product, to check if a specific modification resulted in an improvement or not. Also, the end user wants his purchased and installed product to perform as specified (at least), and needs methods to check this. Further, other actors along the developing, marketing and dissemination chain need to be aware of the end-user's reaction and needs – and preferably be able to anticipate them. All this calls for performance monitoring and evaluation.

The topic of the recent issue of the IEA Heat Pump Centre Newsletter is Heat pump performance monitoring and evaluation. A summary of the long-term heat pump field monitoring is provided, as well as evaluations of a part-load performance of an air conditioner, and of a foundation heat exchanger. Also, a method for on-line monitoring and evaluation of heat pump performance is described. In addition, you will find a Strategic Outlook from the US.

The IEA HPC Newsletter is a newsletter/journal from the IEA Heat Pump Centre (HPC) with four issues per year. The HPC is an international information service for heat pumping technologies, applications and markets. Visit the website at www.heatpumpcentre.org

The IEA Heat Pump Centre Newsletter can be downloaded (free for readers in HPP member countries) from http://www.heatpumpcentre.org/en/newsletter/Sidor/default.aspx

Implementing the EPBD in the EU Member States

– Status in the end of 2012

Editor: Eduardo Maldonado (Coordinator of Concerted Action EPBD), 368 pages

The Concerted Action EPBD is a forum where EU Member States' experts in charge of transposition of the Energy Performance of Buildings Directive (EPBD), its implementation and the practical day-to-day running can gather and discuss common problems from a variety of points of view. Building certification, training of experts, inspections, information campaigns, preparing building regulations and calculation tools, national approaches to Nearly Zero-Energy Buildings (NZEB), cost-optimal studies and many other tasks related to energy efficiency in buildings and planning/financing the rehabilitation of the existing building stock towards NZEB status are all tackled.

This is the third edition in what has by now become a regular tradition. Every two years, starting with the 2008 report, these national representatives report on the status and on the progress achieved in their respective countries or regions. This book contains national reports with a snapshot of the status of implementation for all EU MS, and Norway. These national reports clearly state what is working well or needing improvement. They also indicate expectations for the future that still depend on political decisions and, therefore, any references to future developments should always be taken with the required care.

National reports follow a common structure:

- the history of the legal status of the transposition of the EPBD (Directive 2002/91/EC) and the EPBD recast (Directive 2010/31/EC);
- the evolution of minimum energy efficiency requirements over time, starting before the EPBD, showing the impacts of both the EPBD and its recast, and expectations, if available, till the 2020 NZEB target, for new and existing, residential and non-residential buildings;
- the detailed energy performance requirements for all building categories at the end of 2012;
- the functioning of the certification market, including the Energy Performance Certificate (EPC) formats and their main contents, building classes, how EPCs are issued, their use in advertisements, sales and rental contracts, required qualifications and training for Qualified Experts (QE), information about the numbers of QEs and issued EPCs, as well as provisions for quality control;
- the status of certification of public buildings;
- the status of inspections of boilers, heating and air-conditioning (AC) systems, required qualifications and training for inspectors, information about the numbers of inspectors and inspections, as well as provisions for quality control and compliance, or what has been done in terms of alternative measures that, according to the EPBD, may replace mandatory inspections;
- and an overview of the next steps for transformation of the building stock to improved energy performance levels.

Preceding the national reports, the book contains a collection of topical summaries describing the main accomplishments and the remaining problems for each of the major issues covered by the EPBD across Europe, according to the views expressed by the CA EPBD participant such as certification; inspections of boilers; heating and AC systems; training of experts and inspectors; cost-optimal studies and regulations; NZEBs; compliance with regulations, as well as quality control on EPCs and inspection reports; and financial instruments, namely for rehabilitation.

Available from www.epbd-ca.eu

VDI-Guideline 6022 Hygiene requirement for ventilation and air-conditioning

– a success-story

VDI 6022 has changed the view of health in the filed of air-conditioning and the knowledge was brought to several other standards and guidelines during the last 15 years.

At the 1st of July, there is the 15th birthday of the VDI-Guideline 6022. The first version of the guidelinie was published after hard public discussions of the sick building syndrom and the influence of air-conditioning systems on this case. In the first issue, there was a focus on the maintenance of air-conditioning systems.

The second edition from 2006 adds the responsibility of the planners and the installers. In that issue, the former part 3 of the guideline was included in the first part. Today, the third edition of the guideline is getting some additional parts in the last and the following 12 month. VDI 6022 part 1.1 gives a Checklist to aprove an air-conditioning system with the requirements of VDI 6022/1. VDI 6022 part 1.2 deals with the hygiene requirements of air-ducts in the ground and VDI 6022 part 1.3 will be about the cleanliness of the ducts.

In addition to the standardisation, VDI rised a training-concept for people working in the maintenance, planning or installation of air-conditioning systems. In this courses, more than 19 000 people have been trained in the level A and the level B, discribed in the guideline VDI 6022 part 4. Scince 2012, there is a new certified training level, called "VDI-geprüfter Fachingenieur RLQ". Further information is available on www.vdi.de/6022.

VDI-Guidelines published July 2013

D VDI 2053/1 "Air conditioning; Car parks; Exhaust ventilation (VDI Ventilation Code of Practice)"

This VDI Guideline applies to ventilating and air-conditioning for garages. Garages are buildings, or parts of buildings, which are dedicated to the parking of motor vehicles. Medium-sized (100, up to 1 000 m²) and large garages (above 1 000 m²) with a closed building envelope require sufficient ventilation to ensure operation without health hazards. It is the goal of this VDI Guideline that pollutant concentrations do not exceed the limits which are deemed acceptable. The described required protection is intended for short-term exposure only. The guideline does not apply to automated garages, open garages and rooms where extended occupation by persons is intended.

D VDI 2073/3 "Hydraulics in building services installations; Trainings"

Hydraulic compensation in building services installations is often carried out insufficiently or not at all. It is, however, vital to achieve optimized, and particularly energy-efficient, operation. This VDI Guideline offers a concept for trainings for all experts involved in the planning, execution, operation, and maintenance of building services installations. It conveys knowledge which has to be taken into consideration in the conceptual design of hydraulic distribution systems and various applications. The trainings are tailored to various groups; mandatory previous qualifications are given, as are the syllabus and the boundary conditions.

VDI 3819/2 "Fire protection in building services; Functions and correlations"

The means of structural and technical fire protection are an issue of continual controversy because either the approaches assume different starting points, or background information for alternative approaches is unknown. The technical systems for detection of fire and the technical solutions to save life or property have influence on each other in their effect. This guideline describes integral solutions in an understandable manner and points out the limitations of various individual solutions. Examples and tables illustrate the various interactions between the individual trades, thereby increasing the understanding of integral fire protection. The guideline describes the typical operational systems running on the brand and interactions with other systems.

D = Draft Guideline

Clivet multiplex solutions

Solutions dedicated to multiplex cinemas

From many years experience in rooftop solutions, Clivet created Multiplex Clima Solution, a specialized renewable energy system to ensure the highest quality of air, quick operating time and optimum constant comfort for multiplex cinemas.

With equipment in more than 1000 cinemas/theatres and cooperation with major operators such as Warner Village, UCI Cinemas, The Space Cinemas, Clivet is the leader in heat pump solutions for comfort and energy saving in multiplex cinemas.

In 2011-2012 Clivet updated the entire product range and control system of this range of equipment, which in the next few years will result in a major evolution both in terms of new features and replacement of units currently operating with R22.

A complete solution that is efficient and easy to install and maintain, whose extraordinary value has also been recognised in 2012 by the jury of Next Energy. This include Clivet units designed for screening rooms, hallways, the box office and projection corridor area, **CLIVET PACK CSNX-XHE,** the selection of products and systems representing the most advanced research in the field of energy efficiency in buildings.

For further information:
Clivet UK LTD - Paul O'Gorman, tel. +44 (0) 1489 572238 – e-mail: p.ogorman@clivet-uk.co.uk
Clivet SPA - Barbara Casagrande, tel. +39 0439/313235 – e-mail: b.casagrande@clivet.it - www.clivet.com

POWERCIAT2 – CIAT's new 610–1350 kW eco-designed water chiller

POWERCIAT2 is available in two versions – a standard (STD) version designed for the most demanding technical and economical requirements, and a High Energy Efficiency (HEE) version, which is the reference for energy efficient projects. Thanks to its state-of-the-art components, the HEE version of POWERCIAT2 achieves the highest possible energy rating, CLASS A, with an average EER of 3.18 and exceptional levels of seasonal efficiency, proven by an average ESEER of 4.1. In addition to its low energy consumption, POWERCIAT2 offers a power/refrigerant charge ratio of 7 kW of refrigerant/kg R134a – the highest on the market. POWERCIAT2 is currently the only water chiller that combines both micro-channel coil and shell-and-tube dry expansion evaporator technologies. It has been engineered using eco-design principles to minimise its environmental impact throughout its entire life cycle.

www.ciat.com

Send information of your event to Ms Cynthia Despradel cd@rehva.eu

Events in 2013 - 2014

Conferences and seminars 2013

September 22 - 27	8th Conference on Sustainable Development of Energy, Water and Environment Systems	Dubrovnik, Croatia	www.dubrovnik2013.sdewes.org
September 25 - 26	34th AIVC- 3rd TightVent- 2nd Cool Roofs' - 1st Venticool	Athens, Greece	www.AIVC2013Conference.org
September 25 - 27	5th International Conference Solar Air-Conditioning	Germany	www.otti.eu
September 25 - 29	International Conference on Sustainable Building Restoration and Revitalisation	Shanghai, China	www.wta-conferences.org/conference/1869
October 3 - 4	CLIMAMED - VII Mediterranean Congress of Climatizacion	Istanbul, Turkey	www.climamed.org
October 15 - 16	European Heat Pump Summit	Nürnberg, Germany	www.hp-summit.de
October 15 - 18	IAQ 2013 - Environmental Health in Low Energy Buildings	Vancouver, Canada	www.ashrae.org/membership--conferences/conferences/ashrae-conferences/iaq-2013
October 16 - 18	Building Services for the Third Millenium	Sinaia, Romania	www.aiiro.ro
October 18 - 19	COGEN Europe Annual Conference & Dinner	Brussels, Belgium	www.cogeneurope.eu
October 19 - 21	ISHVAC	Xi'an, China	www.ishvac2013.org
October 20 - 21	Energy Efficiency & Behaviour	Helsinki, Finland	www.behave2012.info
November 5 - 6	8th ENERGY FORUM on Solar Building Skins	Bressanone, Italy	www.energy-forum.com
December 4 - 6	44 International Congress of HVAC&R	Belgrade, Serbia	www.kgh-kongres.org

Conferences and seminars 2014

January 18 - 22	ASHRAE 2014 Winter Conference	New York, USA	www.ashrae.org/membership--conferences/conferences
February 24 - 26	First International Conference on Energy and Indoor Environment for Hot Climates	Doha, Qatar	www.ashrae.org/HotClimates
February 26 - 28	World Sustainable Energy Days 2014	Wels, Austria	www.wsed.at
February 26 - 28	49th AiCARR International Conference	Rome, Italy	www.aicarr.org
April 29	REHVA Annual Conference	Dusseldorf, Germany	www.rehva.eu
May 13 - 15	11th IEA Heat Pump Conference 2014	Montreal, Canada	www.geo-exchange.ca/en/canada_to_host_the_11th_international_energy_agenc_nw211.php
July 7 - 12	Indoor Air 2014	University of Hong Kong	www.indoorair2014.org
August 31 - Sep 2	11th IIR-Gustav Lorentzen Conference on Natural Refrigerants - GL2014	Hangzhou, China	
October 18 - 19	CCHVAC Congress	China	
October 19 - 22	Roomvent 2014	Sao Paulo, Brazil	www.roomvent2014.com.br

Exhibitions 2013

September 3 - 6	Aqua-Therm Almaty	Almaty, Kazakhstan	www.aquatherm-almaty.com
September 25 - 27	ISH Shanghai & CIHE	Shanghai, China	www.ishc-cihe.com
October 23 - 26	Aqua-Therm Baku	Baku, Kazakhstan	www.aquatherm-baku.com
November 4 - 8	Interclima+Elec	Paris, France	www.interclimaelec.com

Exhibitions 2014

January 21 - 23	AHRI Expo	New York, USA	www.ahrexpo.com
February 4 - 7	Aqua-Therm Moscow	Moscow, Russia	www.aquatherm-moscow.ru/en/
Feburary 27 - March 1	ACREX 2014	New Delhi, India	http://acrex.in/
March 4 - 7	Aqua-Therm Prague	Prague, Czech Republic	www.aquatherm-praha.com/en/
March 18 - 21	MCE - Mostra Convegno Expocomfort 2014	Fiera Milano, Italy	www.mcexpocomfort.it
March 30 - Apr 4	Light + Building	Frankfurt, Germany	www.light-building.messefrankfurt.com
April 1 - 4	NORDBYGG 2014	Stockholm, Sweden	www.nordbygg.se
May 7 - 10	ISK - SODEX 2014	Istanbul, Turkey	www.hmsf.com
May 13 – 15	ISH China & CIHE	Beijing, China	www.ishc-cihe.com
September 30 - Oct 3	Finnbuild 2014	Helsinki, Finland	www.finnbuild.fi
October 14 - 16	Chillventa 2014	Nuremberg, Germany	www.chillventa.de/en/

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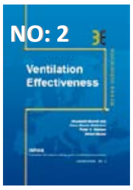
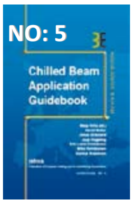
REHVA GUIDEBOOKS

REHVA Federation of European Heating, Ventilation and Air-conditioning Associations

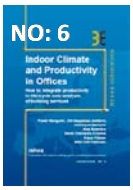
REHVA Guidebooks are written by teams of European experts



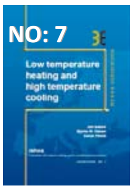
Improving the ventilation effectiveness allows the indoor air quality to be significantly enhanced without the need for higher air changes in the building, thereby avoiding the higher costs and energy consumption associated with increasing the ventilation rates. This Guidebook provides easy-to-understand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



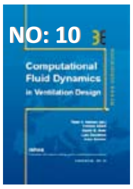
Chilled beam systems are primarily used for cooling and ventilation in spaces, which appreciate good indoor environmental quality and individual space control. Active chilled beams are connected to the ventilation ductwork, high temperature cold water, and when desired, low temperature hot water system.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



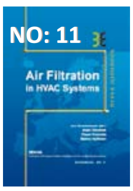
Indoor Climate and Productivity in Offices Guidebook shows how to quantify the effects of indoor environment on office work and also how to include these effects in the calculation of building costs. Such calculations have not been performed previously, because very little data has been available. The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



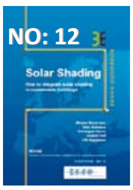
This Guidebook describes the systems that use water as heat-carrier and when the heat exchange within the conditioned space is more than 50% radiant. Embedded systems insulated from the main building structure (floor, wall and ceiling) are used in all types of buildings and work with heat carriers at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



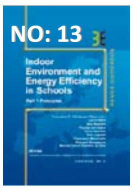
CFD-calculations have been rapidly developed to a powerful tool for the analysis of air pollution distribution in various spaces. However, the user of CFD-calculation should be aware of the basic principles of calculations and specifically the boundary conditions. Computational Fluid Dynamics (CFD) –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



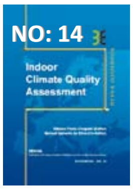
Air filtration Guidebook will help the designer and user to understand the background and criteria for air filtration, how to select air filters and avoid problems associated with hygienic and other conditions at operation of air filters. The selection of air filters is based on external conditions such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



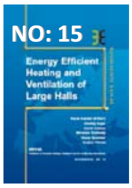
Solar Shading Guidebook gives a solid background on the physics of solar radiation and its behaviour in window with solar shading systems. Major focus of the Guidebook is on the effect of solar shading in the use of energy for cooling, heating and lighting. The book gives also practical guidance for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



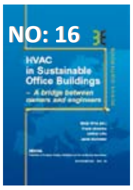
School buildings represent a significant part of the building stock and also a noteworthy part of the total energy use. Indoor and Energy Efficiency in Schools Guidebook describes the optimal design and operation of schools with respect to low energy cost and performance of the students. It focuses particularly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



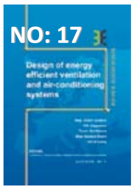
This new REHVA Guidebook gives building professionals a useful support in the practical measurements and monitoring of the indoor climate in buildings. Wireless technologies for measurement and monitoring has allowed enlarging significantly number of possible applications, especially in existing buildings.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



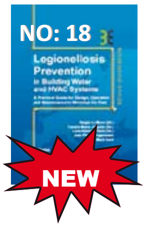
This guidebook is focused on modern methods for design, control and operation of energy efficient heating systems in large spaces and industrial halls. The book deals with thermal comfort, light and dark gas radiant heaters, panel radiant heating, floor heating and industrial air heating systems. Various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



This guidebook talks about the interaction of sustainability and heating, ventilation and air–conditioning. HVAC technologies used in sustainable buildings are described. This book also provides a list of questions to be asked in various phrases of building's life time. Different case studies of sustainable office buildings are presented.



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



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

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

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

In this REHVA Report in cooperation with CEN, technical definitions and energy calculation principles for nearly zero energy buildings required in the implementation of the Energy performance of buildings directive recast are presented. This 2013 revision replaces 2011 version. These technical definitions and specifications were prepared in the level of detail to be suitable for the implementation in national building codes.

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