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Federation of European Heating, Ventilation and Air Conditioning Associations

# The REHVA European HVAC Journal

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## DOMESTIC HOT WATER in focus

- New methods to design domestic water systems
- In-house waste water heat recovery
- Energy labelling of space and water heaters

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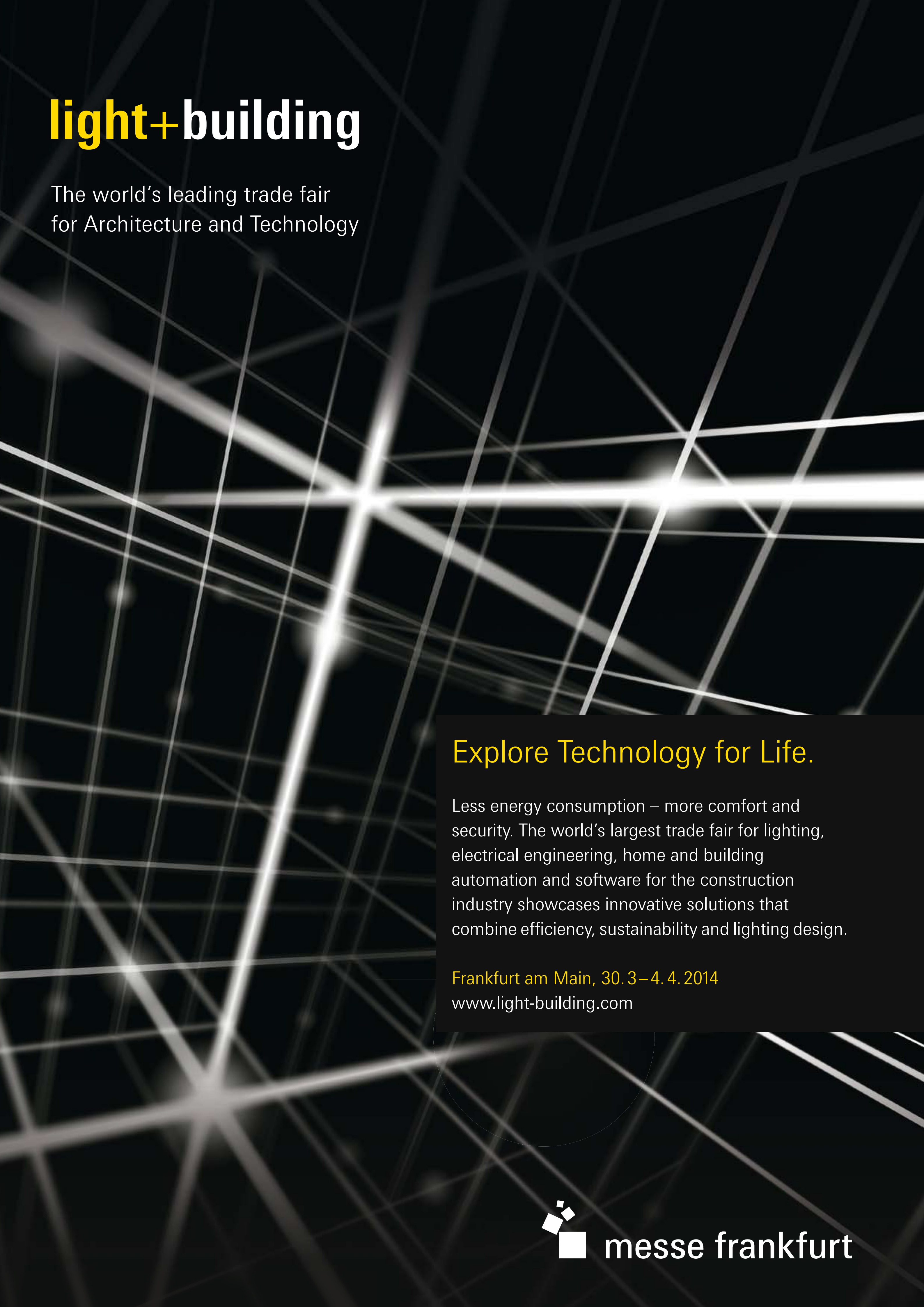
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# Domestic hot water in focus

**The EPBD 2010 demands all new buildings in EU countries to be nearly zero energy buildings by 2020. This requirement has gained a lot of attention since 2010, also in this Journal. The focus has mainly been on the building envelope performance, space heating and ventilation.**

OLLI SEPPÄNEN
Professor, Editor-in-chief

One area which has not been discussed much is the use of domestic hot water (DHW), and how to reduce energy used to heat the water. However, its role is getting more and more important, especially in residential buildings. The share of energy used to heat the DHW has been increasing significantly as the thermal performance of building envelope has been improving. The heating energy for DHW depends on the use of water, which has decreased significantly during the last few decades. Twenty five years ago the average use was around 200 litres per day per occupant in residential buildings; now it is 120–140 litres (113 to 133 litres per day per person in Germany – article by Seybold & Brunk in this issue). The reduction is partly due to water saving faucets, new washing methods and even more importantly, the common use of a shower instead of a bath tub for better personal hygiene. About 40% of the domestic water is used as hot water. It can correspond to 30–40 kWh/m² of energy use in residential buildings, which is significant (25%) in relation to energy use in the EU buildings that is typically in the range of 100–150 kWh/m². The share is even higher in low energy and nearly zero energy buildings: about 50% in single family buildings and more than 50% in multifamily buildings.

An interesting article by Agudelo-Vera et al in this issue reports that the water systems may be oversized in non-residential buildings like hotels, and new design rules should be established. Water use, including hot water, depends, of course, on the occupants, their behaviour and customs. Not much information is available on the variation of real use between countries. However, the European Commission has based the sizing of water heaters on water use profiles. An article by Klobut in this issue gives an overview of the contents of the recently adopted ecodesign regulations for space and water heaters. Occupant behaviour can be influenced and DHW saved by charging the actual heating cost from occupants based on metered use. Metering can be installed in new buildings as required by EPBD, but is a problem in existing buildings.

Water usage profiles depend on the day, time and month in addition to the building type and occupants. The information on profiles is becoming more and more important for the efficient use of renewable energy sources for heating. Solar heating of DHW is, in most cases, the most cost effective use of renewable energy. Water use profiles affect the sizing of the collector, storage tanks and back up heating. An important issue to keep in mind with solar water heating systems is the possibility of low temperature level (below 55°C) in the system, which may allow the growth of *Legionella* bacteria in the plumbing system.

Water use can be further reduced by user behaviour and wider use of water saving technology, like easy to operate and automatic faucets and well-designed shower heads. The reduction in water use may have an effect on the waste water system. The sewage pipes and their slopes are designed for a minimum water flow to stay clean. The reduced water flow may have an effect on sewage system design. An opposite trend, however, is the luxury bathrooms with private jacuzzis and rain showers. Domestic hot water systems can also 'leak' heat through the uninsulated or insufficiently insulated piping, and the bath room or towel heaters which circulate high temperature hot water year around.

Heat recovery is a widely used technology; it is also possible with waste water. The article by Seybold & Brunk focuses on that and reports significant saving potential, but also points out the problems with the fouling of heat transfer surfaces and the need to develop automatic cleaning methods. The reduced sewage water temperature may also have an effect on the performance of sewage treatment plants. ■

# EU Commission adopted energy labelling criteria for space heaters

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**Energy Labelling Directive (ELD) has recently been adopted in European Union to improve the energy efficiency of appliances sold on the market. Energy labels are aimed to assist consumers in choosing products which save energy. Energy labelling was first addressed on a more general level in REHVA Journal – March 2013 issue. In this article the new Delegated Regulation published on 6 September 2013 in Commission's Official Journal is discussed.**

**Key words:** boiler, space heater, energy labelling, energy labelling directive, boiler regulation, efficiency, seasonal efficiency, ecodesign

## Background

Directive 2010/30/EU of the European Parliament and of the Council on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products (ELD) establishes a framework for the Commission to develop regulations for the *labelling* of energy-related products. [1]

The aim of the new Delegated Regulation [2] is to introduce a harmonised scheme for labelling products according to their energy efficiency and energy consumption and providing standard product information for consumers. It complements the Commission's Regulation implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to *ecodesign* requirements for space heaters and combination heaters [3]. It was considered relevant that both regulations are adopted simultaneously. The ecodesign requirements aim to achieve potential for cost-effective improvements in the energy efficiency of heaters, while the labelling scheme creates market transparency for consumers and provides incentives for manufacturers to innovate and invest in energy efficiency. Both Regulations [2] and [3] were published in the Official Journal on 6 September 2013.

This Delegated Regulation [2] sets EU energy labels for stand-alone heaters and for packages of heaters combined with further heating products. It introduces the widely known A-G scale to cover the various types of conventional boilers. Additionally, the dynamic top classes $A^{+}$, $A^{++}$ and $A^{+++}$ are intended to promote the use of cogeneration and renewable energy sources.

## Contents of the regulation

The introduced measure sets out new mandatory labelling and standard product information requirements for suppliers placing on the market and/or putting into service heaters, temperature controls, solar devices (solar-only system, solar collector, solar tank and other solar products placed on the market separately), and for dealers offering stand-alone heaters and packages of heaters, temperature controls and/or solar devices. The scope of the measure is aligned with the scope of parallel ecodesign implementing measure setting ecodesign requirements for the energy efficiency, nitrogen oxide emissions and sound power levels of heaters.

The energy efficiency ranking of heaters is based on the scheme laid down in Directive 2010/30/EU in having a single efficiency scale for space heating, covering boilers, cogeneration, heat pumps and their packages with further products.

The Delegated Regulation enters into force on 26 September 2013 and the requirements will be strengthened gradually. Two years after the entry into force, a scale from G to A for conventional heaters (i.e. presumably G–D for electric boilers, C–B for non-condensing boilers in collective buildings, B–A for condensing boilers) with higher classes A+ for cogeneration and A++ for heat pumps will be introduced. Six years after the entry into force of the Delegated Regulation, a further class A+++ will be added on top of the labelling scale, while classes G to E will be abolished due to more ambitious ecodesign requirements. This will ensure dynamic market transformation toward highly efficient heaters using modern energy technologies.

The water heating energy efficiency class of a combination heater shall be determined on the basis of its water heating energy efficiency. Two years after the entry into force, a scale from G to A will be valid. Six years after the entry into force of the Delegated Regulation, a further higher class A+ will be added on top and the lowest class G abolished.

Furthermore, the product label will show the sound power level to end-users (**Figure 1**), standardized product information will be introduced for heaters, such as a product fiche and technical documentation, and requirements will be specified for information to be provided in any form of distance selling of heaters and in any advertisements and technical promotional material for them.

As heaters might be sold in packages with other heating products such as solar devices and temperature controls, a package label and a comprehensible calculation on the fiche are introduced to provide information on the overall efficiency of the package of products to the end-user. The package label is based on energy efficiency classes from G to A+++, reflecting the potentially higher energy efficiency of such packages.

The proposed product and package labels and standardised product information will help overcome the lack of information for people buying heaters and the split incentives for building owners and tenants.

The measurement methods and the verification procedure for market surveillance in this Delegated Regulation are aligned with those in the ecodesign implementing measure.

## Technical requirements for boilers

The following definitions are introduced.

'Space heater' means a device that a) provides heat to a water-based central heating system in order to reach and maintain at a desired level the indoor temperature of an enclosed space such as a building, a dwelling or a room; and b) is equipped with one or more heat generators.

'Combination heater' means a space heater that is designed to also provide heat to deliver hot drinking or sanitary water at a given temperature levels, quantities and flow rates during given intervals, and is connected to an external supply of drinking sanitary water.

'Seasonal space heating energy efficiency' is in a key role as a base for labelling classification. It is defined as the ratio between the space heating demand for a designated heating season, supplied by a heater and the annual energy consumption required to meet this demand, expressed in %.

The calculation formula for fuel boiler space heaters and fuel boiler combination heaters is:

$$\eta_s = 0.85\eta_1 + 0.15\eta_4 - \Sigma F(i)$$

where:

$\eta_s$ is seasonal space heating energy efficiency, expressed in %,

$\eta_1$ is useful efficiency at 30% of the rated heat output, expressed in %,

$\eta_4$ is useful efficiency at rated heat output, expressed in %,

$F(i)$ are relevant corrections. See [5] for details.

Efficiencies are determined based on respective CEN standards for boilers. All corrections F(i) relevant for boilers, e.g. due to auxiliary electricity consumption or due to standby loss, are negative. Different dedicated standards apply for determination of annual efficiencies of cogeneration devices and heat pumps. Additionally, for cogeneration devices one positive correction $F(i)$ is applied due to electricity produced by the device itself. This makes it possible for a device to achieve efficiency exceeding 100%. A 'conversion coefficient' (CC=2.5) is used, reflecting the estimated 40% average EU generation efficiency referred to in Directive 2012/27/EU of the European Parliament and of the Council.

The calculation formula for the annual efficiency is not provided in the Regulation itself but in an accompanying draft document [6], and it was discussed in the previous article on ecodesign requirements [5]. An official document further elaborating on determination of annual efficiency is expected to be published by the Commission in the near future.

This Delegated Regulation [2] establishes requirements for the energy labelling of, and the provision of supplementary product information on, space heaters and combination heaters with a rated heat output ≤ 70 kW, packages of space heater ≤ 70 kW, temperature control and solar device and packages of combination heater ≤ 70 kW, temperature control and solar device.

Annual efficiency requirements serving as a basis for classification of boilers are given in **Table 1**.

**Table 1.** Seasonal space heating energy efficiency requirements serving as a basis for classification of heaters and combination heaters.

| Seasonal space heating energy efficiency class | Seasonal space heating energy efficiency $\eta_s$ in % |
|---|---|
| A+++ | $\eta_s \geq 150$ |
| A++ | $125 \leq \eta_s < 150$ |
| A+ | $98 \leq \eta_s < 125$ |
| A | $90 \leq \eta_s < 98$ |
| B | $82 \leq \eta_s < 90$ |
| C | $75 \leq \eta_s < 82$ |
| D | $36 \leq \eta_s < 75$ |
| E | $34 \leq \eta_s < 36$ |
| F | $30 \leq \eta_s < 34$ |
| G | $\eta_s < 30$ |

'Water heating energy efficiency' means the ratio between the useful energy in the drinking or sanitary water provided by a combination heater and the energy required for its generation, expressed in %. This table serves as a basis for labelling classes regarding water heating function for combination heaters. The classification is presented in **Table 2**. Sizes 3XS – XL of combination heaters are defined by 'load profile', that means a given sequence of water draw-offs, as specified in Annex VII, Table 15; each combination heater meets at least one load profile; [2]

'Water draw-off' means a given combination of useful water flow rate, useful water temperature, useful energy content and peak temperature, as specified in Annex VII, Table 15; [2]

**Table 2.** Water heating efficiency classes of small combination heaters classified by declared profile of sizes 3XS–XL.

| | 3XS | S | M | L | XL |
|---|---|---|---|---|---|
| A+++ | $\eta_{wh} \geq 62$ | $\eta_{wh} \geq 90$ | $\eta_{wh} \geq 163$ | $\eta_{wh} \geq 188$ | $\eta_{wh} \geq 200$ |
| A++ | $53 \leq \eta_{wh} < 62$ | $72 \leq \eta_{wh} < 90$ | $130 \leq \eta_{wh} < 163$ | $150 \leq \eta_{wh} < 188$ | $160 \leq \eta_{wh} < 200$ |
| A+ | $44 \leq \eta_{wh} < 53$ | $55 \leq \eta_{wh} < 72$ | $100 \leq \eta_{wh} < 130$ | $115 \leq \eta_{wh} < 150$ | $123 \leq \eta_{wh} < 160$ |
| A | $35 \leq \eta_{wh} < 44$ | $38 \leq \eta_{wh} < 55$ | $65 \leq \eta_{wh} < 100$ | $75 \leq \eta_{wh} < 115$ | $80 \leq \eta_{wh} << 123$ |
| B | $32 \leq \eta_{wh} < 35$ | $35 \leq \eta_{wh} < 38$ | $39 \leq \eta_{wh} < 65$ | $50 \leq \eta_{wh} < 75$ | $55 \leq \eta_{wh} < 80$ |
| C | $29 \leq \eta_{wh} < 32$ | $32 \leq \eta_{wh} < 35$ | $36 \leq \eta_{wh} < 39$ | $37 \leq \eta_{wh} < 50$ | $38 \leq \eta_{wh} < 55$ |
| D | $26 \leq \eta_{wh} < 29$ | $29 \leq \eta_{wh} < 32$ | $33 \leq \eta_{wh} < 36$ | $34 \leq \eta_{wh} < 37$ | $35 \leq \eta_{wh} < 38$ |
| E | $22 \leq \eta_{wh} < 26$ | $26 \leq \eta_{wh} < 29$ | $30 \leq \eta_{wh} < 33$ | $30 \leq \eta_{wh} < 34$ | $30 \leq\leq \eta_{wh} < 35$ |
| F | $19 \leq \eta_{wh} < 22$ | $23 \leq \eta_{wh} < 26$ | $27 \leq \eta_{wh} < 30$ | $27 \leq \eta_{wh} < 30$ | $27 \leq \eta_{wh} < 30$ |
| G | $\eta_{wh} < 19$ | $\eta_{wh} < 23$ | $\eta_{wh} < 27$ | $\eta_{wh} < 27$ | $\eta_{wh} < 27$ |

Examples of the labels for combination boilers are depicted in **Figure 1**.

Icons in **Figure 1** have the following meaning [2]:

I. supplier's name or trade mark;
II. supplier's model identifier;
III. the space heating function and the water heating function, including the declared load profile expressed as the appropriate letter in accordance with Table 15 of Annex VII [2];EN 6.9.2013 Official Journal of the European Union L 239/25
IV. the seasonal space heating energy efficiency class and the water heating energy efficiency class, determined in accordance with points 1 and 2 of Annex II; the head of the arrows containing the seasonal space heating energy efficiency class and water heating energy efficiency class of the boiler combination heater shall be placed at the same height as the head of the relevant energy efficiency class;
V. the rated heat output in kW, rounded to the nearest integer;
VI. the sound power level LWA , indoors, in dB, rounded to the nearest integer.
VII. for boiler combination heaters able to work only during off-peak hours, the pictogram referred to in point 9(d)(11) of this Annex may be added [2]

## Expected impact

According to the impact assessment, heaters are responsible for about 16% of the total gross energy consumption of the EU–27. The aim of this regulation is to reduce the energy consumption of these appliances. It is

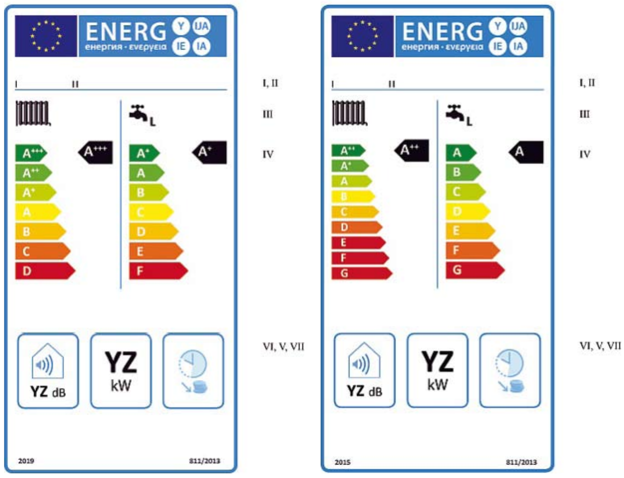


**Figure 1.** Labels for boiler combination heaters: valid between 26 September 2015 and 26 September 2019 (left) and since 26 September 2019 forward (right).

estimated that the combined effect of the proposed new ecodesign requirements and the new labelling scheme set out in this proposal would lead to an annual reduction of about 1 900 PJ (45 Mtoe) by 2020, corresponding to about 110 Mt $CO_2$ emissions.

The impacts of policy scenarios for introducing energy labels were assessed against the 'business as usual' scenario. Based on an assessment of costs and benefits, a combination of ecodesign requirements, labelling and system requirements for the energy performance of buildings was identified as the preferred option to solve the problem of market failure in the take-up of heaters with improved environmental performance, as that combination best meets the requirements of the Ecodesign and Energy Labelling Directives. ■

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[2] COMMISSION DELEGATED REGULATION (EU) No 811/2013 of 18 February 2013 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to the energy labelling of space heaters, combination heaters, packages of space heater, temperature control and solar device and packages of combination heater, temperature control and solar device. Published in Official Journal: http://eur-lex.europa.eu/JOHtml.do?uri=OJ:L:2013:239:SOM:EN:HTML

[3] COMMISSION REGULATION (EU) No 813/2013 of 2 August 2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for space heaters and combination heaters. Published in Official Journal: http://eur-lex.europa.eu/JOHtml.do?uri=OJ:L:2013:239:SOM:EN:HTML

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[6] Testing Calculation Space and Combi Heater-Draft0213. Draft COMMUNICATION FROM THE COMMISSION in the framework of the implementation of Commission Regulation (EU) No …/… implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for space heaters and combination heaters, and of the implementation of Commission Delegated Regulation (EU) No …/… supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of space heaters, combination heaters, packages of space heater, temperature control and solar device and packages of combination heater, temperature control and solar device. Version 19.2.2013

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# New method to design domestic water systems


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**Key words:** water use, DHW, domestic hot water, water system, simulation

## Introduction

In the last decades, we have gained insight in the water use of residential and non-residential buildings. However, until recently, Dutch guidelines on design of drinking water installations were based on measurements carried out between 1976 and 1980 and there were no guidelines for the hot water design. As a result, suppliers of heating systems use company specific guidelines. **Figure 1** shows an overview of the use of guidelines for the design of water systems in the Netherlands

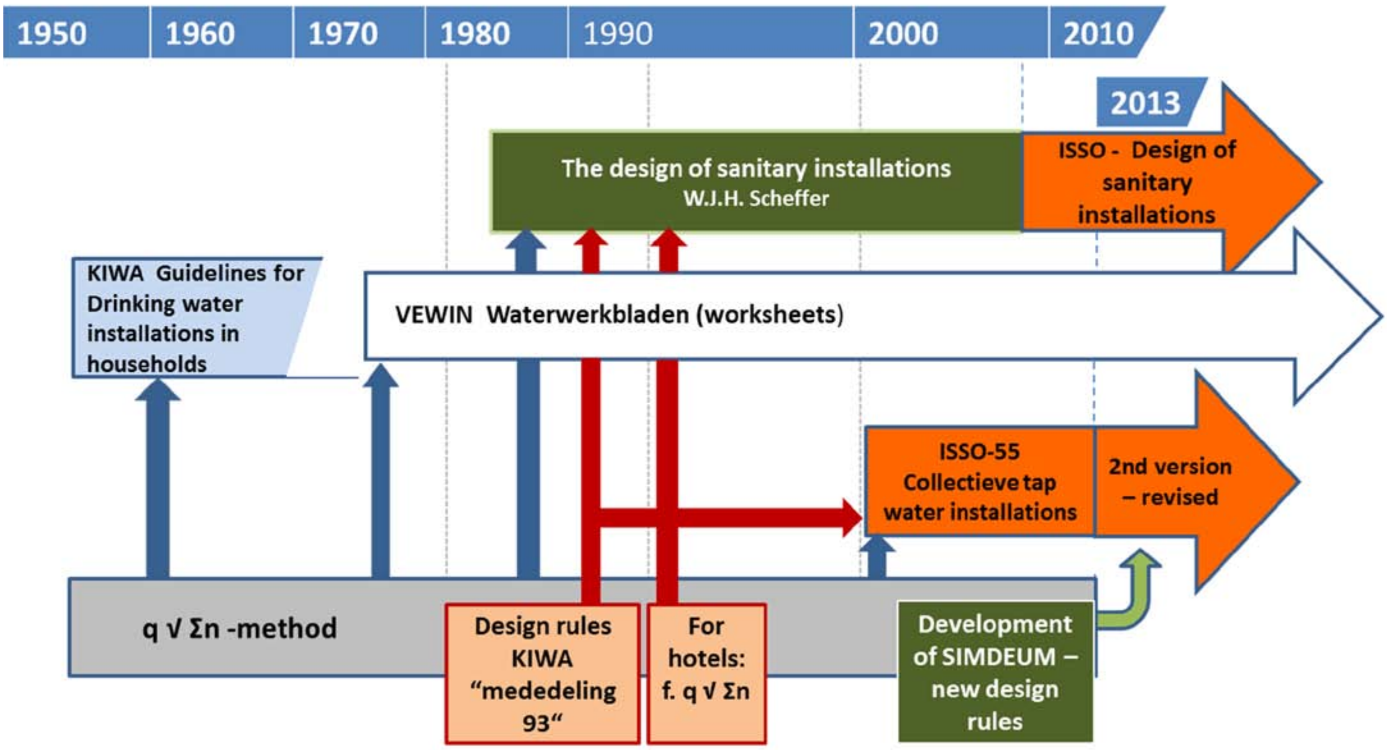


**Figure 1.** Overview of available methods and guidelines for the design of water systems in the Netherlands.

for residential and non-residential buildings. The old approach was no longer suitable for the current situation due to the increasing range of available appliances in the market and to changes in the behaviour of building occupants. In general, old guidelines overestimated the peak demand values. These peak values are crucial for the optimal design of the water system. Badly designed systems are not only less efficient and therefore more expensive, but can also cause stagnant water, possibly leading to increasing health risks.

Although updating the guidelines represented a major challenge, in the long run it represented a win-win-win situation for the customers, the environment and the installation sector. Since 2002 KWR Watercycle Research Institute and the Dutch installation sector (Uneto-VNI, TVVL and ISSO) worked on developing new design rules for non-residential buildings not based on measurements, but based on simulations performed with SIMDEUM.

## Predicting cold and hot water use patterns with SIMDEUM

SIMDEUM stands for "**SIM**ulation of water **D**emand, an **E**nd-**U**se **M**odel." It is a stochastic model based on statistical information of water appliances and users (Blokker et al., 2010). SIMDEUM models water use based on people's behaviour, taking into account the differences in installation and water-using appliances. This means that in each building, whether it is residential or non-residential, the characteristics of the present water-using appliances and taps (i.e. flow rate, duration of use, frequency of use and the desired temperature) are considered as well as the water-using behaviour of the users who are present (i.e. presence, time of use, frequency of use), see **Figure 2**.

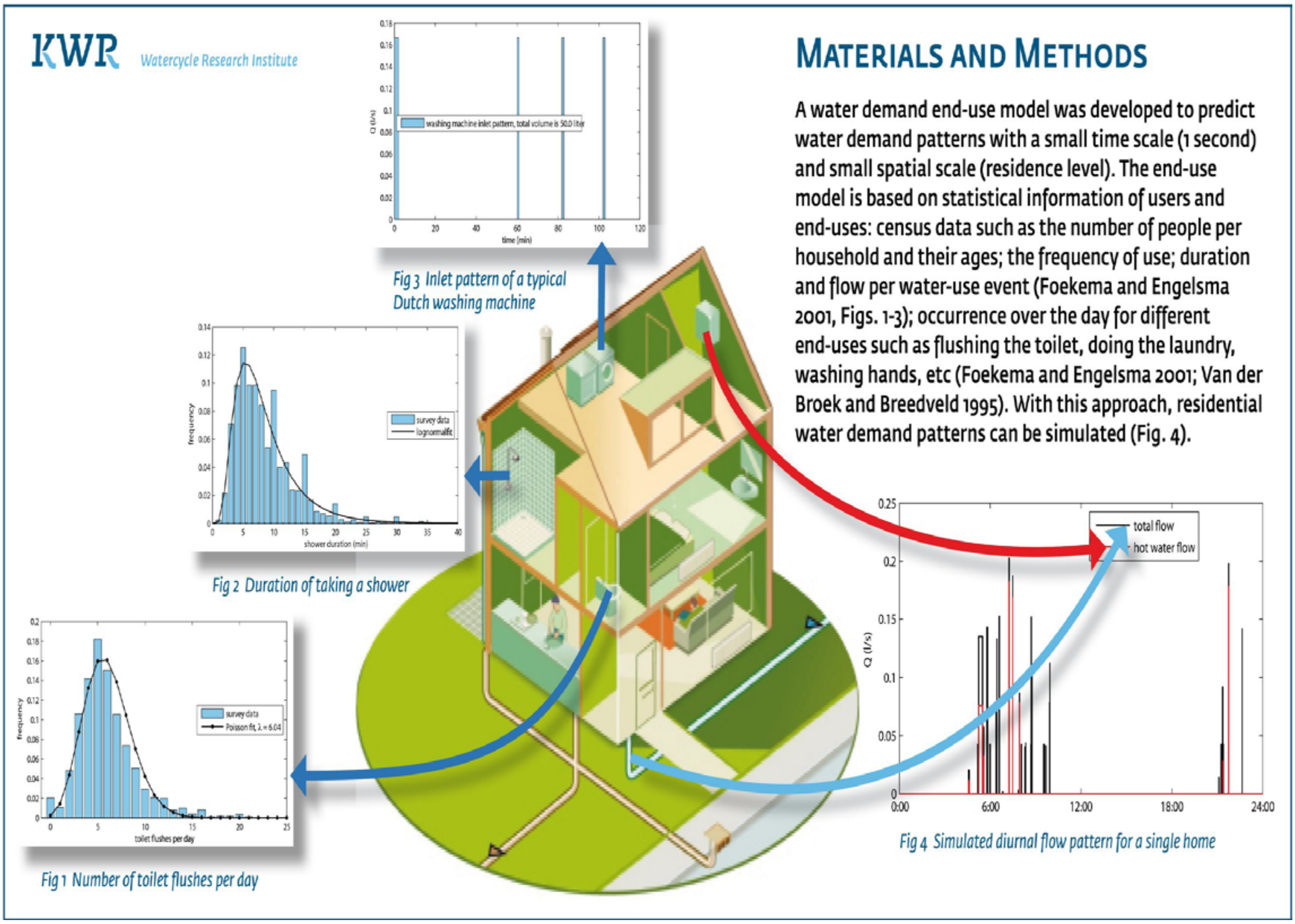


**Figure 2.** Schematic representation of the simulations with SIMDEUM.

SIMDEUM for non-residential water demand follows a modular approach. Each building is composed of functional rooms, characterised by their typical users and water using appliances (Blokker et al. 2011). With this approach, water demand patterns over the day for cold and hot water demand can be simulated for a specific non-residential building. From these daily water demand patterns, the characteristic peak demand values of cold and hot water during various time steps were derived. These characteristics form the basis for the new design guidelines of 2013.

## Deriving new design rules using "design-demand equations"

For the design of the drinking water distribution system, the peak value of the total water demand, the instantaneous peak demand or maximum momentary flow ($MMF_{cold}$) is essential (Loureiro et al., 2010; Blokker and van der Schee, 2006). Additionally, the peak demand of hot water, i.e. maximum momentary flow ($MMF_{hot}$) and the hot water use (*HWU*) in different time periods is required to select the correct type of water heater as well as the design capacity of the hot water device. In 2010, a procedure was developed to derive design-demand equations for the peak demand values of both cold and hot water for various types of non-residential buildings, i.e. offices, hotels and nursing homes (Pieterse-Quirijns et al., 2010).

The aim of the design-demand equations is to predict the peak demand values ($MMF_{cold}$, $MMF_{hot}$ and *HWU* in different time periods) for various types and sizes of buildings. The new design-demand equations predict the peak demand values as a function of the most important (dominant) variable. The dominant variable for hotels is the number of rooms, which can be occupied by 1 or 2 guests, depending on the type of hotel, for offices is the number of employees and for nursing homes de number of beds.

For a specific value of the dominant variable, a standard building was constructed, i.e. each functional room is equipped with appliances and users. For this purpose, the number of appliances and users is established as a function of the dominant variable for each type of non-residential building. From 100 stochastic demand patterns simulated with SIMDEUM at different values of the dominant variable, the peak demand values were derived, i.e. maximum momentary flows ($MMF_{cold}$ and $MMF_{hot}$) and the maximum hot water use (*HWU*) for different time periods: 10 minutes, 1 hour, 2 hours and 1 day. These peak demand values and the *HWU* for several buildings could be described by simple linear relations as a function of the dominant variable. These linear relations form the design-demand equations.

## Test and validation of the "design-demand equations"

The validation of the new design rules was performed in two steps. The first step focused on validating the assumptions of how to standardize the buildings, using the functional rooms. This was done with measurements and surveys. Cold and hot water diurnal demand patterns were measured (in seconds) for three categories of small-scale non-residential buildings, viz. offices, hotels and nursing homes. The surveys gave information on the number and characteristics of users and appliances, and on the behaviour of the users, like the frequency of toilet use, or the use of coffee machine. Comparison of the surveys with the standardized buildings showed that the assumptions of the number of users and their water using behaviour as well as the number of appliances correspond with the surveyed buildings. Comparison of the simulated water demand patterns and the measured patterns showed good correlation. This good correlation indicates that the basis of the design-demand equations, the SIMDEUM simulated standardised buildings, is solid. The results for a business hotel are presented in **Figure 3**, showing the measured and simulated cold and hot water flow.

The second step focused on validating the design-demand equations by comparing the simulated and measured peak flows. For hotels, the derivation of peak demand values from the measured water demand patterns was especially difficult, due to the varying occupation of rooms. However with the proposed method, the $MMF_{cold}$ can be predicted fairly well. **Figure 4** shows the comparison of measured and simulated peak flows and compares them with the old guideline (Scheffer, 1994) and with the original $q\sqrt{n}$ -method. The $MMF_{cold}$ and $MMF_{hot}$ can be predicted fairly well. The studies showed that the old guidelines overestimate the $MMF_{cold}$ with 70–170% for hotels, resulting in too large heaters.

## Consequences for design of distribution systems and heating system

The new SIMDEUM based design-demand equations lead to a better estimation of the $MMF_{cold}$ than with the old guidelines. Moreover, the pattern of water use of different building types can be easily determined using the functional rooms.

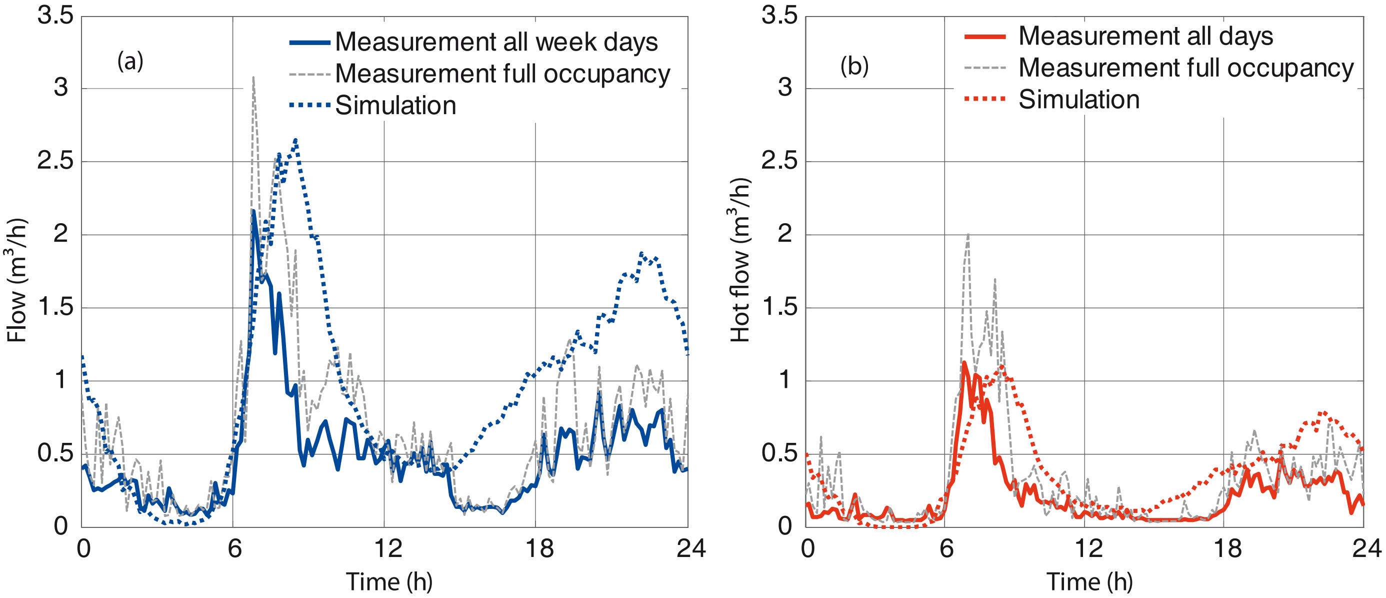


**Figure 3.** Comparing average measured and simulated demand of a) cold water and b) hot water of a business hotel.

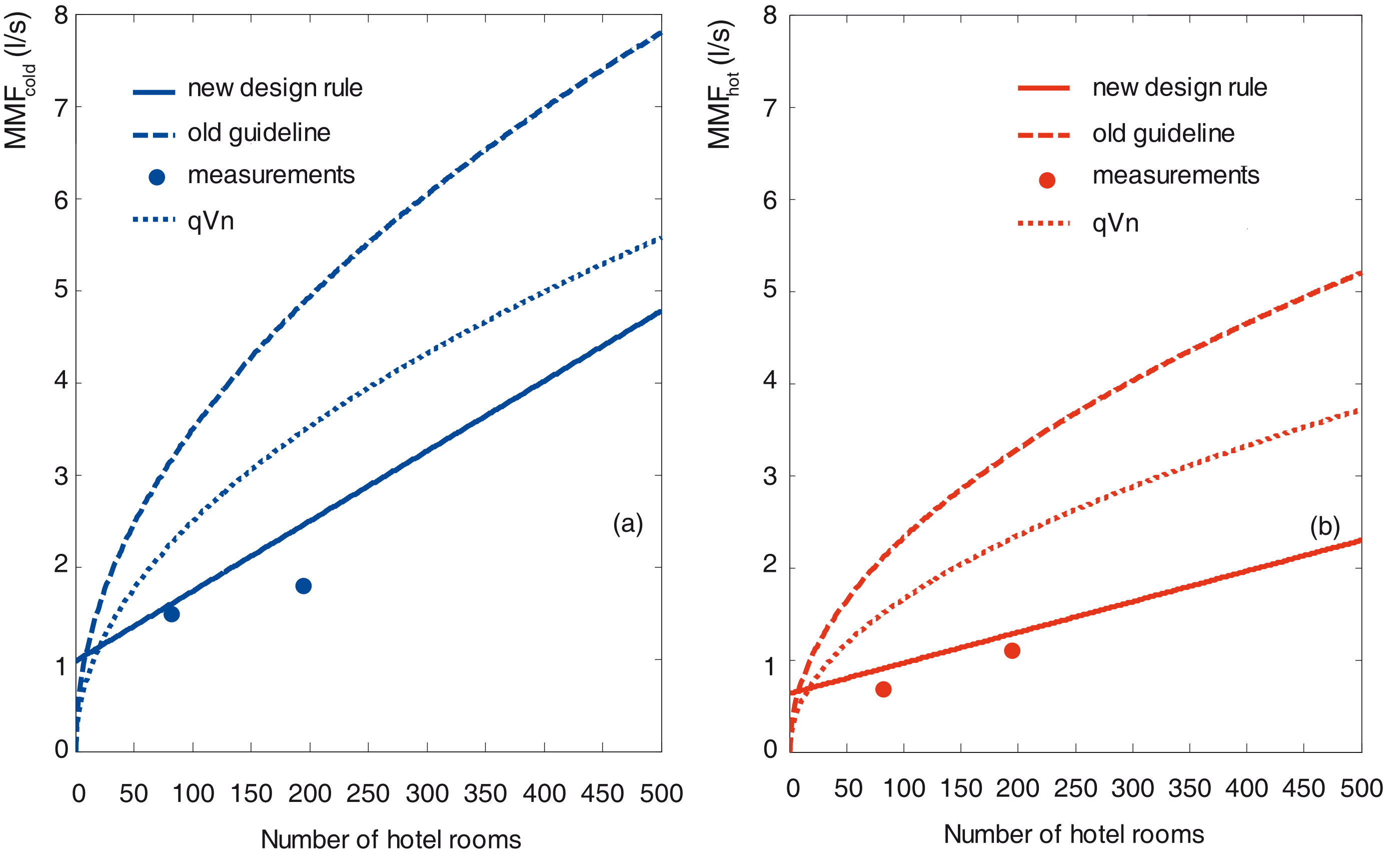


**Figure 4.** Comparing measured and simulated peak flows a) cold water and b) hot water of a business hotel.

SIMDEUM based design-demand equations reduce the design of heater capacity with a factor 2 to 4 compared to suppliers proposals, while still meeting the desired need and comfort. Thus, the improved insight of the new design-demand equations will lead to an energy efficient choice of the hot water systems, and thus save energy. Moreover, the smaller design of the heating system reduces the stagnancy of water, which may lead to less hygienic problems.

The selected pipe diameters are smaller than the ones used in practice and the ones predicted by the existing guidelines. This indicates that the common practice leads to oversized systems, with corresponding potential quality problems. The tendency to over dimension the system might also be present in other countries. Given the physical basis of SIMDEUM, the presented procedure is easily transferable to other countries when some specific information on users and appliances is available. Although international guidelines do not exist in the public domain, international knowledge exchange regarding design rules of residential and non-residential buildings will strongly contribute to better understanding drinking water use. Further, the knowledge exchange can support the design of more efficient and sustainable water systems. With increasing concern for sustainability, this approach can support the development of guidelines for the design of on-site water systems, such as rainwater systems or energy harvesting techniques i.e. harvesting energy from water flows.

## Conclusion

The validation shows that the model predicts the cold and hot water daily demand patterns reasonably well to good. The correlation of the simulated patterns with the measured patterns indicates that the basis of the design-demand equations is solid. Due to the modular approach of SIMDEUM and its physical basis, it is possible to construct a specific building and simulate its water demand. In this way, SIMDEUM was used to develop diurnal profiles for several different buildings, like schools, shops, restaurants, sporting facilities etc. (Pieterse-Quirijns and Van de Roer, 2013).

The new design-demand equations have been adopted in a revised version of the Dutch guidelines, which were released in 2013. The Netherlands is a frontrunner, being the only country in the world with specific regulations for water use in non-residential buildings. Therefore, they are a step ahead in the transition to more sustainable buildings. ■

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# In-house waste water heat recovery

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**Key words:** waste water, sewage water, heat recovery, domestic hot water, DHW, tap water, water use, heat recovery

## Introduction

A measurement-based analysis of the energetic potential of waste water within six buildings in Germany shows the high temperature level of the so far widely unused resource waste water. The waste water has average temperature of about 21 to 26°C. Due to measurements of the consumption of drinking water the estimated amount of waste water for a weekday is in average 113 to 133 litres per day and person in residential buildings, 184 litres per day and room in hotels and 327 litres per day and bed in hospitals. The usage of thermal energy from waste water provided by heat pumps leads to high seasonal performance factors enabling economical as well as ecological use of the in-house heat recovery systems. To ensure the efficiency of the system the biofilm that grows on the sewage-sided heat exchanger, as a result of the nutritional richness of the waste water, has to be removed regularly.

## Research approach

About 5% of the total delivered energy consumption in Germany is used for water heating [1]. Referring to buildings, the percentage of the delivered energy consumption for domestic hot water is about 11% [2]. Due to continuous efforts to reduce the heating demand of buildings the percentage of energy used for hot water supply will increase decisively during the upcoming years. This tremendous amount of energy in the waste water is usually discharged unused in the sewage system.

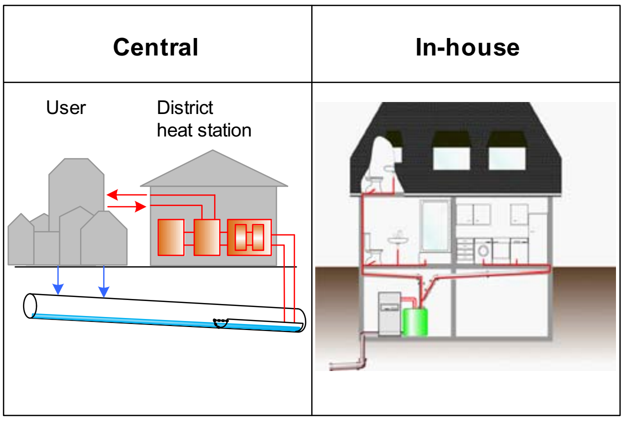


**Figure 1.** Concepts of waste water heat recovery.

In order to achieve the European objectives of climate protection waste water heat recovery provides an enormous and for the most part unexploited potential to develop resource-efficient heating devices in buildings.

The idea of heat recovery from waste water with heat pumps is certainly not new. Since the 1980s centralized systems in Germany, Switzerland and in the Scandinavian countries make use of the heat in waste water (**Figure 1**), either in the sewage system or in the effluent of sewage treatment plants [3]. The temperature of waste water is about 10 to 15°C throughout the whole year and even up to 20°C during summertime that guarantees an adequate heat source for the operation of heat pumps [4]. During the winter months with high heating demand waste water temperatures of only about 10°C are available that leads to decreasing heat pump efficiency.

In contrast to this technology, the aim of the project supported by the German Federal Ministry of Transport, Building and Urban Development called "In-house heat recovery of domestic waste water to increase the energy efficiency of buildings", which is compiled by the Chair of Construction Business and Building Services of RWTH Aachen University, is different [5]. Here the main objective is the decentralized use of thermal energy of all waste water flows before having entered the sewage systems within buildings to prevent the emission of energy to the surrounding soil. That's how to explain the waste water temperatures of about 23 to 26°C on average, which are substantially higher compared to the temperatures in centralized systems. As a consequence, the efficiency and cost-effectiveness of the heat pump systems can be increased decisively. Thus, a heat cycle is built up, in which the thermal energy of the waste water can be used by means of a heat pump to produce domestic hot water directly within the building.

In the context of the research project metrological potential analysis of the energy source waste water within buildings, as well as the simulative investigation of different system concepts, is conducted in order to evaluate the efficiency of the system compared to conventional energy generation.

## Monitoring concept

In order to determine the energetic potential of waste water flows the consumption of cold drinking water, as well as the temperature of the waste water, has to be measured in the monitored objects. Here, the consumed amount of drinking water is equal to the estimator for the amount of waste water. The waste water temperature is measured redundantly with respectively two temperature sensors on each sewer. The measuring points are situated on the main sewers on the back of all internal sewers and before the waste water flow enters the sewage system (**Figure 2**).

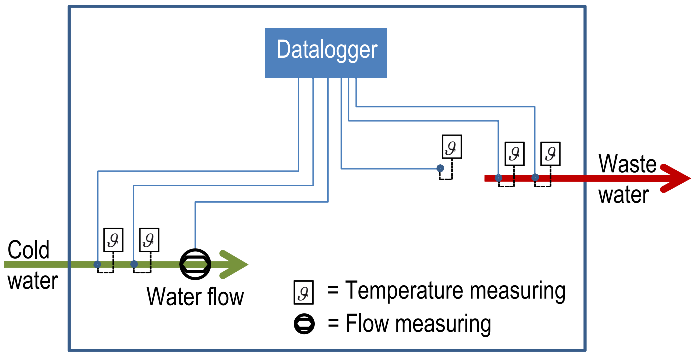


**Figure 2.** Monitoring concept.

The six monitored objects include a multiple-family house with 19 residents in the city of Düren, another multiple-family house with 49 inhabitants in the city of Pforzheim, two student residences with 244 and 208 occupants, a business hotel with 150 rooms and a hospital with 348 beds in the city of Aachen.

## Monitoring results

**Figures 3 and 4** show the representative daily variations of the consumption of drinking water and the waste water temperatures for a weekday based on arithmetic averages for one of the multiple-family houses and one of the student residences.

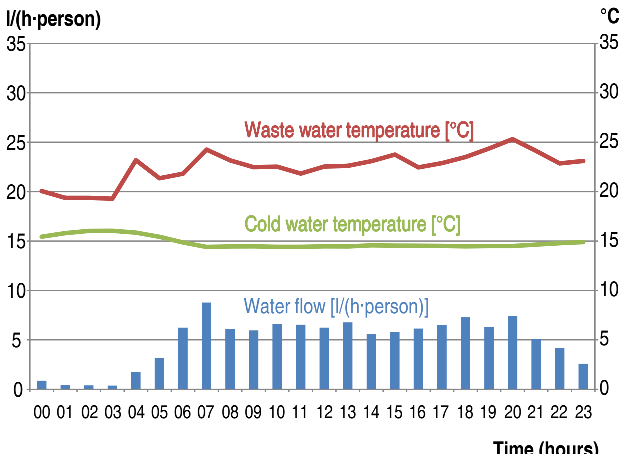


**Figure 3.** Multiple family house with 19 residents, hydrograph for a weekday.

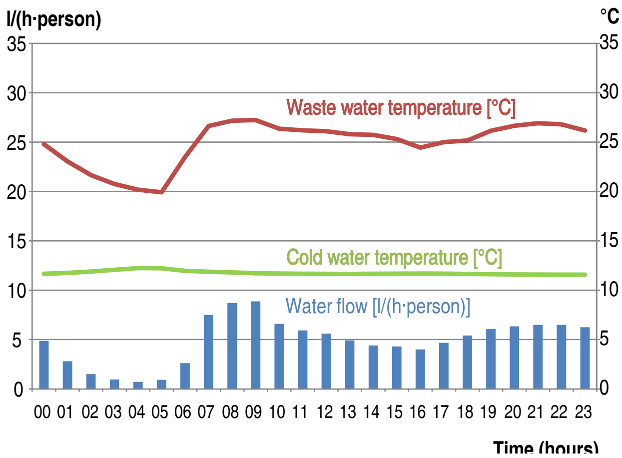


**Figure 4.** Student residence (TKH) with 244 residents, hydrograph for a weekday during the lecture period.

Derived from the measurement data for the multiple family house in the city of Düren with 8 accommodation units and 19 residents from May 2012 to July 2012 the average flow on weekdays results in 117.0 litres per day and person or rather 2.2 cubic metres per day. The average waste water temperature is 22.5°C while the average temperature of cold drinking water is 14.8°C during this period. **Figure 3** shows the daily fluctuation of water flow and waste water temperature. It can be noticed that the consumption of drinking water starts at 4:00 am and reaches its maximum of 8.8 litres per hour and person between 7:00 am and 8:00 am. Afterwards during the day, the flow is on a constant level between 5.6 (2:00 pm to 3:00 pm) and 6.8 (1:00 pm to 2:00 pm) litres per hour and person. During the night hours the flow increases slightly until 9:00 pm whereupon a steady decrease follows. The waste water temperature reaches its maximum average hourly value of 24.3°C (7:00 am to 8:00 am) and 25.3°C (8:00 pm to 9:00 pm) during the morning and the evening peak. The profiles of the curves are different on Saturdays and Sundays (not to be seen in the chart). The early consumption peaks begin with a three-hour delay on both days of the weekend. It is remarkable that the average consumption is with 133.9 litres per day and person higher on Sundays.

The results derived from the measurement data for the student residence in the "Theodore von Kármán" building (TKH) with 244 residents from May 2011 to February 2012 are the following: on a characteristic weekday (Monday to Friday) during the lecture period the average consumption of drinking water is 116.9 litres per day and person respectively 28.53 m³ per day while the average waste water temperature is 24.9°C. The average temperature of cold drinking water is around 11.8°C during the measurement period. **Figure 4** shows the representative daily variations of the water flow and the waste water temperature. It is obvious that the drinking water consumption starts at 6:00 am in the morning and reaches its daily maximum of about 9 litres per hour and person between 8:00 am and 10:00 am. During the afternoon hours between 4:00 pm and 5:00 pm the consumption is slightly lower. Between 10:00 pm and 11:00 pm there is a second consumption peak with 6.5 litres per hour and person. The curve of the waste water temperatures shows a similar trend: The maximum hourly value of 27.2°C can be observed during the early consumption peak between 9:00 am and 10:00 am while the temperature falls to 19.9°C between 5:00 am and 6:00 am. The shape of the curve shows that during periods with much flow water the waste water temperature is higher than in periods with less flow water. On Saturdays and Sundays the profiles are slightly different (not to be seen in the chart): The consumption peaks in the morning begin with a one-hour delay on Saturdays and with a two-hour delay on Sundays.

## Evaluation of the performance

Due to the high temperature level of waste water it can be described as an ideal heat source for a heat pump system, as shown in **Figure 5**. The waste water storage compensates the fluctuating amount of incoming waste water in the course of a day and serves at the same time as an installation site for the sewage-sided heat exchanger, which absorbs heat from the waste water. The heat pump supplies the required rise in temperature and distributes the heat on a higher temperature level to the domestic water heating. In bivalent designed systems the heat pump accomplishes a preheating of the drinking water, whereupon a second generator (a conventional gas boiler for instance) rises the temperature from the preheating-level to the drinking water temperature of 60°C. This is done in order to keep Legionella bacteria from growing and to ensure a hygienically unobjectionable supply system.

In the context of the research project [6] different system concepts are analysed concerning their ecological and economic advantages by simulation calculations, where the hydrographs of the waste water energy profiles serve as input quantities for the simulation. In the following the simulation results are presented for a heat pump system wherein the heat pump provides a preheating of the domestic hot water to a 45°C-level and a gas boiler rises the temperature up to 60°C using the example of the student residence TKH with 244 occupants. Further constraints are:

- ensuring the domestic hot water temperature $\vartheta_{DHW} = 60°C$
- preheating of domestic hot water through heat pump $\vartheta_{pre} = 45°C$
- domestic cold water temperature $\vartheta_{DCW} = 10°C$
- volume of water heater $V_{water\ heater} = 5\ m^3$
- volume of waste water storage $V_{waste\ water\ storage} = 5\ m^3$
- heat output of heat pump is 24 kW
- thermal disinfection of water heater once daily using the gas boiler

Because of the nutritional richness of the medium waste water the formation of biofilms on all contact surfaces is expected. Here, the biofilm formation on the sewage-sided heat exchanger is of particular interest because the biofilm has a low thermal conductivity and thus

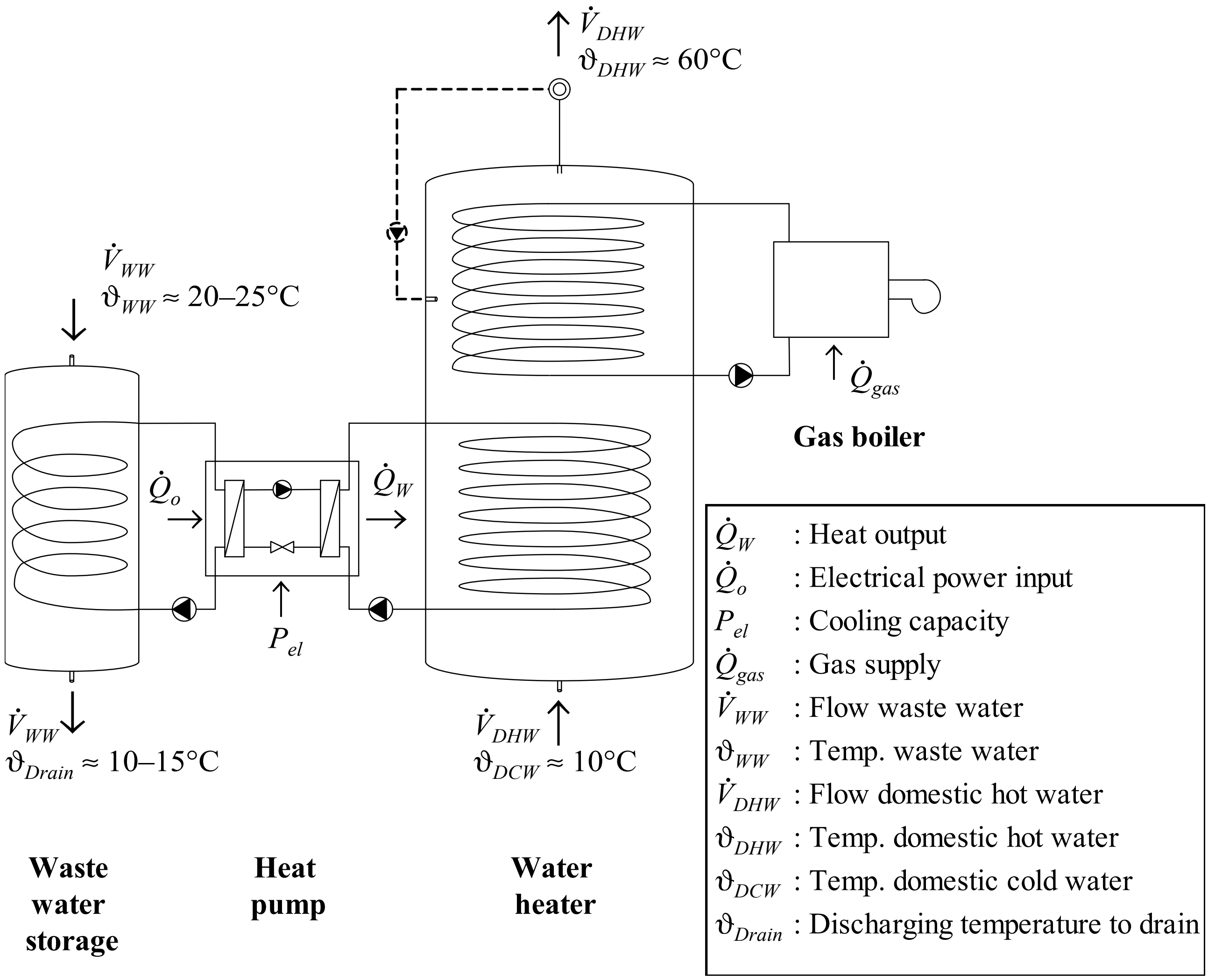


**Figure 5.** Possibility for using waste water energy to heat up drinking water by means of a heat pump.

has an insulating effect and can significantly impede the heat transfer of the heat exchanger. In the simulation a biofilm with an average thickness of 1 mm is applied, which requires regular cleaning of the sewage-sided heat exchanger in one-day-intervals:

- thickness of biofilm on sewage-sided heat exchanger $d_{bio}$ = 1 mm
- thermal conductivity of biofilm $\lambda_{bio}$ = 0.5 W/m·K

For the simulated system, a delivered energy demand for domestic hot water of 991.2 kWh/a·person is calculated, from that the heat pump provides 475.5 kWh/a·person and the gas boiler 515.5 kWh/a·person. The performance factor of the heat pump is extrapolated on company data to 5.5 with a heating coverage of 48.0%. On average, the heat pump operates with a temperature rise from 17.7°C to 44°C. Based on the calculations, the waste water is cooled down to 18°C on average. Thus, no damaging effects on downstream waste water cleaning processes in the sewage treatment plant have to be expected. For detailed results, reference is made to other publications that were compiled within this research project, see [6].

The reduce of biofilm formation on the sewage-sided heat exchanger, for example with the help of highly innovative and automated cleaning methods, is essential for the efficiency of the system. The main objective of the research project is the expansive use of waste water as a heat source. The in-house waste water heat recovery can be considered as a forward-looking technology that can increase the energy and resource efficiency of heating devices in buildings. ■

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

# HVAC benefits translated to building valuation

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**High performance HVAC solutions are often introduced to the market with characteristics phrasing their technical and environmental performance in terms of energy efficiency and indoor climate benefits. Yet these characteristics are often insignificant in the context of an overall building evaluation made by potential investors and it is useful to open a debate on a suitable assessment of HVAC benefits on building appraisal, taking into account "global costs" and considering functionalities, investments costs and operation and maintenance issues. This article aims at discussing the factors that allow the construction of a bridge between HVAC engineers and building investors and guidelines to translate typical HVAC systems benefits in the overall valuation of real estate are proposed.**

**Key words:** building value, real estate investor, market value of building, value of HVAC, building owner, assessment of building

## The problem

While the environmental benefits of green buildings and high performance HVAC systems have been firmly established, their compelling financial and social benefits have been neglected. It happens in spite of the more and more importance of HVAC emerging technologies: research clearly shows that there are a large number of compelling benefits from using high performance HVAC systems, which are received by different stakeholders throughout building lifecycle. Actually, a building affects the workers where the building material are sourced, the workers that will work in the project, the community where it will be built. In economics terms the dilemma of a real estate investor is balancing all the stakeholders and translate the HVAC benefits to building valuation.

## The drivers of market value

One issue that has remained controversial is whether it is possible to associate a financial value to the benefits of different HVAC solutions: this is crucial information for real estate lenders and the investment community. Do high performance HVAC solutions attract financial premiums in terms of rental and sales market value? Are they more attractive to tenants? Are employees provided of comfort technologies more productive?

To do that, investor must focus on his own long-term value creation: from the property's point of view this value creation corresponds to the building features the occupants look at when leasing or owning a building (Hines Italia, 2009). So, buildings with certain features will achieve a premium respect to other buildings. The key question is then what are those features that investors are looking for, and willing to pay a premium for. Data from literature are encouraging (IMMOVALUE project, 2010; Fuerst and McAllister, 2011; Wiley et al., 2010; Eichholtz et al., 2010), since there is evidence that the investors are willing to pay a premium for a sustainable buildings, and many characteristics of these buildings are closely linked to the installed HVAC systems. Actually, the *Market Value* of a building has three main components (or "drivers"): *Income*, *Expenses* and *Residual Value* as delineated by equation (1).

$$\textit{Market Value} = \textit{Net Income} - \textit{Expenses} + \textit{Residual Value} \quad (1)$$

The HVAC systems features have an impact on the three elements in the second term of equation 1, giving a contribution in the rent per area, in the rentable area, in the operation and maintenance expenses and also in the risk factors influencing the residual value of the building.

## Income

Studies undertaken on certified green buildings have determined that a rental rate premium exists in many cases. This is attributed to the attractiveness in terms of their better indoor environment, lower operating costs and enhanced marketability. In some markets where green buildings are more mainstream, such as in USA, a slightly different concept is emerging: buildings that are not green result in lower rental and lease rates, or 'brown discounts'. In an office building the *Net Income* is given by the income related to *Rent* (net of expenses allocated to the owner) and other incomes related to productivity and reduction of absenteeism; thus, income can be increased by increasing rent or decreasing expenses allocated to the owner. However, rent can be further broken down into rentable area and rent per area.

$$\textit{Rent} = \textit{Rent per Area} \times \textit{Rentable Area} \quad (2)$$

The *Rent per Area* is defined by many qualities that tenants or owners look for and high performance HVAC solutions could reflect. These qualities are related to the attractiveness to tenants in terms of indoor environmental quality (thermal, visual and acoustical comfort and indoor air quality), presence of individual automation control (BAC) and building management systems (BMS), together with the presence of facility management, continuous commissioning of the building services and an effective communication platform. Quality of common area and the image, which could be combined under the name "building best looking", could be affected by different solutions of HVAC systems, and represent reasons for choosing one building over another. The other variable in equation (2) is the *Rentable Area*. This is why space efficiency is such a critical measure. On the exact same plot and in the exact same building envelope, an efficient building with clear, regular floor plates and minimal core areas will create more usable space, i.e. rentable area. This creates more rent, which increases income and in turn increases value for the investor. A successful business "learns" and evolves quickly, and the workplace needs to respond to changes in use: flexibility of layout is an important dimension of the primary design and planning of the workplace's layout and systems. In addition to the level of the income, the investor is also focused on the *stability of the income*. Thus, it is important to keep the building and its HVAC system modern and up-to-date. Tenants that are satisfied with the quality and efficiency of their occupancy spaces are less likely to look for new quarters when their lease terminates. Less turnover provides a more stable cash flow and therefore higher value for the owner. High performance HVAC systems can improve *worker's productivity* and *occupant's health and wellbeing*, resulting in bottom line benefits for businesses. Literature data show that the effects of the thermal environment and air quality on human performance and learning can be much higher than 1% (Rehva Guidebook n.6). This suggests enormous potential benefits from improving indoor climate in relation to the investments required, considering that worker salaries in offices typically exceed building energy and maintenance costs by a factor of approximately 100, and they exceed the annual amortized cost of construction or rental by almost the same factor. Case studies demonstrate benefits of providing individual temperature control for each worker measuring productivity gains and demonstrating up to a 3% increase in overall productivity, while improving ventilation with up to 11% gains in productivity, as a results of increased outside air rates, dedicated delivery of fresh air to the workstation and reduced level of pollutants.

## Expenses

Certified green buildings tend to use less energy and water and are therefore often cheaper to own and operate, making them more attractive to prospective tenants and owner-occupiers where energy and water costs are a major concern related to overall costs, including rents.

Operating expenses (**Figure 1**) for HVAC systems typically include the *Energy* costs for electricity, heating and cooling. Energy efficiency measures permit to reduce energy costs. However, considering a holistic approach as cost optimal analysis, a significant reduction of energy costs is coupled with high investment costs. The energy use is closely linked to the *Emissions* of pollutants (mainly

$CO_2$) in atmosphere and the cost of the reduction of the emissions can be used as a way to determine market value pollutants in an established trading markets. Actually, the Guidelines of Directive 2010/31/EU define the calculation of the cost optimum at macroeconomic level and it requires the consideration of greenhouse gas emission costs by taking the sum of the annual greenhouse gas emissions multiplied by the expected prices per ton $CO_2$ equivalent greenhouse gas emission allowances issued in every year (20 EUR/ton in 2020; 35 EUR/ton until 2030 and 50 EUR/ton until 2050). HVAC system expenses are also due to both *Operation and Maintenance* and *Continuous Commissioning* activities. HVAC solutions that are designed and operated to reduce the operation expenses will increase the income for the owner because tenants with lower operating costs can spend more money on rent. This in turn translates into more value for the investor. Furthermore, HVAC systems over the years could lead to *Major Refurbishment* costs because of the lack of functionality of the old system. This is another parameter to account in the analysis of the expenses.

## Residual value

The residual value of a building and HVAC system should reflect investor risk related to the potential reduction in value or increase in costs associated with holding an investment (World Green Building Council; 2013). There are different risks (**Figure 2**) related to the HVAC system that could be evaluated at the different stage of building life cycle, but all can be considered ways to "future-proofs" investments.

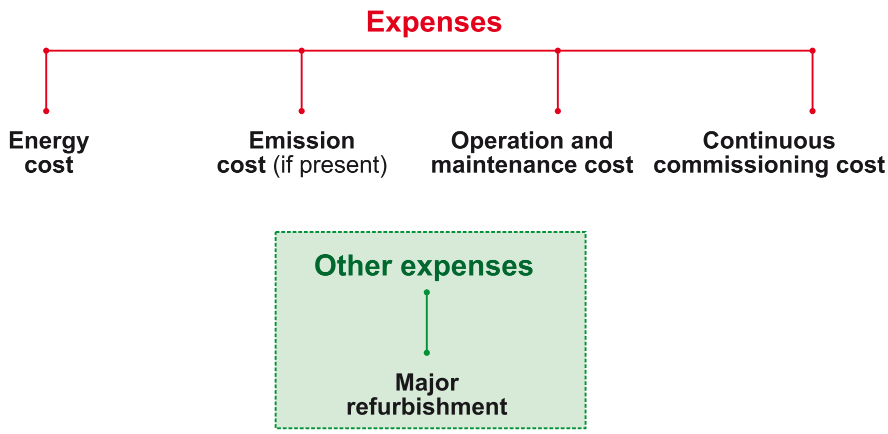


**Figure 1.** Classification of expenses for HVAC systems.

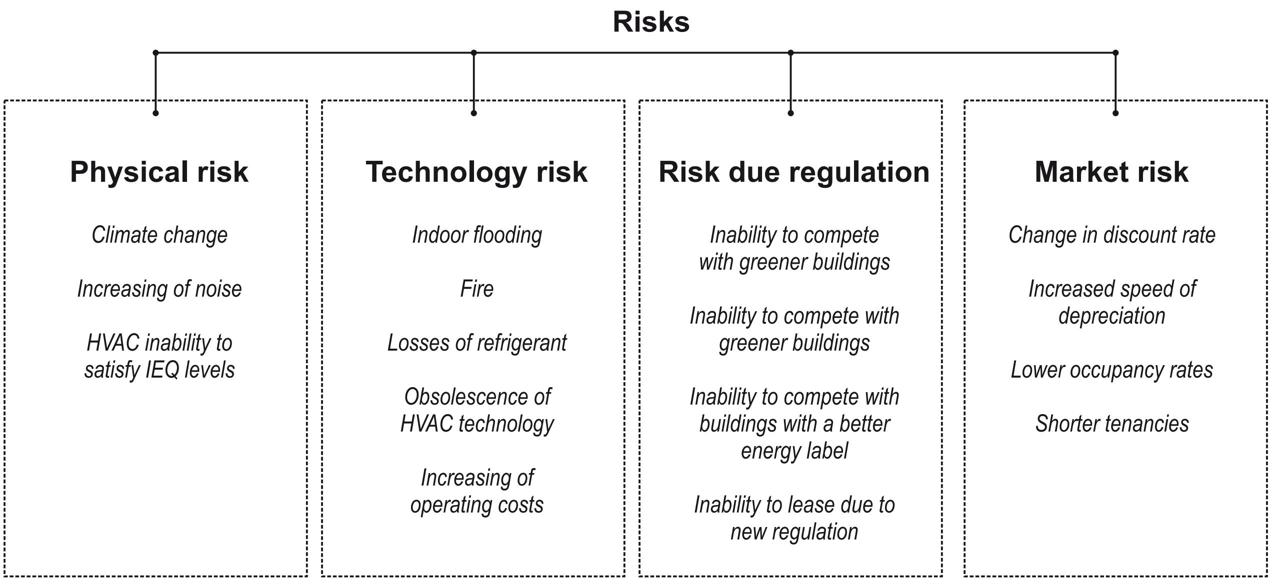


**Figure 2.** Risks classification for HVAC systems.

Climate change represents a real *Physical risk* for investors: chief among the climate change impact will be the ability of the HVAC systems to cope with the foreseen increased temperature of the planet. For this reason, investors should consider the ability of HVAC systems to ensure that the building's occupants will view premises as desirable (HVAC inability to satisfy adequate indoor environmental quality levels). Actually, there is a cash flow risk for buildings which are not enough resilient to face future climatic challenges and to ensure occupant's satisfaction. Innovative technologies like new HVAC equipment have their own risks (*Technology risk*), arising from unintended outcomes from their use or concerns about appropriate maintenance regimes. However, reticence to use new technologies could increase the risk of obsolescence and could miss opportunities for reduced operational costs. Regulation of sustainability issues, like reduction of carbon emissions, has become increasingly important to real estate investors, since the built environment is regarded as responsible for significant environmental impact. The *Risk due to regulation* is reflected by the inability of existing asset to compete with greener buildings, or with buildings with a better energy label. There is increased consensus that governments will implement regulations that target sustainability factors more forcefully than has previously been the case: actually this is reflected by the inability to lease buildings without high performance HVAC systems due to new regulation. As well as responding to regulatory pressure, real estate investors simultaneously need to understand how high performance HVAC solutions affect them from a market perspective (*Market risk*). The financial performance and valuation of a real estate asset is to a large part determined by the security of its cash flow. The likelihood that tenants might leave a building (lower occupancy rates) or not lease it in the first place (shorter tenancies), because of its inadequate performance in terms of energy and indoor environmental quality, is also recognized as a key risk by investors. As more high performing buildings (with high performance HVAC systems) become available and occupants become less willing to occupy not-performing buildings, it will increase the speed of their depreciation.

## HVAC benefits valuation

The HVAC benefits are the factors leading to an added investment value for the building, actually they could be translated in "*quantitative indices*" (i.e. the energy costs for controlling the indoor environmental conditions or operation and maintenance costs) and "*qualitative indices*" (i.e. the characteristics of the system in order to allow modification in building layout or the best looking). The quantitative indices could be expressed as costs in Euros while qualitative indices, that can't be directly expressed in Euros, could be expressed as correction coefficients (**Table 1**).

Energy use, pollutants emission, continuous commissioning and O&M expenses are categorized as quantitative indexes. Flexibility of layout in space and time, comfortable indoor environmental conditions as well as best looking are categorized as qualitative indices that affect the income by the rent per area and the rentable area values.

**Table 1.** HVAC systems influencing factors and costs (for each HVAC typology).

| | | |
|---|---|---|
| ***Expenses, €*** | Energy cost<br>Emissions cost<br>O&M<br>Continuous Commissioning cost | ***QUANTITATIVE INDICES*** |
| ***Net income factors*** | Flexibility [$f_1$]<br>IEQ [$f_2$]<br>Best looking [$f_3$]<br>BAC [$f_4$]<br>BMS[$f_3$] | ***QUALITATIVE INDICES*** |
| ***Residual Value factors*** | Losses of refrigerant [$z_1$]<br>Indoor flooding [$z_2$]<br>Fire [$z_3$]<br>HVAC technology obsolescence [$z_4$]<br>Increasing of operation costs [$z_5$] | |

The risks factors in **Figure 2** are categorized as qualitative indices affecting the residual value of the building. Looking at equation 1, both the quantitative indexing factors and the qualitative indexing factors can be inserted modifying directly the market value (correcting the income or the residual value, increasing or decreasing the expenses). Then it becomes:

$$Market\ Value = f_{1,2,3,\ldots,n} \times Net\ Income - Expenses + z_{1,2,3,\ldots3,n} \times Residual\ Value \quad (3)$$

## Discussion

It has been highlighted the fact that HVAC systems benefits are not considered yet in the current market valuation and the problem of how market could integrate these benefits is crucial and relevant for the HVAC industry. The research on the methodology to evaluate the benefits linked with the installations of high performance HVAC system arose interesting discussion points. It's very important to find a method to evaluate the qualitative benefits related to income and the risk factors related to residual value. As above mentioned, an increase in comfort conditions could gain an increase on productivity and reduction of the so called "sick building syndrome", but the issue of comfort is not actually translated in money, which is an important aspect to consider when investing in a building. Between the qualitative benefits related to income, the presence of BACs could be expressed by default in a quantitative index as the reduction of energy cost (see standard EN 15232 "Impact of building automation, controls and building management"). The topic of risk assessment is of crucial relevance: risk factors have be included in the HVAC valuation, but it still remains difficulties in assessing the investment risks related to high performing buildings and systems. Between the risk factors related to residual value, some of them could be reduced by an increase of O&M and continuous commissioning costs. Maintenance best practice integrate management of risk and an interesting passage for HVAC industry should be moving from selling only products to sell after sale services. To find a way of communication from HVAC industry to investors is a fundamental aspect in order to correctly translate all the HVAC benefits in the market valuation. Therefore a work table of technicians and investors is fundamental to have a more integrated perspective. ■

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Articles

# Refrigerants – Part 2: Past, present and future perspectives of refrigerants in air-conditioning applications

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**Key words:** refrigerants, CFCs, HCFCs, HFCs, natural refrigerants, ODP, GWP

## Abstract

The second part of the refrigerant paper deals with the refrigerant development throughout the history, which took place due to different reasons, such as safety, stability, durability, economic or environmental issues, thus giving the boost to new research and equipment improvement in terms of safety and efficiency. Recent legislation worldwide and in the EU is still not quite completed concerning refrigerant issues. The delicate subject of refrigerants is widely discussed, viewpoints of different parties are opposite, depending on positions and interests, and compliance on that issue is not easy to achieve. The chance for "closing the circle" and return to natural refrigerants exists and should not be missed.

## Historical overview of refrigerants' development

**Beginnings** of mechanical refrigeration, starting from early 19$^{th}$ century are characterized by use of natural refrigerants. Water and air were the first refrigerants considered for use in mechanical refrigeration systems. In 1834 Perkins proposed ethyl ether as the working fluid in his patent of the vapor - compression refrigeration system. Perkins system was a closed circuit comprising all the modern vapor-compression system components: the compressor, the condenser, the expansion device and the evaporator. By that time ammonia, sulfur dioxide and carbon dioxide had been isolated and were available for use as well. The first one who used methyl ether, which operated at higher pressure and thus reduced the risk of drawing air into the system and forming an explosive mixture within the machine was Tellier in 1863. First ammonia compressor for refrigerating purposes was designed and constructed by Boyle in 1872, and 4 years later Linde designed the first machine working with ammonia. In 1862 Lowe developed a carbon-dioxide refrigerating system. Carbon dioxide has very low toxicity but required high-pressure machinery and was difficult to use because of its low critical temperature (31,6°C) which does not allow for condensation in many situations. Methyl chloride was used for the first time as a refrigerant in 1878. Most of those early refrigerants were flammable, toxic or both [1,2]. **Table 1** shows properties (molecular weight M, normal boiling point NBP at pressure 1 bar, critical temperature CRT, critical pressure CRP, safety group according to ASHRAE standard 34, ozone depletion potential ODP and global warming potential GWP

**Table 1.** Properties of early refrigerants.

| Substance | R number | Chemical formula | M kg/kmol | NBP °C | CRT °C | CRP bar | Safety group | ODP | $GWP_{100}$ |
|---|---|---|---|---|---|---|---|---|---|
| Carbon dioxide | R-744 | $CO_2$ | 44,01 | -55,6[1] | 31,6 | 73,77 | A1 | 0 | 1 |
| Ammonia | R-717 | $NH_3$ | 17,03 | -33,3 | 132,25 | 113,33 | B2 (B2L[2]) | 0 | 0 |
| Sulfur dioxide | R-764 | $SO_2$ | 64,06 | -10,0 | 157,49 | 78,84 | B1 | 0 | 0 |
| Ethylether | R-610 | $C_4H_{10}O$ | 74,12 | 35 | 194,0 | 36 | - | 0 | 0 |
| Dimethylether | E-170 | $C_2H_6O$ | 46,07 | -25 | 126,9 | 53,7 | A3 | 0 | 0 |
| Methyl chloride | R-40 | $CH_3Cl$ | 50,49 | -24,2 | 143,1 | 66,77 | B2 | 0,02 | 16 |

[1] – tripple point

[2] – new class introduced since 2010

**Table 2.** Properties of CFC and HCFC refrigerants dominant in 20th century.

| Substance | R number | Chemical formula | M kg/kmol | NBP °C | CRT °C | CRP bar | Safety group | ODP | $GWP_{100}$ |
|---|---|---|---|---|---|---|---|---|---|
| Trichlorofluoromethane | R-11 | $CCl_3F$ | 137,4 | 23,71 | 197,96 | 44,1 | A1 | 1 | 4000 |
| Dichlorodifluoromethane | R-12 | $CCl_2F_2$ | 120,91 | -29,75 | 111,97 | 41,4 | A1 | 1 | 8500 |
| Chlorotrifluoromethane | R-13 | $CClF_3$ | 104,5 | -81,3 | 29,2 | 39,2 | A1 | 1 | 11700 |
| chlorodifluoromethane | R-22 | $CHClF_2$ | 86,47 | -40,81 | 96,15 | 49,9 | A1 | 0,055 | 1700 |
| R22/R115 | R-502 | $CHClF_2$ + $CF_3CClF_2$ | 111,6 | -45,3 | 80,73 | 40,2 | A1 | 0,33 | 5600 |

based on 100 years) of practical refrigerants available for vapor compression cycles at the end of the 19th century.

**The second generation of refrigerants**, chlorofluorocarbons (CFCs) replaced classic refrigerants in early 20th century. Midgeley and his associates, in their research aimed to find for stable, but neither toxic nor flammable refrigerant in 1928, selected R-12, dichlorodifloromethane as a suitable compound for refrigeration applications [2]. The commercial production of R-12 began in 1931, followed by R-11 in 1932 and R-13 for low temperature applications in 1945. Chlorofluorocarbons (CFCs) and starting in 1950s hydrochlorofluorocarbons represented by R-22 and azeotropic mixture R-502 dominated the second generation of refrigerants. Those refrigerants dominated throughout the second half of 20th century. Ammonia was only natural refrigerant that still remained the most popular refrigerant in industrial applications. [1,2]

## Present situation

Present situation is determined by use of refrigerants of zero ODP with no impact on ozone layer, according to demands of Montreal protocol (1987). In 1974 researchers Roland and Molina predicted that emissions of HFCs could damage Earth's atmosphere by the catalytic destruction of ozone in the stratosphere. The hypothesis has been proven in 1985 by measurements which have shown the destruction of the ozone layer over Antarctica. In 1987, the Montreal Protocol limits the production and consumption of CFCs. Between 1990 and the present emissions have decreased substantially as a result of the Montreal Protocol and its subsequent amendments and adjustments coming into force. By 2008, stratospheric chlorine abundances in the stratosphere were 10% lower than their peak values reached in the late 1990s and were continuing to decrease. January 2010 marked the end of global production of CFCs under the Protocol. In 2009 the Montreal Protocol was universally ratified by 196 nations [3]. European regulation concerning that issue is No. 2037/2000 of June 29, 2000 on substances that deplete the ozone layer.

The discontinuation of CFC (2006) and HCFC (2015) use brings us to the today's state of utilization of HFCs, the mixtures thereof and the natural refrigerants. In EU countries HCFC phase-out has been accelerated and those are not in use anymore. Today's refrigerants may not contain chlorine, they must ensure efficient performance and must have a low impact on global warming.

The commercially available refrigeration units mostly use R-134A for fresh produce and R-404A (or R-507A) for frozen produce. Natural refrigerant R-290 is in some countries used in refrigerated display cabinets at medium and low temperatures. R-404A is used in direct central refrigeration systems for low and medium refrigeration temperatures. It may also be used for both fresh and frozen produce. Natural refrigerant $CO_2$ is used as a refrigerant in the lower cascade of the cascade systems or in transcritical systems. It may also be used either as a heat transfer medium. R-134A dominates as the refrigerant in the home refrigeration units and some regions use the hydrocarbons (e.g. isobutane R-600a) as well [4].

Ammonia is still widely used in industrial systems and its previously decreasing utilization due to halogenated hydrocarbons use is on the increase again [4]. The modern-day refrigeration systems using ammonia are constructed with the tendency of decreasing ammonia charge in the system as much as possible for safety reasons. One way of doing that is to apply indirect systems with the heat transfer medium, so that the ammonia is kept in the refrigeration device, whereas the heat transfer medium flows through the distribution system.

Chillers are important part of HVAC installations. R-134a is used in large chillers equipped with centrifugal compressors and flooded evaporators. R-407C is used in direct expansion systems with counter flow heat exchangers. Recently, R-410A units became competitive with the R-407C units and almost fully replaced

**Table 3.** Some ozone friendly refrigerants (ODP = 0).

| R number | Chemical formula / composition | M kg/kmol | NBP [°C] | CT [°C] | CP bar | Temp. glide [°C] | Safety group | $GWP_{100}$ |
|---|---|---|---|---|---|---|---|---|
| R-32 | $CH_2F_2$ | -52,02 | -51,65 | 78,11 | 57,8 | 0 | A2L[1] | 580 |
| R-134A | $CH_2FCF_3$ | 102,03 | -26,07 | 101,06 | 40,6 | 0 | A1 | 1300 |
| R-404A | R143A/125/134A (52/44/4) | 97,6 | -46,6 | 72,14 | 37,4 | 0,46 | A1 | 3800 |
| R-407C | R32/125/134A (23/25/52) | 86,2 | -43,8 | 86,05 | 46,3 | 5,59 | A1 | 1600 |
| R-410A | R32/125 (50/50) | 72,59 | -51,6 | 70,17 | 47,7 | 0,1 | A1 | 1900 |
| R-507 | R143A/125 (50/50) | 98,86 | -47,1 | 70,75 | 37,2 | 0 | A1 | 4000 |
| R-508A | R23/116 (39/61) | 100,1 | -87,4 | 11,01 | 37,0 | 0 | A1 | 13000 |
| R-717 ammonia | $NH_3$ | 17,03 | -33,3 | 132,25 | 113,33 | 0 | B2L[1] | 0 |
| R-744 Carbon dioxide | $CO_2$ | 44,01 | -55,6 | 31,6 | 73,77 | 0 | A1 | 1 |
| R-600A isobutane | $CH(CH_3)_3$ | 58,12 | -11,6 | 134,66 | 36,29 | 0 | A3 | 20 |
| R-290 propane | $C_3H_8$ | 44,1 | -42,11 | 96,74 | 42,51 | 0 | A3 | 20 |
| R-1270 propylene | $C_3H_6$ | 42,08 | -47,62 | 91,06 | 45,55 | 0 | A3 | 20 |

[1] – new safety classes introduced since 2010

**Table 4.** Today's refrigerant alternatives [5]

| Traditional Service Refrigerants | | Medium and Long-Term Alternative Refrigerants | | | | | |
|---|---|---|---|---|---|---|---|
| HCFC/HFC<br>Partly chlorinated | | HFS<br>Chlorine fee | | Low GWP<br>refrigerants | | Halogen free<br>natural | |
| Single substances | Blends | Single substances | Blends | Single substances | Blends | Single substances | Blends |
| R-22<br>R-123<br>R-124<br>R-142B | Predominantly R-22 based | R-134A<br>R-125<br>R-32<br>R-143A<br>R-152A | R-404A<br>R-507A<br>R-407 serie<br>R-410A<br>R-417A7B7<br>R-422A/D<br>R-427A | HFO-1234yf<br>HFO 1234ze | HFO-1234yf/<br>HFO 1234ze/<br>HFC | R-717<br>R-290<br>R-1270<br>R-600A<br>R-170<br>R-744 | R-600A/<br>R290<br><br>R-290/<br>R-170<br><br>R-723 |

them in use. Design of micro channel heat exchangers was initiated by development of R-410A equipment. $CO_2$ is not usually used in chillers, mostly due to low energy efficiency of the process. $CO_2$ heat pumps for water heating started selling in Japan in 2001. They can heat the domestic water up to 70-80°C. The capacity of those chillers goes up to 100 kW. A transcritical cycle operated VRF systems have also been available on the market in recent years, but problems with lower efficiency and construction of high pressure refrigerant piping never allowed wide application. In recent years Japanese producers have pushed hard R-32 as a suitable refrigerant for VRF systems. New safety class A2L as defined by ASHRAE standard 34 discussed in previous paper (Part 1) comprises R-32 as well and one of arguments for R-32 application is the lower burning velocity as described in class A2L definition. The market share of ammonia chillers is still very small due to important issues as safety, charge reduction and first cost. Recently increased research focused on charge reduction (and thus safety) and energy efficiency of those chillers can give boost to wider use of ammonia chillers in HVAC, besides traditional industrial, food processing and beverage applications. Hydrocarbon chillers production is very low. Refrigerants are R1270, R290 and propane and ethane mixtures. The typical performance ranges from 20 to 300 kW and the amount of the refrigerant from 3 to 34 kilograms [4].

Replacement of R-22 in existing refrigeration systems is still actual. There is a significant number of chillers with high performance, built for a longer operational period, and those chillers are potential candidates for that operation called "retrofit". Retrofit basically means adaptation of the refrigeration system to the new refrigerant with changed safety and control equipment and instrumentation within the system, and with changed system performance. That adaptation is not so simple, especially in the case when transition from mineral oil lubricated systems (HCFCs) to synthetic oil lubricated systems (HFCs) is necessary. A lot of research is ongoing presently in order to find suitable, so called "drop-in" replacement for R22. Experience with previous retrofit of R12 systems using replacement R-134A do not give boost to any enthusiastic expectations. Cost of such an operation should carefully be analyzed, and experience shows that equipment replacement is much more likely to occur instead of retrofit.

## The future

GWP of HFCs is another issue addressed by Kyoto protocol (1997). The European Parliament has issued a directive (No. 842/2006) banning the use of HFCs whose GWP is higher than 150 (the "F Gas" Directive) in air-conditioning units of newer cars from 2011 and of all new cars from 2017. Directive also requires periodic leakage check-ups of stationary systems containing HFCs. Changes may be expected in the direction of the ban on HFCs with high GWP use in stationary systems. Review of the F-gas Regulation started in 2010. The European Commission proposal is to broaden the scope of the regulation to refrigerated transport, to modify the frequency of leakage checks based on the $CO_2$ equivalents of the HFCs used and to modify the obligations regarding training and certification of personnel. A gradual phase-down of HFCs is also proposed using the 2008-2011 total quantity of HFCs in EU as a baseline. The document proposes a freeze by 2015 and a gradual reduction ending with 21% of baseline quantity by 2030. This proposal also includes a ban on HFCs in domestic, hermetically sealed commercial systems and movable air-condi-

**Table 5.** Possible directions of future development of refrigerants [2]

| Refrigerants | Remarks |
|---|---|
| Natural refrigerants<br>($NH_3$, $CO_2$, hydrocarbons HCs, $H_2O$, air) | Efficiency; flammability for $NH_3$ and HCs |
| HFCs with low GWP<br>(R-32, R-152a, R-161...) | Flammability, most of the ones that are subject to the ban have a high GWP |
| Hydrofluoroethers HFEs | Disappointing thus far, still? |
| Ethers (HEs)<br>(RE170 – dimethyl ether) | Flammability |
| Olefins – unsaturated alkenes<br>(R1234yf) | Short atmospheric lifetime and therefore low GWP. Flammability? Toxicity? Compatibility? |
| HFICs and FICs<br>(R-31I1 (CH2FI), R-13I1 (CF3I)...) | Expensive, ODP>0, but not subject to the Montreal Protocol. Some are toxic. Compatibility? |
| Fluorinated alcohols (-OH) and ketones<br>[-(C=O)- ] | Efficiency? Flammability? Toxicity? Compatibility? |
| Other | ??? - no ideal refrigerant |

tioners by January 1st 2015. Refrigerators and freezers for commercial use (hermetically sealed systems) will be prohibited by January 1st 2017 for HFCs with a GWP of 2500 or more and by January 1st 2020 for HFCs with a GWP of 150 or more. Movable room air-conditioning appliances (hermetically sealed) using HFCs with a GWP of 150 or more will be prohibited by January 1st 2020. Industry and trade organizations agree on a phase-down of HFCs but with a less ambitious goals and some modifications. The approval of the proposed action is necessary within the European Council. Then the proposal shall be discussed at the level of the European Parliament. A new regulation cannot enter into force before 2014 and it is very likely that modifications will be adopted during the approval process. However, a phase-down of HFCs will certainly take place in Europe in the near future [6].

Possible future development of refrigerants is not easy to predict. Interesting projection is presented in Calm's paper [2] and the summary is repeated in **Table 5**.

## Natural refrigerants

From the viewpoint of the author of this article, natural refrigerants, especially ammonia are presently available, and long experience exists with their application dating far into the beginning of mechanical refrigeration. The "circle" is now somehow closed, we already returned to natural refrigerants, but now with new technologies and with a lot of experience behind us.

**Ammonia** has no ozone depletion potential (ODP = 0) and no direct global warming potential (GWP = 0). Due to high energy efficiency of refrigerating equipment operating with ammonia, its contribution to the indirect global warming potential is also low. Ammonia is flammable. However, its ignition energy is 50 times higher than that of natural gas and ammonia will not burn without a supporting flame. Due to the high affinity of ammonia towards (air) humidity it is rated as "hardly flammable". Ammonia is toxic, but has a characteristic, sharp smell which makes a warning below concentrations of 3 mg/m³ ammonia in air possible. This means that ammonia is evident at levels far below those which endanger health. Furthermore ammonia is lighter than air and therefore rises quickly into the atmosphere [7]. New experience shows that with proper care ammonia can be used efficiently and in a secure manner even in HVAC systems. The market opportunity produced by R-22 phase-out should not be missed by ammonia chiller producers. The major obstacles are legal demands in some countries as well as high initial costs as the consequence of present production in small series. Experience shows also that reasonless fear is connected with security of ammonia application and that should be overcome by adequate addressing to technical as well as to general public.

**Carbon dioxide** has low critical temperature and condensation is not possible at supercritical temperatures.

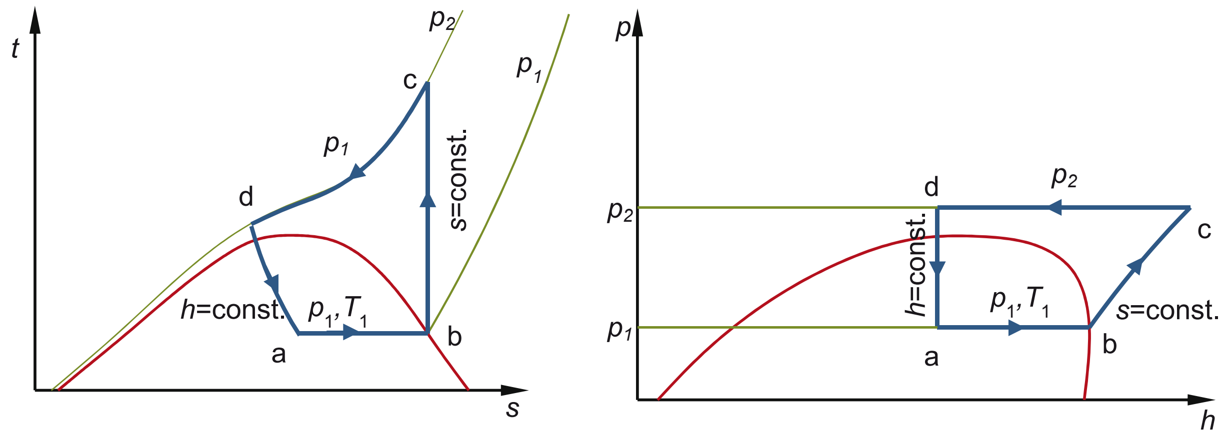


**Figure 1.** Single-stage vapor - compression transcritical process with R-744 ($CO_2$) in temperature - entropy t,s- and pressure – enthalpy p,h- diagrams

In that case transcritical process presented in **Figure 1** can be used. Refrigerant cooling down with significant temperature glide at a constant pressure $p_1$ takes place in a gas cooler (without the phase change) instead in the condenser. Pressure $p_1$ is not temperature-dependent as in subcritical processes. Temperature glide makes such a process more suitable for countercurrent domestic hot water heating than for application within heating systems with circulation. Internal heat exchange between condensed liquid and suction vapor refrigerant can increase process efficiency. Recent research activities have focused particularly on optimizing plant engineering, and more effective refrigeration plants are being developed to benefit from its extraordinary properties [7].

Hydrocarbons like propane (R290, $C_3H_8$), propylene (R1270, $C_3H_6$) or isobutane (R600a, $C_4H_{10}$) have been used in refrigeration plants all over the world for many years. Hydrocarbons are colorless and nearly odorless gases that liquefy under pressure, and have neither ozone depletion potential (ODP=0) nor significant direct global warming potential (GWP < 3). Thanks to their thermodynamic characteristics, hydrocarbons make particularly energy efficient refrigerants. Hydrocarbons are flammable, however, with current safety regulations, refrigerant losses can be maintained near zero. Hydrocarbons are available cheaply all over the world; thanks to their ideal refrigerant characteristics they are commonly used in small plants with low refrigerant charges [7].

## Conclusion

In the future we may expect further research, regulation changes, the design of new systems suitable for the use of newly developed and natural refrigerants, the optimization of the system in the sense of compensating the lower efficiency of some refrigerants, but with keeping cost within acceptable limits. Conclusion is always the same: “No ideal refrigerant”, but proper applications suitable for different refrigerants can be found. The chance for “closing the circle” and return to natural refrigerants at a new, high technology level exists and should not be missed. ■

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Articles

# Net zero energy buildings in focus at ClimaMed 2013 Conference


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Climamed'13 Congress was held on 3–4 October 2013, in İstanbul, Turkey. Climamed conferences are organized by 5 member countries of the REHVA. Founders of Climamed conferences are France, Italy, Spain and Portugal. Turkey joined this group later 4 years ago. Main goal of the conference is discussing regional topics of the Mediterranean climate. This conference was the 7th conference in series since 2004.

Main theme of the congress was the nZEB, especially approaches to the nZEB in these Mediterranean countries. 159 abstracts were received from not only member counties but from 21 countries in the region and all over the world. Finally 90 full papers included in the proceedings book and 66 papers presented orally during the congress and 11 posters were exposed. 22 Technical Sessions were held in 7 parallel rooms during the congress. Technical sessions were designed according to congress themes. Besides, 3 invited lectures were also presented during the congress and a panel was held. Additionally, a seminar was organized by the Eurovent. 429 participants were registered formally at the conference. Including guests and other accompanying people, more than 500 people attended the conference.

## Nearly Zero Energy Buildings

The theme of the congress was actually "net zero energy buildings" however the focus was on the nearly zero energy buildings. After EPBD recast announced, nZEB is on the agenda of the EU building and HVAC sector. This topic has been discussed and studied extensively during the conference. Especially approaching nZEB in terms of Mediterranean climate, Mediterranean traditions and finance was the focus point.

We certainly can achieve the nZEB target for new buildings as we achieved the building performance evolution of the last 12 years in Europe. Boundary conditions definition of the global performance evaluation needs still some work and common consensus. But the move towards nZEBs is going to be a major shift, almost a revolution, requiring many changes even to the life of professionals. Buildings of the future shall be quite different from what we are used to design and use today

The general concept of nearly zero energy building was illustrated, introducing the basic concept of "nZEB": low energy demand, high energy efficiency of the system, energy demand cover by RES produced in situ or nearby.

The definition should be clarified first of all. It was highlighted that the indicator to classify the energy performance of an nZEB is expressed in term of primary energy. The boundary where to consider the primary energy indicators has to be clearly accepted by all the countries – a discussion is ongoing at CEN level about the new standard to be adopted. Moreover, a big challenge is how to traduce the "primary energy indicator" in a comprehensible indicator for the market: this issue is at this stage too much academic and it is important to translate this concept to the policy makers, investors and final users.

The other ambiguity is related to renewable energy production on-site or nearby. The definition of nearby is not clear enough. Actually the nZEB concept can be achieved more successfully by designing group of buildings, districts, cities instead of individual buildings. A successful nZEB design ensures a good architectural and urban integration.

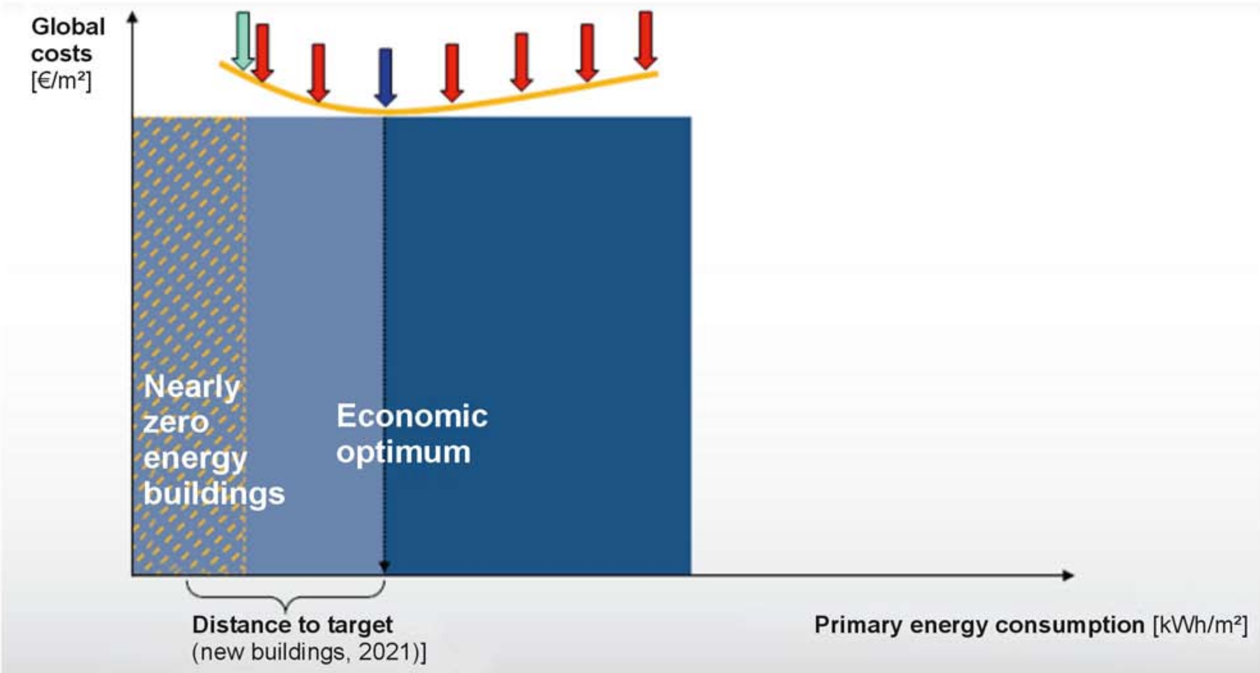


**Figure 1.** Nearly zero energy buildings may not be cost optimal with current technology and construction practice.

The major challenge is still applying nZEB approach/concept to present building stock. It is expressed as nZERB (nearly zero energy retrofitted buildings). We need to develop this nZERB concept. Urban transformation processes going on especially in developing countries for example in Turkey can be used effectively transforming present building stock.

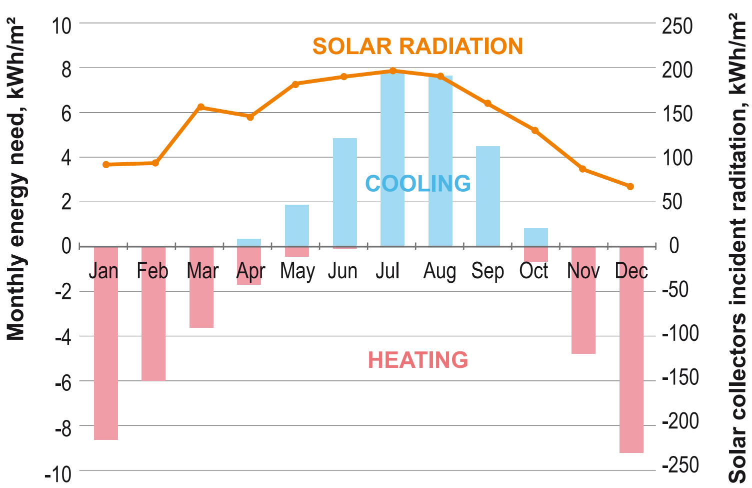


**Figure 2.** Typical Office Building Energy Need over a Year in Mediterranean Climate.

All these measures should take into account economical/financial aspects using a cost optimal approach (**Figure 1**). The cost optimality has always to be considered when defining the targets of nZEB and cost optimal solutions cannot be achieved without integrated design.

Embedded or embodied energy in the building itself and in its HVAC systems (including renewable energy generation) is very important. Without considering embodied energy satisfactory evaluation of measures cannot be done.

There is yet a clear lack of consensus on what a nZEB should be in the warmer south European climates, where summer cooling plays a fundamental role (**Figure 2**):

- Adequate but not too much insulation;
- Inertia activation;
- Shading;
- Role of natural and mechanical ventilation

This is a challenge at design stage. It is evident that a common and unique vision about "what a nZEB is" has yet to be found for the Med region.

## The situation in different Mediterranean countries has been analyzed:

In France, the process, started with the energy certification RT2012, aimed at increasing the energy performance of buildings is going on towards nearly zero energy buildings (**Figure 3**). The new indications of the protocols are addressed firstly to optimize the building envelope and to control the air permeability of buildings. Moreover, the energy classification is now referred to absolute values instead of to the comparison with reference building. New voluntary labels have been set up in order to promote buildings even more efficient than the new regulation; in particular "BEPOS effinergie" is aimed to promote the design and construction of high performing buildings towards positive energy buildings.

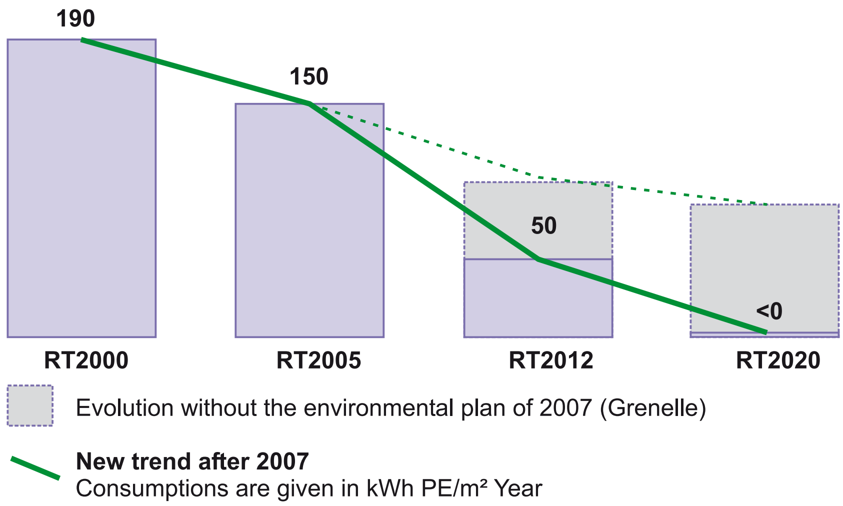


**Figure 3.** Evolution of the limit for primary energy consumption in French building regulations.

In Italy, the transposition of the EPBD recast has been done in June 2013 by a national law. Now the national law has to be converted into regional laws. The process will require time. By now, only a couple of regions have activated tables to implement the nZEB concept. Critical aspects for these implementations have been highlighted. First, to avoid a "copy and paste" tendency that is to transfer the experiences from Germany and the Scandinavian countries without a critical investigation: in Mediterranean climate, super-insulation is not required, thermal mass activation is needed, mechanical ventilation is not always economically convenient, punctual control of solar radiation along the year is absolutely required.

Also in Portugal, the process of implementing the nZEB concept has to be yet fully developed. There is a definition and a concept, but no values yet. It is highlighted that a major goal is to handle retrofitted buildings: how to plan a deep renovation of the existing building stock toward nearly zero energy building while keeping the costs under control. An open discussion is related to ventilation: natural or mechanical? The national tradition is for natural ventilation: in fact, in the Mediterranean areas, the temperature differences between outdoors and indoors is quite low also in the extreme season. The energy production by RES is also discussed: the use of RES produced "nearby" is considered as locally produced by the Portuguese interpretation, in RES installations specifically linked to a building or a group of buildings.

In Spain, the new concepts about nZEB have been transposed in a law in September 2013. The process is considered as a natural evolution of the energy certification, using the same tools and approach. Basically, the requirements about the building energy performances have been incremented (for example, lower thermal transmittance are required) in order to create a process towards nZEB.

Turkey is stating an ambitious program to follow the EU indications. The first step is the definition of reference buildings for the residential sector, and the application of packages of retrofit measures for cost optimality investigations.

## Indoor air quality and nZEB

Human being is in the focal point of the whole air conditioning activities. We air condition the buildings for occupant's comfort and health, we need to give a comfortable and reliable environment to occupants. Productivity is the primary criteria designing some type of buildings, such as office buildings or educational facilities. It is necessary to satisfy the occupant's requirements in nZEB. The design should consider the IAQ requirements.

The other very important issue is the occupant behaviour on energy consumption. **Occupant behaviour can impact the energy consumption with a factor 3–6.** Often main reason why predicted energy use does not match measured energy use is the occupant behaviour. Assumptions regarding occupant behaviour are used as input parameters to energy calculation. Suitable models for occupant behaviour are required for a better prediction of energy consumptions of buildings.

Findings of a presented study demonstrated that predefined heating set-point preferences and air change rates used as assumption in building energy simulation are far away from actual occupant's preferences in buildings. Results of the study highlight significant influences of occupant behavior on the building energy demands. Energy consumption in the simulated high performing building in which occupants personal control is performed by probabilistic functions, raised up to 36% in comparison to the high performing building where the occupants' interaction with the controls is regulated in a deterministic way by fixed schedules.

Revision of Indoor Environmental Quality Standard **EN15251,** need to be complying with nZEB concept. Standard EN15251 brings new approaches. Instead of absolute values, categories and ranges are defined. Moreover, adaptive comfort approach is introduced.

**Table 1.** The recommended criteria are given for several categories (EN 15251:2007).

| Category | Explanation |
|---|---|
| I | High level of expectation and is recommended for spaces occupied by very sensitive and fragile persons with special requirements like handicapped, sick, very young children and elderly persons |
| II | Normal level of expectation and should be used for new buildings and renovations |
| III | An acceptable, moderate level of expectation and may be used for existing buildings |
| IV | A level that may cause some discomfort; but no health risk. |
| V | Outside categories. This should only be accepted for a limited part of the year |

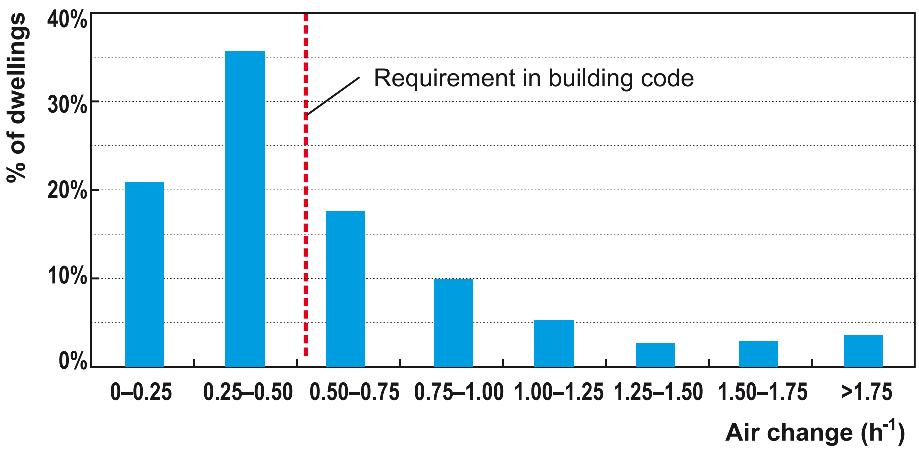


**Figure 4.** Air change has been measured in 500 Danish homes. In more than half of the homes ventilation was below the requirements in building code.

This European Standard specifies the indoor environmental parameters which have an impact on the energy performance of buildings.

- Set points are effective both on energy consumption, comfort and productivity.
- $CO_2$ sensors can effectively be used in ventilation applications, especially in demand controlled ventilation applications.
- Ventilation rates are specified for different categories and applications.
- Ventilation rates should consider both people and building (**Figure 4**)
- Air cleaners and ventilation can be combined.
- Occupant behavior should be considered.

## Renewable Energy and nZEB

Future developments in the HVAC sector seem toward the renewable supported mixed systems. For such systems energy efficiency will be expected to reach 150%.

Photovoltaic solar power production seems most promising renewable electricity production system. There are many studies continuing on photovoltaic alone or hermetic systems. Simultaneous power and thermal energy producing special vertical sandwiching option of a PHVT module yields higher specific power outputs.

Photovoltaic panels can be used to power the compressor of an inverter air conditioning unit. This hybrid air conditioning unit simultaneously connected to grid and to photovoltaic panels. This option is especially suitable for small installations.

Variable Refrigerant Flow systems bring opportunities to reducing $CO_2$ emissions for hot water heating systems. Air to water VRF heat pump systems are considered as renewable heat generators and their thermal efficiency values are much higher than the conventional gas firing boilers. New generation VRF systems can work efficiently even in cold winter conditions. Combining VRF with the photovoltaic panels it was proved that net Zero Energy Building target can be achieved. This was shown by the measured data of a case study in Germany. ■

# Impacts of the thermal environment and indoor air quality on potential risks for elderly people with cardio-vascular diseases


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**Key words:** cardio-vascular diseases, elderly people, heat wave, health risk, thermal discomfort, indoor air quality, $CO_2$ concentration, heart rate, arterial pressure

## Introduction

In the REHVA Journal Vol. 50, Issue no. 3, the problems of suitable indoor environment conditions for elderly people were discussed (van Hoff and Westerlaken, 2013). Present study prolong these theme with presentation of in-situ analyze of physiological response of elderly people with and without cardio-vascular disease. Simultaneous influence of indoor thermal comfort and indoor air quality conditions on response of the cardiovascular system during summer time including two heat wave periods was studied and presented.

## Importance of indoor comfort for elderly people

With ageing, human ability to thermo-regulate the body temperature tends to decrease. This multi-factorial process involves many of human physiological systems and could be clearly identified thought the response of the cardiovascular system. Among several parameters, increase of heart rate and a decrease of blood pressure are most indicative risk factor for cardiovascular morbidity and mortality (Fox et al., 2007). High heart rate is considered to promote atherosclerosis, meanwhile excessively low mean arterial pressure can indicate serious heart or neurological disorders. Not only inappropriate indoor thermal comfort (*ITC*), low indoor air quality (*IAQ*) as well affects human health and results in even more extensive cardiovascular system response. The aim of the article is to present the research on combine influence of *ITC* and *IAQ* conditions on physiological response of the elderly people and to show that physiological response is even more intensive in case of elderly people with cardio-vascular diseases (CVD).

## Real environmental experiment of elderly's physiological response to ITC and IAQ

Research was focused on the determination of combine impacts of *ITC* and *IAQ* conditions on the cardiovascular system response of the elderly people in elderly home in Ljubljana. The building itself has no mechanical ventilation, nor air conditioning as it is still very common practice in Slovenia. Two groups of people older than 65 years were studied at the same time: a group of 27 persons (46% male, 54% female) without CVD called control group and group of 50 people (48% male, 52% female) with CVD diagnose in accordance with the International Classification of Diseases. The research was conducted for 80 days from June to September 2011. In the period of research two heat waves occurred: the first one between July 7th and 14th and the other between August 17th and 26th, which was even more pronounced. During the experiment which was performed as natural experiment without controlling the indoor parameters, indoor air temperature ($T$) and indoor relative humidity ($RH$) and $CO_2$ concentration was measured during the daily observation period (between 11:00 and 15:00 o'clock). The Humidex index ($HI$) was used to combine effect of air temperature and humidity. $HI$ describe perceived environment temperature (for example at $T$=30°C and $RH$ =40% HI is equal to 34 and at the same temperature and $RH$=60% HI is equal to 38) and is similar to U.S. Heat index. Analysis of physiological response was focused on individual's relative change of the heart rate ($\Delta HR$) and change of the mean arterial pressure ($\Delta MAP$).

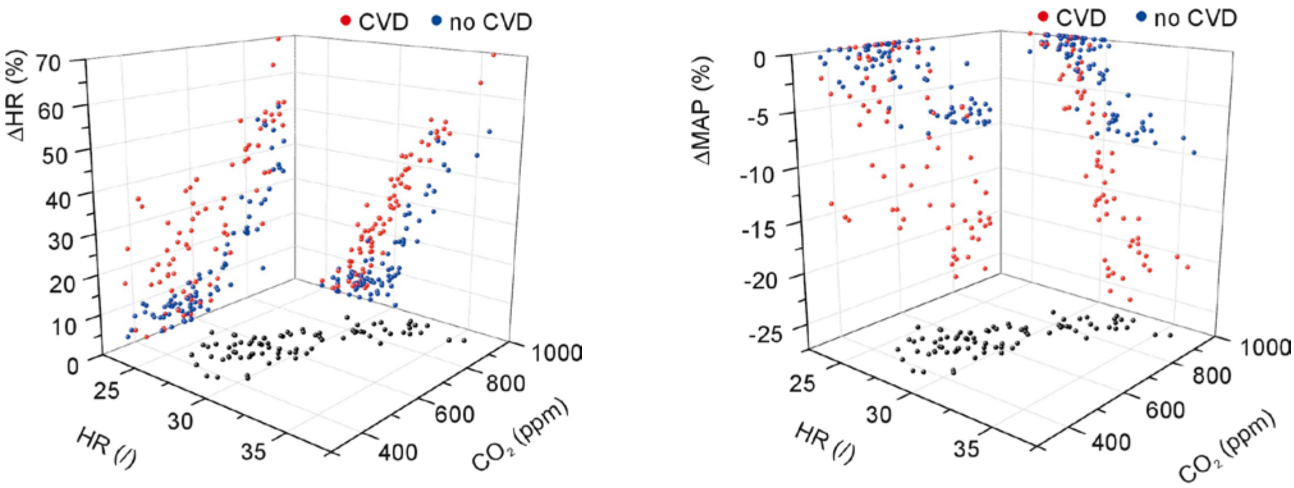


**Figure 1.** Physiological response of the group of elderly people without and with cardio-vascular diseases (CVD) to Humidex HI (combine indicator of temperature and humidity) and $CO_2$ concentration in indoor environment presented as group's average daily value of relative change in heart rate (**Δ**HR) and mean arterial pressure (**Δ**MAP) during the observed summer period.

Reference values (*ΔHR*=0 and *ΔMAP*=0) were defined separately for each of the group as average value of *HR* and *MAP* in none stress conditions (it was found out that this conditions corresponds to $T < 25$°C and $CO_2$ <500 ppm). Results are presented on Figure 1 as average values for each day of during the research.

## Results

During the research period no adaptations of physiological parameters were found in any group, but significant differences between groups with CVD and no CVD is obvious. During both heat waves lower *IAQ* (higher $CO_2$ concentration) appeared due to the fact that residents are closing the windows to prevent over heating the rooms. Group with CVD responses to the *ITC* and deteriorated *IAQ* much more intense than control group therefore elderly people with CVD are at considerable higher risk for mortality events. We found significant combined effects of *ITC* and *IAQ* on cardio-vascular parameters although increase in Δ*HR* due to heat burden and low indoor air quality in case of people with CVD was significantly higher. For this group increase of Δ*HR* up to 70% can be seen, meanwhile in group with no CVD the Δ*HR* up to 50% was found (**Figure 1**). Respectively decrease in Δ*MAP* as consequence of vasodilatation in both groups can also be observed. In particular, *HI* has significant impacts on physiological parameters, although $CO_2$ as indicator of *IAQ* has also noticeable effects on human response (Figure 1). Since it is known that elevated *HR* and low *MAP* are risks factors for cardio-vascular morbidity, such populations are also at higher risk for mortality events.

## Conclusion

Risk groups, like elderly people with chronically diseases, are at greater threats as thermo regulation is direct depended on cardiovascular response. It was found out that group with CVD respond to *ITC* and *IAQ* significantly more intensively than control group. Nevertheless our research also show that not only heat burden, but combined influence of the indoor air quality have to be taken into the account when assessment of indoor comfort is made. Planners and decision makers that work in the field of designing indoor environment for elderly people or other risk groups should be aware of joint influence of the thermal environment and the air quality on health and that unsuitability conditions could be ascertain by the occupancies physiological response. ■

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# Indoor Environment Quality as a multi-level, multi-factor, multi-disciplinary and multi-stakeholder issue

**A condensed version of the inaugural speech "Understanding the indoor environment" spoken on May 22, 2013 at the occasion of her acceptance of the position of full professor of Indoor Environment at the Faculty of Architecture of the Delft University of Technology.**

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**Key words:** indoor environment, indoor environmental quality, thermal comfort, indoor air quality, indoor climate

## Introduction

How to achieve a healthy indoor environment has been an issue among architects, engineers and scientists for centuries. However, it was not until the early decades of the twentieth century that the first relations between parameters describing heat, lighting and sound in buildings and human needs were established. For most of the time, science has relied on the optimisation of single factors such as thermal comfort or air quality. The realisation that the indoor environment is more than the sum of its parts, and that its assessment has to start from human beings rather than benchmarks, has only been gaining ground in recent years. The understanding of that indoor environment has only just begun.

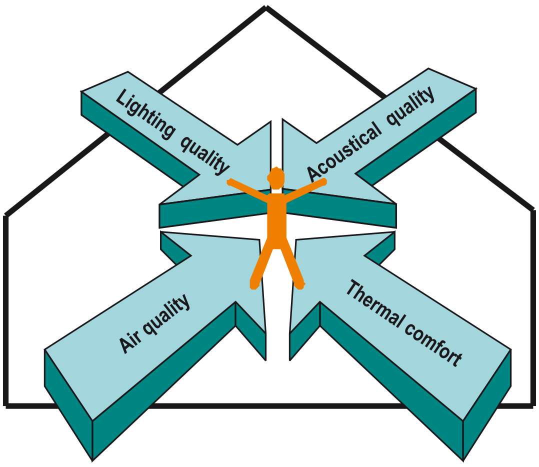


**Figure 1.** What is indoor environment quality? (Bluyssen, 2009: figure 3.1).

The indoor environment can be described by the environmental factors or (external) stressors indoor air quality, thermal comfort, acoustical quality and visual or lighting quality (**Figure 1**). These various factors have slowly become incorporated within the building process through environmental design. However, aesthetic quality and spatial and ergonomical quality are also part of the indoor environment. In fact, historically these parameters received the most attention when designing a building. The chair "Indoor environment" merely focuses on the environmental parameters, without downgrading the dimensions and aesthetics of shapes and spaces.

## Facts and gaps

Most people are aware of the importance of the outdoor environment, especially in relation to climate change issues but also related more directly to our health, the effects of indoor environment quality are not that common knowledge. What most people also don't realize is that there are many diseases and disorders related to that indoor environment. In the last decade or so we are confronted with new diseases and disorders related to indoor environmental quality such as mental illnesses (Houtman et al., 2008), obesity (Bonnefoy et al. 2004) and illnesses that take longer to manifest, among which cardiovascular and chronic respiratory diseases and cancer (Lewtas, 2007; Fisk et al. 2007). If you look at the scientific outcomes it seems that staying indoors is not good for our health, even though the conditions seem comfortable enough (according to the standards we apply, according to the control strategies we have taken).

Why do we have still do not have this under control? Even after more than 100 years of R&D. To my opinion there are at least two major gaps contributing to an explanation for this situation.

### *Gap1*

Starting with the first one: a gap or lack of knowledge shown by the discrepancy between standards and end-users wishes and needs! Even though standards are met, complaints and symptoms occur. Why and how do people respond, and which indicators can be used is thus an important question to answer. The health and comfort indicators we are today familiar with can be divided in three groups of indicators:

- The occupant or end-user: such as sick leave, productivity, number of symptoms or complaints, health adjusted life indicators or specific building related illnesses.
- The dose or environmental parameter: concentrations of certain pollutants, temperature and lighting intensity.
- The building and its components: certain characteristics of a building and its components, such as possibility for mould growth and even labelling of buildings or its components.

Of these groups of indicators, the dose related indicators, are used most frequently in guidelines and standards. But the dose-response mechanisms are not straightforward. Ventilation rate is a good example of this. Based on either $CO_2$ as an indicator for bioeffluents or on certain emissions of building materials, minimum ventilation rates have been discussed and are still being discussed for almost two hundred years now (**Figure 2**).

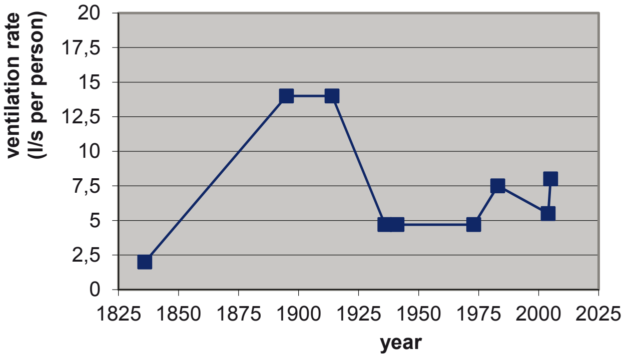


**Figure 2.** The recommended minimum ventilation rate over the years (Bluyssen, 2009: figure 5.2).

Also with thermal comfort discussions are prominent present. Another model, based on field studies of people in daily life, slowly begins to win ground (de Dear and Brager, 2002): the adaptive comfort model, in which the context and preferences of the occupant are considered to be important. And then even more recently it was suggested that thermal neutral conditions do not have to be necessarily healthy (Marken Lichtenbelt et al. 2009).

While current guidelines are focused on providing sufficient task lighting, research on biological lighting demands has revealed that the dosing of natural light is important for health purposes. The amount of light that enters the eye affects our bio-rhythm: under influence of light, the hypothalamus signals to the pineal body to produce melatonin, a hormone that makes us want to sleep. If exposed to light during night, the production of the anti-oxidant melatonin is immediately stopped, alertness and core body temperature is increased and sleep is distorted (Duffy and Czeisler, 2009).

And last but not least, noise has been associated with direct and indirect stress reactions. Annoyance is an important aspect in this mechanism (Babisch, 2002). It seems that noise effects do not only occur at high sound levels, but also at relatively low environmental sound levels, when certain activities such as concentration, relaxation or sleep are disturbed.

Diving into the literature of several fields of research, it can be found that the relations between the stressors, the stress mechanisms the human body has to cope with those stressors and the identified diseases and disorders, are very complex. It seems that interactions occur at human level, which can partly explain the complexity. Additionally, interactions at parameter level can be seen that need to be considered, for example chemical interactions between pollutants in the air and microbiological growth at indoor surfaces, and interactions with the outdoor environment such as noise from outdoors, fine dust and biological lighting. And then we are also dealing with interactions between elements of the buildings and between the building and the environment. Interactions occur at different levels and in different ways.

### *Gap2*

The second gap is related to the use of knowledge. The discrepancy seen between what end-users want/need and what they get, points not only to a lack of knowledge but also to an inefficient or wrong use of existing knowledge. The question 'How can existing knowledge be applied efficiently during the whole life cycle of a building' seems therefore just as important to answer in order get more insight in this complexity.

Answers should be found in the way communication takes place in the building process, lead by the different stakes of the stakeholders involved. The dynamic process of designing, constructing and managing the indoor environment, involves many stakeholders, such as the investor, owner, the end-user, the contractor, sub-contractors, local authorities and pressure groups. If those stakeholders do not understand each other, problems can occur. But answers can also be found in the fragmented structure of the buildings sector, leading to lack of coherency and slow take-up of innovation. In other words, the general awareness of what indoor environmental quality is, how you can improve it and who should or can undertake actions, is poor.

### *Drivers*

In addition to the gaps presented we can also see that the drivers for health and comfort in the indoor environment are different from 100 years ago, leading to an increase in complexity. We see (**Figure 3**):

- Climate change resulting in serious energy-efficient measures for the built environment that can certainly have an effect on health and comfort of the indoor environment.
- Change from family-oriented to multifunctional and divers society.
- Individualization/Ageing population leading to other/new needs and demands.
- New products and materials leading new emissions and other behaviour.

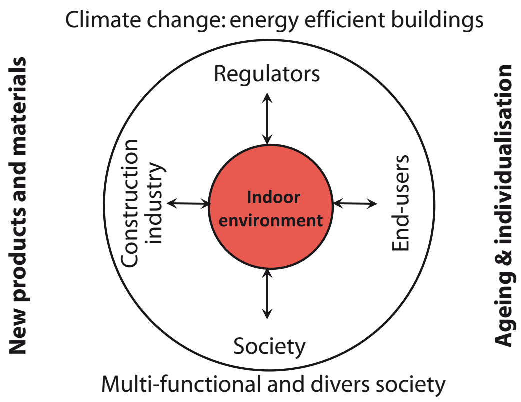


**Figure 3.** Drivers are different from 100 years ago (Bluyssen, 2013: figure 8.3).

Keeping to our old ways of assessing things, will therefore certainly not be enough. We need to adapt our current assessment and designing methods as well.

## Needs

To cope with these gaps and changes we need first of all a different view on Indoor Environmental Quality (IEQ). The current view only considers single-dose relationships. With the exception of health-threatening stimuli, the complexity and number of indoor environmental parameters as well as lack of knowledge make a performance assessment using only threshold levels for single parameters difficult and even meaningless. We need a view in which for different scenarios, possible problems, interactions, people and effects are all taken into account. Focusing on situations rather than single components (**Figure 4**).

How we evaluate and respond to our environment does not only depend on the external stressors involved (physical and psycho-social), but also on personal factors

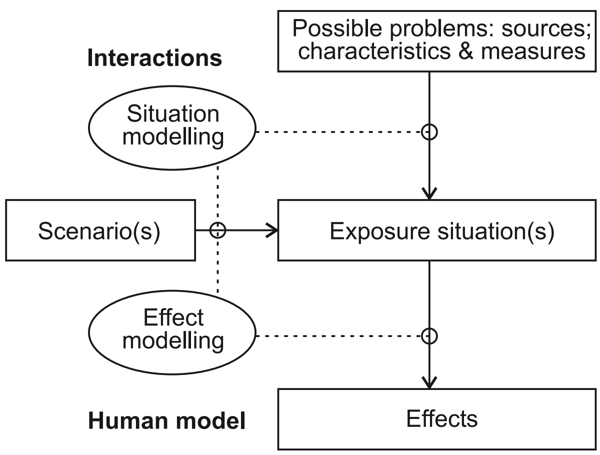


**Figure 4.** A different view on indoor environment quality (Bluyssen, 2013: figure 7.1).

and processes that occur over time, influenced by past events and episodes. They all determine the way external stressors are handled at the moment or over time. And they are all important to consider when an attempt is made to pinpoint the effects caused by different stressors (or combination of stressors). This means that besides a different view on IEQ it is important to consider other assessment methods and indicators.

The challenge of today lies in the accomplishment of sustainable and low-energy built environment and at the same time a healthy and comfortable built environment. This emerging fact, requires a multidisciplinary interactive top-down approach to facilitate the (re)design, construction, maintenance and operation of an indoor environment, in which the architect as well as the other stakeholders fulfil a new or different role. The architect as the integrating engineer who is able to optimise all components of a building along with the overall demands and needs, whether this is related to health, comfort or sustainability issues.

## Ambition

My ambition is to establish an integrated research & education programme on Understanding and managing the indoor environment, in which is dealt with all the needs presented, in due time. A programme for future architects that can help them to fulfil the required multidisciplinary coordinating role in the building industry on the one hand and the creation of truly sustainable buildings during the whole life-cycle on the other. Two books have been written to support this creation of awareness and will be made available for the educational programme at bachelor and/or masters level (Bluyssen, 2009 and 2013). The development of an integrated approach towards risk assessment of indoor environment quality, based on the assumption that the indoor environment is more than the sum of its parts, and that its assessment has to start from human beings rather than benchmarks (of single-dose relationships), will form the basis to realize this ambition.

## Closure

I strongly believe a multi-disciplinary approach is needed in the building industry to create sustainable buildings. At national, European and world-wide level, it is acknowledged that a healthy and comfortable indoor environment is important for the quality of life, now and in the future. The architect will need to have a more than ever coordinating role in this approach as the overall systems engineer, with a basic multi-disciplinary knowledge and integrating capabilities. This new role requires a multi-disciplinary educational program with strong cooperation within and outside of the university, with organisations such as REHVA which is an excellent vehicle for bringing theory and practice together. ■

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Research note

# Outdoor air pollution – a leading environmental cause of cancer deaths


**IARC scientific publication no. 161: Air Pollution and Cancer**
**Editors: Kurt Straif, Aaron Cohen and Jonathan Samet**

The specialized cancer agency of the World Health Organization, the International Agency for Research on Cancer (IARC), announced on 17 October 2013 that it has classified outdoor air pollution as carcinogenic to humans (Group 1).

After thoroughly reviewing the latest available scientific literature, the world's leading experts convened by the IARC Monographs Programme concluded that there is sufficient evidence that exposure to outdoor air pollution causes lung cancer (Group 1). They also noted a positive association with an increased risk of bladder cancer.

Particulate matter, a major component of outdoor air pollution, was evaluated separately and was also classified as carcinogenic to humans (Group 1). The IARC evaluation showed an increasing risk of lung cancer with increasing levels of exposure to particulate matter and air pollution. Although the composition of air pollution and levels of exposure can vary dramatically between locations, the conclusions of the Working Group apply to all regions of the world.

Air pollution is already known to increase risks for a wide range of diseases, such as respiratory and heart diseases. Studies indicate that in recent years exposure levels have increased significantly in some parts of the world, particularly in rapidly industrializing countries with large populations. The most recent data indicate that in 2010, 223 000 deaths from lung cancer worldwide resulted from air pollution.

The IARC Monographs Programme, dubbed the "encyclopaedia of carcinogens", provides an authoritative source of scientific evidence on cancer-causing substances and exposures. In the past, the Programme evaluated many individual chemicals and specific mixtures that occur in outdoor air pollution. These included diesel engine exhaust, solvents, metals, and dusts. But this is the first time that experts have classified outdoor air pollution as a cause of cancer.

"Our task was to evaluate the air everyone breathes rather than focus on specific air pollutants," explains Dr Dana Loomis, Deputy Head of the Monographs Section. "The results from the reviewed studies point in the same direction: the risk of developing lung cancer is significantly increased in people exposed to air pollution."

The predominant sources of outdoor air pollution are transportation, stationary power generation, industrial and agricultural emissions, and residential heating and cooking. Some air pollutants have natural sources, as well.

"Classifying outdoor air pollution as carcinogenic to humans is an important step," stresses IARC Director Dr Christopher Wild. "There are effective ways to reduce air pollution and, given the scale of the exposure affecting people worldwide, this report should send a strong signal to the international community to take action without further delay."

The International Agency for Research on Cancer (IARC) is part of the World Health Organization. Its mission is to coordinate and conduct research on the causes of human cancer, the mechanisms of carcinogenesis, and to develop scientific strategies for cancer control. The Agency is involved in both epidemiological and laboratory research and disseminates scientific information through publications, meetings, courses, and fellowships.

**Download the report in ePUB format from**
http://www.iarc.fr/en/publications/books/sp161/index.php

# Eurovent Market Intelligence celebrates its 20th anniversary

In 2013, Eurovent Market Intelligence celebrates 20 years of service to businesses in the field of market intelligence. The following the evolution of market intelligence during last two decades is

Eurovent Market Intelligence (EMI) is the **European Statistics Office on the HVAC&R market**, and provides key market data like :

- **Annual** and **Quarterly** analyses
- Market **Trends and Forecasts** (annually and quarterly)
- **Detailed information** on the equipments sold (technology, capacity...)
- Analyses **by country** (in Europe, Middle-East and Africa)

Detailed information on statistic program & database can be found at www.eurovent-marketintelligence.eu

## 1993-2007: CECOMAF/Eurovent Association

The statistical activity came about through two men, Sule Becirspahic, consultant for Eurovent, and Jean-Pierre Hughet, Chairman of the chillers working group and Head of Marketing at Carrier. At the time, there was a real need for statistics that were both reliable and standardised for all European countries. The questionnaires would be sent by post to the manufacturers, who would fill in their tables with their sales figures and would send them to a notary, who would then forward them to Eurovent in such a way as to ensure the anonymity of the participant. The first data collections were initially done "by hand", i.e. calculations were done on a sheet of paper with the help of a calculator, and the results were handwritten in a blank table. They soon moved on to being processed by computer but, as the files arrived by post, a significant amount of manual input work was carried out until 2008.

## 2007-2009: the emergence of EMI

The next turning point occurred in 2007, when Mr Becirspahic retired and a department dedicated to Market Intelligence was created. Since then, Eurovent Market Intelligence has formed an integral part of Eurovent Certification. The first managers, Andrea Bencelova and Emilie Behnert successively, laid down the legal foundations of the new entity, created a website and consolidated the statistical processing and validation stages. At the same time they put in place an ambitious project running over a three-year period: transferring the programmes onto an Extranet, whose contents are reserved for those participating in data collections. There, they are able to upload their sales file, download the results of the data collections and also carry out additional analyses, such as cross-checking data, measuring development against a constant panel and especially checking their position within each type of market or sub-market. It was in 2010, under the leadership of the current manager, Mr Yannick Lu-Cotrelle, who arrived in June 2009, when this project was finally completed.

## 2009 – 2013: a period of expansion

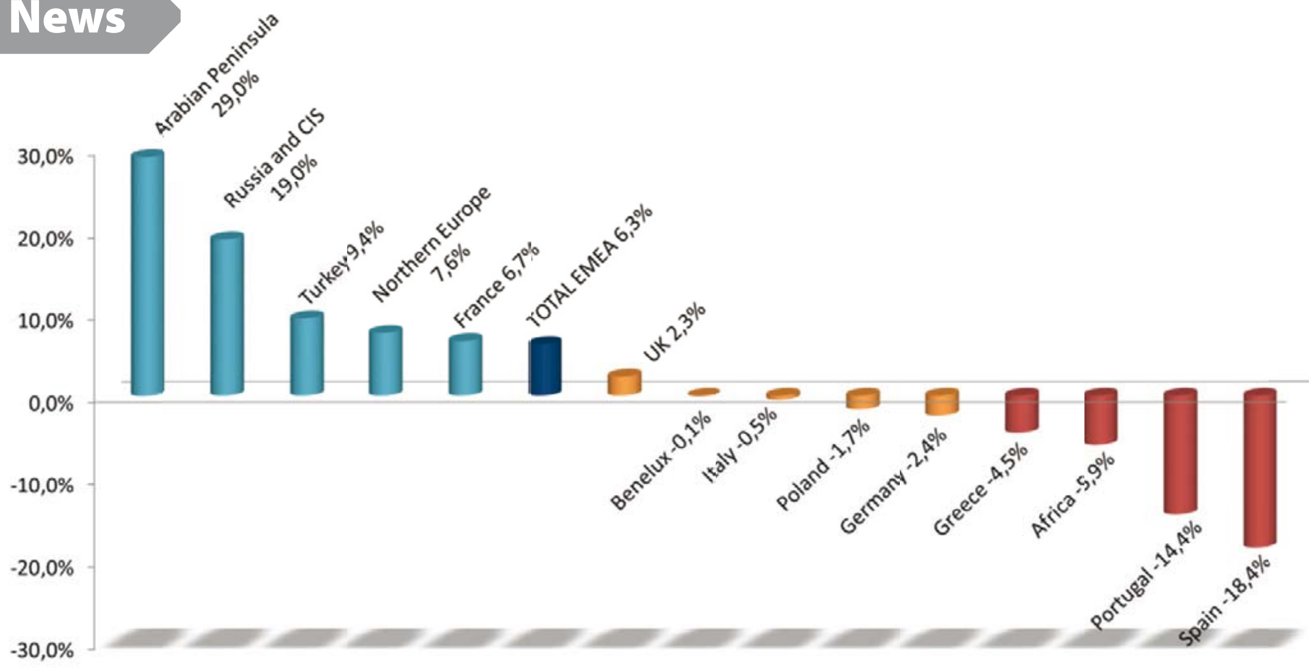
In June 2009, the simultaneous arrival of Erick Melquiond, at the head of Eurovent Certification, and Yannick Lu-Cotrelle, at the head of Eurovent Market Intelligence, led to the activities of EMI entering a new age of expansion. Erick Melquiond, the new Director of ECC, wanted to give EMI the means to fulfil its ambitions and to make it the European reference body for HVAC&R market data, thus supplying the quantified data needed for the European Union's Action Plans. As for Yannick Lu-Cotrelle, he injected a less institutional and more customer service-focused approach.

Yannick Lu-Cotrelle's first project was to break the downward trend in the overall number of participants that had been observed for several years. The department's new objectives were:

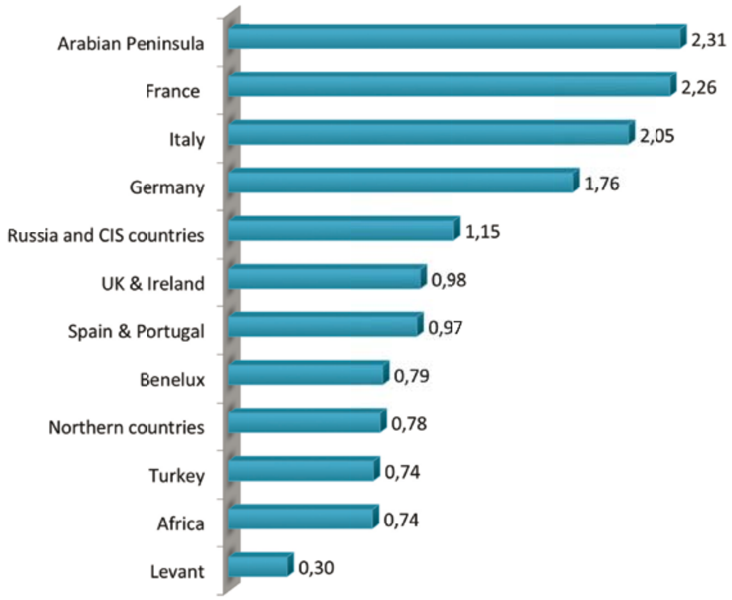
- To re-stimulate the appeal of the various statistical programmes, particularly through adding better quality or higher added value information;
- To implement rigorous follow-up of marketing to manufacturers, in order to optimise the canvassing that is carried out during the collection of data;
- To rationalise the existing offering, by abandoning the least promising and most time-consuming programmes and by focusing on those with greater potential;
- To regularly release new statistical programmes in order to ensure the continuous development and the durability of the activity.

**Quarterly Forecasts for HVAC-R Market in Europe for the 3rd Quarter 2013 by the Eurovent Market Intelligence.**

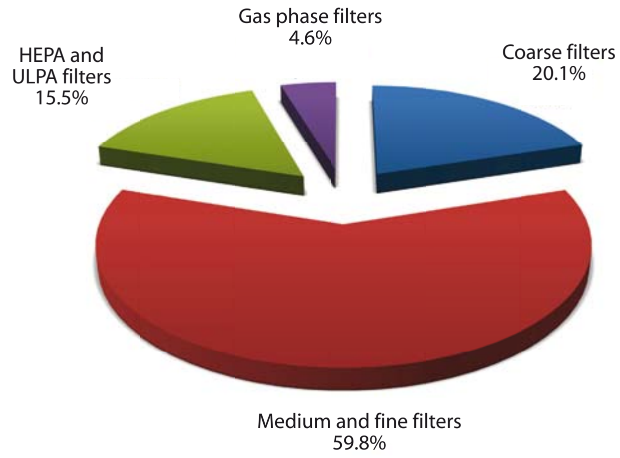
| Product* | Quarter 2013Q3 Market trend (vs 2012Q3) | Trend 2013 vs 2012 |
|---|---|---|
| AHU | +3,4% | +1,6% |
| Fan Coils | –1,2% | –4,3% |
| Chillers | –5,2% | –2,1% |
| Rooftops | +8,4% | +6,9% |




**Market trends of air handling units in 2011-12 based on sales in Euro in Europe, Middle East and Africa (EMEA).**




**Chiller market in 2012 based on sold cooling power in Gigawatts (millions of kW).**




**Air filter market in Europe based on sales in Euro.**

It has been a success because, in 3 years, the number of manufacturers participating in EMI programmes has doubled, going from 78 in 2009 to 156 in 2012.

The second project was to raise EMI's profile around the world. From 2009, EMI started regularly communicating in trade journals regarding both the beginning of data collection campaigns and on market data. It also participated in conferences at the majority of trade shows, such as the Mostra Convegno Expocomfort in Milan, Chillventa in Nuremberg, the BIG5 in Dubai and in 2013, the ISH in Frankfurt and Climate World in Moscow are on the agenda.

## 2013: a year of transition towards a new dimension

Two new developments are expected in the summer of 2013. Firstly, the planned merger of Eurovent Certification and Certita, 2 leading certification companies operating in the field of Heating, Ventilation, Air conditioning and Refrigeration (HVAC&R) products. This association of activities will open the doors of the heating and green energy sectors to EMI.

Finally, the arrival of a new statistician within the department will enable the increased flow of activity that has occurred over the last three years to be better managed, in addition to broadening EMI's service offering. These two factors together have already enabled a significant expansion of EMI's activities to be planned up to 2015. ■

# National renovation roadmaps and their financing in the focus of REDay 2013

Organised by the Renovate Europe Campaign, in partnership with the Lithuanian Presidency of the EU, REDay 2013 took place on 9th October 2013 in Brussels. As Member States prepare to draw up their National Renovation Roadmaps for April 2014 (EED requirement), this third edition of REDay tackled the opportunities for designing Ambitious Renovation Roadmaps, and the challenges of unlocking the needed financing.

According to the Article 4 of the Energy Efficiency Directive (EED) Member States have to submit their national renovation strategies to the European Commission by April 2014 and renew them each 3 years afterwards. Renovation roadmaps are long term strategies for mobilising investment in renovation of the national stock of residential and commercial buildings, both public and private. REDay 2013 put the ambitious implementation of Article 4 in its focus providing a platform of exchange on the need for deep renovations, highlighting the multiple benefits of deep renovations - including improved health, job creation and investment opportunities, and demonstrating through concrete examples of roadmaps and finance models that deep renovation is the necessary and feasible next step for the building sector's contribution towards climate and energy targets.

In the first section speakers from the building research sector, energy agencies and NGOs presented different aspects of buildings energy renovation: the impact on renovations on public health and the related expenses, challenges and good practices of renovation strategy building, as well as the social impacts and the role of building energy renovation in combating fuel poverty.

BPIE published earlier this year a Guide to Developing Strategies for Building Energy Renovation to assist Member States in the strategy development. Oliver Rapf, General Director of BPIE presented the methodological framework and gave an overview about the status of renovation Roadmaps across Europe, highlighting frontrunner countries among other Denmark and France. In France a new programme was launched in September 2013 to retrofit 500,000 housing units per year between 2013 and 2017, which means a 3-time increase of the recent refurbishment rate. BPIE is working with the World Green Building Council's Europe Regional Network on the establishment of a knowledge bank on member state progress with Article 4, where continuous updates will be available.

Oliver Rapf, BPIE

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The second section provided participants with a comprehensive overview of different financing tools joining representatives of commercial and public banks, social businesses, property owners and investors. REHVA vice-president Frank Hovorka presented the Caisse des Dépôts good practice of sustainable property investments and the integration of energy efficiency factors in buildings valuation.

Frank Hovorka, REHVA Vice-president, UNEP FI

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The main message of REDay 2013 is that in order to meet the EU 2050 targets, the energy demand of the existing EU building stock must be reduced by 80% as compared to 2005 levels. Member States need to scale up their renovation rate from the current average of 1% to more than 3% per year and they will need to ensure that all renovations are deep or staged deep renovations. They will only be able to achieve this goal if the necessary financing mechanisms and market drivers are in place.

**Anita Derjanecz**, REHVA Project Officer ■

**Original source:** Build Up platform where submitted to by Heike Erhorn-Kluttig, Fraunhofer Institute for Building Physics, Germany

# National cooperation within three Concerted Actions of EC

With the Energy Performance of Buildings Directive (EPBD), the Renewable Energy Sources Directive (RES) and the Energy Efficiency Directive (EED), the European Union has established common frameworks for reducing energy consumption and increasing renewable energy use. To enhance the sharing of information and exchange of experiences from national adoption and implementation of this important legislation, the European Commission established, for each one of these three directives, a joint initiative with representatives of the national implementation bodies. These joint initiatives are called Concerted Actions.

Since 2005, the three Concerted Actions (EPBD, RES and EED) have been the meeting place for national representatives working on the implementation of the EU directives into national measures and policies. The three Concerted Actions offer structured and confidential dialogue between the delegates. Countries participating in the Concerted Actions exchange experiences and best practices, participate in a peer learning process and develop common approaches. Experience shows that the Concerted Actions have substantially contributed to a better understanding of the implementation challenges and the pro and cons of various strategies. Moreover, this exchange has resulted in more convergence in the national approaches. Although the majority of the activities are not made public (in particular to allow open discussions between the national representatives), the Concerted Actions regularly publish books, information papers, thematic and other reports.

## Concerted Action EPBD

The Energy Performance of Buildings Directive (Directive 2002/91/EC) was first published in 2002 and required all Member States to improve building regulations, to introduce energy certification schemes for buildings and schemes for inspection of boilers and air-conditioners. Due to the ambitious targets set in the directive, the introduction of national laws meeting EU requirements was very challenging. To support Member States, the Concerted Action on the Energy Performance of Buildings Directive (CA EPBD) was launched by the European Commission to promote dialogue and exchange of best practice. An active forum of national authorities from 29 countries, the focus was on finding common approaches for the most effective implementation of this directive.

With the adoption of the recast EPBD (Directive 2010/31/EU) in 2010, Member States faced new challenges. Leading issues are the move towards new and retrofitted nearly-zero energy buildings by 2021 (2019 in the case of public buildings), and the application of a cost-optimal methodology for setting minimum requirements for both the building envelope and the technical systems. The current Concerted Action EPBD, coordinated by ADENE, runs from 2011 until 2015 and discusses the following seven thematic areas (referred to as Core Themes):

- Certification schemes
- Inspection of heating and air-conditioning
- Training of experts and inspectors
- Energy performance requirements using the cost-optimum methodology
- Towards 2020 – Nearly zero-energy buildings
- Compliance and control of energy performance requirements and certification system
- Effectiveness of support initiatives

## Concerted Action RES

In June 2009 the Renewable Energy Sources Directive (Directive 2009/28/EC) entered into force. The directive establishes a common framework for the use of renewable energy within the European Union. Each Member State has a target for the share of energy from renewable sources in its gross final energy consumption for the year 2020. Member States submitted National Renewable Energy Action Plans (NREAPs) to the European Commission on 30 June 2010 describing concrete measures in the electricity, heating and cooling and transportation sectors. The first biannual reports on progress in the promotion and use of energy from renewable sources were submitted by the Member States in December 2011.

The Concerted Action on the Renewable Energy Sources Directive (CA-RES) supports the transposition and implementation of the directive and the achievement of national targets. The first phase of the CA-RES ended in July 2013. The second phase (CA-RES II) started in August 2013 and will run until 2016.

The CA-RES II is coordinated by the Austrian Energy Agency and is organised around seven Core Themes:

- Support schemes for electricity
- Cooperation mechanisms
- Renewable heat
- Electricity Networks
- Guarantees of origin and disclosure
- Biomass mobilisation and sustainability
- Renewables in transport

## Concerted Action EED

The Energy Efficiency Directive (Directive 2012/27/EU) was published on 25 October 2012, repealing the Energy Services Directive (Directive 2006/32/EC) as well as the Cogeneration Directive (Directive 2004/8/EC). The EED is to be transposed by all Member States by the beginning of June 2014. The directive establishes a common framework of measures for the promotion of energy efficiency within the European Union in order to ensure the achievement of the 2020 20% headline target on energy efficiency and to pave the way for further energy efficiency improvements beyond 2020. It lays down rules designed to remove barriers and overcome market failures that impede efficiency in the supply and use of energy, and provides for the establishment of indicative national energy efficiency targets for 2020. Member States report on the progress achieved towards the national energy efficiency targets by submitting National Energy Efficiency Action Plans (NEEAPs).

Similar to the other Concerted Actions, the Concerted Action on the Energy Efficiency Directive (CA EED) was launched to support the Member States in transposing and implementing the directive. The work is coordinated by NL Agency and is structured around eight Core Themes:

- NEEAPs and annual reports and measuring progress in Energy Efficiency
- Public Sector - buildings and public purchasing
- Metering and billing, demand response and grid issues
- Energy services and ESCOs, energy auditing, solving administrative barriers
- Funds and financing for energy efficiency
- Consumer information programmes, training and certification of professionals
- Efficiency in energy supply, high efficiency CHP and heating/cooling
- Energy efficiency obligation schemes, monitoring impacts of eligible measures

**More information:** www.buildup.eu ■

# Surface Heating & Cooling sector joins Association of the European Heating Industry (EHI)

EHI, the Association of the European Heating Industry, welcomed the European Surface Heating & Cooling sector under its umbrella. Previously gathered within the association Eu-ray, leading companies of the sector have recently joined EHI in a move towards better representation and consolidation of the European heating industry landscape.

Ilari Aho, Vice President, New Business Development & CSR for Uponor Corporation, was appointed to convene the activities of the surface heating and cooling group within EHI. He noted: "We are extremely happy to have finalised the process of joining forces with EHI, as an important step forward in strengthening our sector's contribution to the heating market. Our goals are to be more involved, together with the wider heating industry, in the ongoing European political and technical debates on energy and climate issues".

Ulrich Schmidt, EHI Chairman and Member of the Management Board of Bosch Thermotechnik, added: "EHI builds its strength on a long history and continuity of representing the European heating sector, its predecessor organisations going back to the 1960s, and offers a well-established platform for promoting a large variety of affordable and highly efficient thermal comfort solutions. Welcoming our new members is a natural step in the evolution of our organisation, as it aims to represent all elements of a modern heating system and the full industry landscape. The transformation of the European heating market towards low energy demand and high renewable energies integration can only be achieved if all parties involved in the market are appropriately tied in". The sector is now organised in a new EHI Department to cover all kinds of hydronic surface heating and cooling systems for residential, commercial and industrial applications. Its main task is to shape the development and implementation of relevant European policies and standards aiming to ensure favourable framework conditions for radiant heating and cooling solutions.

Today the Association of the European Heating Industry (EHI) represents and promotes the common interests of 40 market leading companies and 14 associations in the European thermal comfort sector, which produce technically advanced, safe and energy efficient solutions for heating in buildings, including: space heaters and renewable energy systems (boilers, heat pumps, solar-thermal, biomass, microcogeneration), water heaters, heating controls and components, heat storage and heat emitters (radiators, surface heating and cooling systems).

The industry has total annual sales of over 20 billion euro and directly employs more than 120.000 people. ■

# Building Simulation for a sustainable world

### 13th International Conference and Exhibition of the International Building Performance Simulation Association (IBPSA).

The conference was successfully held at Aix-les-Bains and Chambéry in August 2013, with the theme of Building Simulation for a Sustainable World. The conference was held at Savoie Technolac, and co-organized by INES (CEA, University of Savoie, CNRS and CSTB) and INSA Lyon.

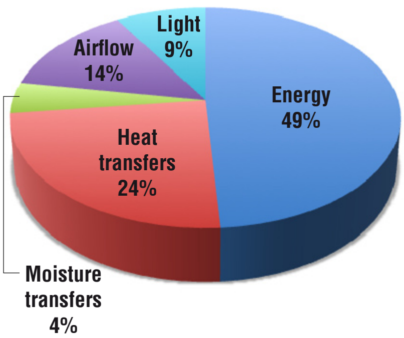
This year's conference attracted even more participants than the last: a total of 630 (450 in 2011), with delegates from 45 countries (36 in 2011). Papers were presented in six parallel sessions with one poster session per day over the three days.

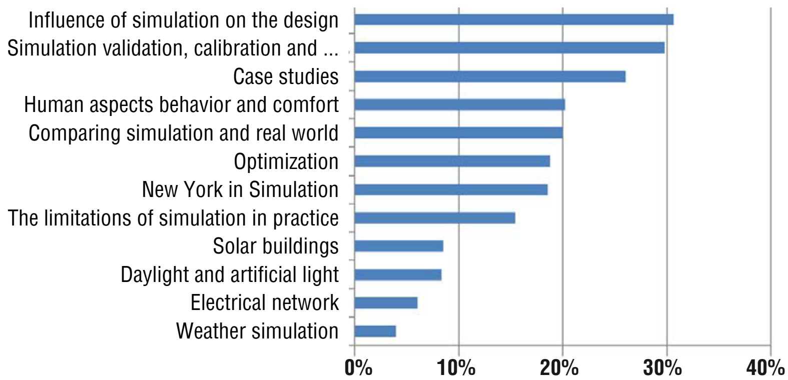
An increased number of students and PhD students attended the conference, too: 256, making up circa 50% of all delegates, and submitting 238 publications between them. In total, 72 parallel sessions were held (3 oral sessions and 1 poster per day) in 6 rooms over three days. All papers submitted to BS2013 were double-blind reviewed.

The next conference, Building Simulation 2015 will be in Hyderabad, India hosted by IBPSA-India.

**All papers from Building Simulation 2013 are now available online at** www.ibpsa.org/?page_id=292

**Contributions accepted for BS 2013: topics (left) and keywords (right)**




# Efficient Energy for EU Cultural Heritage

**http://www.3encult.eu/en/project/welcome/default.html**

**EU Project**: October 2010 - March 2014

Coordinated by EURAC, the project 3ENCULT bridges the gap between conservation of historic buildings and climate protection, which is not an antagonism at all: historic buildings will only survive if maintained as living space. Energy efficient retrofit is useful for structural protection as well as for comfort reasons - comfort for users and "comfort" for heritage collections.

**Background:** Historic buildings are the trademark of numerous European cities, towns and villages: historic quarters give uniqueness to our cities, they are a living symbol of Europe's rich cultural heritage and reflect society's identity.


# REHVA is concerned about unhealthy indoor air in European buildings

**REHVA Board of directors discussed in it meeting on Oct 25th, 2013. the problems related the indoor air quality and climate in buildings, and decided to express REHVA's concern with the following letter to the related Directorates General at the European Commission with copy to several organisations working in field of Indoor Environment and health.**

We, REHVA´s experts of indoor air technology, representing of the scientific community, engineers, academics, industry, building owners, and facility managers would like to draw the attention of the European Commission to the wide range of negative effects caused by deteriorated indoor air in European buildings. Indoors, people are exposed to various pollutants, which cause a wide range of diseases like asthma, allergy and heart disease and many other minor health problems. A poor indoor environment and poor indoor air quality in particular also reduces productivity, performance at work and learning in schools.

Already in 2009, the EnVIE project **www.envie-iaq.eu** funded by DG Sanco, reported that we lose about 2 million disability adjusted life years annually (DALYs) in EU-27 due to exposure to various pollutants indoors.

The conclusions of this report also underlined the need for an integrated approach to tackle effectively poor ▶

IAQ, through a Green Paper aiming at: coordinating future policies with existing legislative tools; promoting a dialogue among all relevant stakeholders; and contributing to the holistic view needed for the management of the built environment.

We point out that – on average – European people spend 90% of their life indoors, and are exposed, most of the time, to pollutants either from indoor or outdoor sources. Existing technologies allow to effectively protect people from the pollutants from outdoors (like particles from combustion processes) and as well pollutants from indoor sources (with better control of moisture damages and with low emission materials and consumer products). This is why we call for the consideration of indoor air quality policy actions in the context of the European Year of the Air.

During last decade, energy efficiency of buildings has gained a lot of attention due to EU ambitious energy efficiency targets. However, building energy use related legislation has been developed without paying enough attention to indoor air quality. The binding goals for energy savings have not been complemented with binding requirements of indoor air quality. The statement in the EPBD recast directive that indoor air quality cannot be compromised needs further regulatory actions to be realised. There is a great danger that energy is saved while the indoor air quality is deteriorated, causing health problems and loss in productivity in work. Although we strongly support the target of nearly zero energy buildings by 2020, proper requirements for indoor air quality shall be set to ensure that energy efficiency initiatives do not jeopardize indoor air quality, and thus the health of building inhabitants.

Recently, the HealthVent **www.healthvent.byg.dtu.dk** project report revealed the lack of regulations on indoor air quality and ventilation at European level, and that national regulations do not exist or are not harmonised, and in many cases not properly formulated. For example, current ventilation regulations and practices in the EU do not properly address the connection between outdoor and indoor pollution and the problems it causes. During the HealthVent launch event held in the European Parliament on 20 February 2013, experts pointed out that air cleaning strategies are needed, with adequate design and proper maintenance of ventilation systems, when World Health Organization (WHO) air quality guidelines are not fully complied with.

The lack of harmonisation between the national ventilation regulations prevent progress on indoor air quality as well as engender increased costs to the construction industry. The work done by the WHO and the CEN is important but not sufficient. In addition, there is significant scientific evidence on the health benefits of improved indoor air quality through source control, ventilation technology and adequate filtration of incoming air.

In light of these findings, there is an urgent need for concrete actions at EU level to promote harmonisation and improve indoor air quality in EU buildings.

**In the context of the 2013 Year of the Air, REHVA calls upon the European Commission to follow the recommendation of the EnVIE report to develop a Green Paper on indoor air quality to launch the policy debate and assess the different policy options to fully tackle indoor pollution, and include the indoor air quality issues in the directives related to air quality.**

In addition the Commission should:

- Develop health based ventilation guidelines to control exposure to pollutants from indoor and outdoor sources, indoor moisture and ensure comfortable indoor temperature and mandate regular inspection and maintenance for all ventilation systems;

- Integrate Indoor Air Quality into the EU Climate Action agenda, the implementation and future evolution of the Energy Performance of Buildings Directive EPBD and Eco-design and energy labeling directives.

- Take concrete measures to effectively implement the priorities set out in the 7th Environment Action Programme, and in particular provisions on indoor air quality.

REHVA experts remain at your disposal for further information and consultation.

Brussels, October 25, 2013

On behalf of REHVA Indoor Air Quality Experts,

sincerely yours

**Jan Aufderheijde**
REHVA Secretary General

**Karel Kabele**
Professor, REHVA President

# REHVA position paper on the European Commission review of the Energy Labelling Directive (2010/30/EU) and the Ecodesign Directive (2009/125/EC)

## General remarks

REHVA supports the main principles of the Ecodesign and Energy Labelling Directives. They can give the opportunity to end-users to assess products by using clear and sustainable criteria, lead industry towards higher competitiveness, high quality and sustainability, and provide indirectly all stakeholders with guidance. The principles of the Directives serve as solid background to lead the way towards a fair and rewarding legislation and benefit the whole EU in achieving the energy efficiency targets. Energy labelling has clearly improved the market situation of several consumer products and accelerated their development towards the right direction. However, some deep concerns must be expressed on many features of the legislation developed or under development within the Ecodesign and Energy labelling framework as described in the recent position paper.

## Coordination among fragmented regulations and standardisation, consistency of the requirements

Ecodesign and Energy Labelling regulations develop separately without systematic co-ordination between the different legislation that concern the same products (e.g. Construction Products Regulation). Taking into account also standardization, the present legislative and supporting (mandatory and voluntary) measures look very fragmented. Timing of preparation of different regulations and standards for the same product is experienced as problematic. Joint efforts between the Commission and CEN should be increased to help stakeholders. Enterprises find it difficult to make the right decisions, for example changes in major production lines or building up own test facilities are very expensive, so these investments cannot be based on changing proposals on regulations. In their case two years is a very short time to adopt the regulation.

The preparatory studies often suffer from unclear scope or borderlines, leaving certain products in and others out without clear and evidence-based justifications. Product definitions are sometimes vague, and even the entire scope and product requirements may change until the final phase. This happened for example in case of Lot 15 and Lot 20, as well as of ventilation units (Lot 10 and ENTR Lot 6).

Ecodesign and Energy Labelling (product-oriented approach) and EPBD (building-oriented approach) look at energy efficiency from different aspects. Technical building systems are recognised by both, but still system aspects are not always taken into account correctly, e.g. fan efficiency requirements do not completely reflect the fan performance in real installations. Due to the complexity of the system approach this problem should be addressed at the first stage of the Ecodesign regulation and be put more in focus in the next stage during the review of product regulations.

The scope should be strictly limited to products not covered by building regulations, for example eco-design regulations of insulation materials or windows, which are already regulated by EPBD and national building codes are not so urgent. Many product groups have already voluntary certifications systems including the performance criteria developed by industry. Very few of these have been acknowledged during the preparation of the regulations. These certification systems are well established in the market and should be used as a starting point when developing new regulations.

## Stakeholder involvement

REHVA supports the stakeholder consultation, however the process have to be improved taking existing resources of stakeholders better into account As HVAC products typically are subject to several EU regulations, the drastically increased number of new regulations and the speed of changes in EU legislation have been experienced as a surprise especially among SMEs. Stakeholders are not prepared to absorb all new regulations or to allocate sufficient resources to follow the preparatory processes. ▶

- Changes during the preparatory process leave the manufacturer in an uncertain situation bearing negative consequences just as in vane investments, unrealistic requirements, too short time for necessary changes in products and production. Stakeholder consultation is necessary also in later phases of the preparatory process in order to ensure consistency between requirements for different products used for the same purpose, e.g. boilers and space heaters under different "Lots".

Much more attention should be paid also on the early steps of the studies, product families should be dealt with in bigger clusters even if this is difficult in case of multifunctional products. The preparatory studies do not necessarily consider the needs, the available technologies, different climate or cultural and legislative differences within Europe. This may lead into unrealistic requirements towards some products or product characteristics, or even close the market for products, which are suitable in certain climates or applications. This has been experienced recently especially in the case of boilers, water heaters and space heaters (Lot 1, 2, 15, 20, 21).

## Problems in the information flow

Stakeholders and their national and European organizations faced difficulties in finding correct information. Manufacturers are uncertain whether their product is "in" or "out"", because the publicly available information is ambiguous, vaguely expressed, or simply too extensive. New information supposed to be published systematically, but this is not the case in practice: enterprises receive messages from authorities and associations but also hear rumors that can't be verified. BuildUp and similar national platforms should be used to assist in providing stakeholders with correct and tailor made information according to their specific questions.

## Energy efficiency versus environmental aspects

The regulations have focused too much on short-time optimization of energy issues, while more attention has to be paid on health and environmental criteria. Health and indoor environment quality are not taken into account sufficiently, which may result in deterioration of indoor environment. It is difficult to comply with both energy efficiency and environmental targets simultaneously, e.g. natural or recyclable materials in certain motors can make the product less energy efficient. The situation is confusing and sometimes unbearable to manufacturers and other stakeholders (end-users, designers, product specifiers, building inspectors etc.).

## Lack of capacities in market surveillance

Market surveillance is a critical point due to lack of resources in each European country. Member states need support from the EU level in developing sufficient capacities for surveying whether a product complies with the requirements and in the development of methodologies on the follow-up of the market situation.

## REHVA recommendations:

1) Ecodesign and Energy Labelling regulations have to be coordinated with other linked legislation (EPBD) and product certification processes including the work of CEN. Contradictory and parallel definitions of the overlapping certification criteria should be clarified and avoided in the future.
2) Stakeholders should be involved during the entire regulatory process and informed about changes within the legislation.
3) The problem of contradictions between health, environmental and energy efficiency requirements has to be handled. Health, sustainability and the life cycle approach should be taken into account within the Ecodesign and Energy Labelling directives.
4) EU level support is necessary in the field of market surveillance and in the development of a tailor made information service system about the quickly changing regulations, especially serving the needs of SMEs.

Brussels, 30 September 2013

**Karel Kabele**
REHVA President

**Jan Aufderheijde**
REHVA Secretary General

**Jorma Railio**
Chair of the REHVA Technical and Research Committee

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# Eurovent Certification: Test room 4 of Clivet lab accredited to run tests on 100 kW – 1 500 kW units

**Eurovent, the European Committee which certifies air handling, air conditioning and refrigeration unit operation performance according to European and International rules/standards, has recognised Clivet test room, dedicated to medium and high capacity units, as being suitable for conducting Eurovent Approved Certification Tests.**

Between 1st – 5th July, technicians from independent DMT laboratory of Essen (D) - appointed by Eurovent, for the first time conducted Certification Tests on two Clivet units in the Clivet laboratory test room 4.

On this occasion, **Clivet laboratory test room 4 was recognised as being suitable to run Eurovent Performance Tests on units from 100 kW – 1500 kW** for stability of conditions and measurement precision.

This test room is also at the disposal of Clivet customers, who can request a **Witnessed Test** on the units purchased in order to verify the declared operation performance.

Mr. Giovanni Ruggeri from Clivet Research & Development Department said: "Eurovent recognised that the test room allows Clivet to run certification tests on medium and high capacity units in its laboratories, with the presence of Eurovent technicians. This recognition by Eurovent is also a guarantee for customers about stability of conditions and precision of results - both certification and Witnessed Test, which Clivet has being running for a couple of years in its labs.

The Witnessed Tests also give customers useful suggestions about the best use of the units at the conditions they will work when installed in order to increase comfort, obtain energy saving and reduce $CO_2$ emission thanks to the renewable energy use."

Witnessed Tests can also be run in the other Clivet lab test rooms: Test room 1 (mono-ambient) for units up to 80 kW, Test rooms 2 and 3 for units up to 30 kW (with the possibility of simulating independent conditions for both the utility side and source side) and Test room 5 - built at the beginning of 2013 - dedicated to Rooftop up to 300 kW plus air renewal and purification units with active thermodynamic recovery up to 100 kW.

**The test rooms of Clivet lab, built between 2008 and 2013,** were part of a larger project which involved about **50 people** working daily to **design and develop innovative products and systems** that satisfy every plant and application need in order to ensure total comfort with the lowest primary energy consumption whilst respecting the environment for residential, commercial and industrial sectors.

**More 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

# Cleaner air, better performance

## AAF announces new generation DriPak® pocket filters

DriPak® NX

### Innovative design for top performance

The leading performance of the new DriPak® pocket filters is the result of the specially designed double tapered pockets, engineered by AAF's own research and development team. This innovative design comes with an optimized geometry that ensures even air and dust distribution across the entire filter surface. The outcome is an increased dust holding capacity (DHC) and a prolonged filter lifetime. Thanks to the more uniform load curve, the new generation DriPak® pocket filters offers a very low pressure drop in combination with a high filtration efficiency.

### Three variants: a solution to all air quality challenges

AAF offers three variants of the new DriPak® pocket filters in various configurations, so that a ready-made solution for all air quality challenges can be provided: DriPak® SX, DriPak® GX and DriPak® NX. Each variant offers distinct variations in terms of material, pressure drop and mode of operation.

The flagship of the all-new DriPak® series is the DriPak® NX with stable pockets, made from the newest generation highly efficient synthetic material. DriPak® NX is available in filter classes F7 and F9 according to EN779:2012. Thanks to its mechanical filtration properties, the air filter performs 10% above the minimum efficiency requirement (ME). This is because performance does not depend on an electrostatic charge, resulting in an excellent result after discharging. Simultaneously, the DriPak® NX pocket filter has an exceptionally low pressure drop of just 65 Pa for filter class F7 and 120 Pa for filter class F9. With these performance figures, DriPak® NX sets new standards in the industry. Not only does this result in rating 'A' based on the new Eurovent Energy Efficiency Classification, it even performs up to 35% better than the A-label limit value established by Eurovent.

**More information:** www.dripak.aafeurope.com

# Heat Recovery Ventilation

## Energy-saving, ecological and healthy solutions


Maintaining the climate in premises, with minimum energy consumption is major factor in operation cost management of the buildings. High efficiency heat recovery ventilation provides the necessary quantity of fresh air with comfort temperature. The most important step is to choose the right option of energy recovery system. The right choice means the cost-effective one, without compromise with the microclimate and in the same time with reasonable payback period.

"TANGRA" has produced heat recovery ventilation systems for more than 20 years. The range of high efficient heat recovery ventilation TANGRA EVB HiE covers air volume from 250 m³/h up to 4 500 m³/h and efficiency up to 85%.

***The following alternatives are available:***

- Horizontal and vertical installation
- Split and monoblock units

***Heat recovery ventilation units TANGRA EVB HiE are suitable for ventilation of:***

- Houses
- Offices
- Trade centers
- Hotels and restaurants
- Small industrial workshops

**More information:** Ivan Armianov, tel: +359 888 914 129 | e-mail: i.armianov@tangra.bg

Product news

# CIAT introduces Comfort Line

## Its latest range of ductable comfort units

### Fully scalable and modular

CIAT's Comfort Line comfort units adapt to the specific requirements of all projects whether they be new buildings built in strict compliance thermal regulation or refurbishment projects to improve energy efficiency, comfort and indoor air quality.

Comfort Line units are an integral part of CIAT's Hysys water loop system solutions and come in three sector-specific configurations – Comfort Line Office and its broad diffusion offer for offices, Comfort Line Hotels/Seniors for hotels or healthcare facilities and Comfort Line Home for collective housing. Three versions are available:

### 1) Comfort Line Standard

HEE motor + standard filtration

### 2) Comfort Line Basic

Standard motor, standard filtration

Comfort Line comfort units with standard filtration can be subsequently retrofitted with the Epure filtration function simply by changing the filtration module. Likewise, the HEE motors can be upgraded very easily without requiring any modifications to be made. Comfort Line boasts a wide range of capacities (0.7 kW to 6.1 kW) and reduced thicknesses (215 mm to 280 mm) for less space usage in suspended ceilings and raised floors.

### 3) Comfort Line Premium

HEE motor + CIAT's exclusive Epure filtration

The High Energy Efficiency version (HEE), which can achieve energy savings of as much as 87%, meets the 2013 and 2015 regulations based on ErP Directive. The fans with airfoil blades specially engineered by CIAT are also HEE.

Already integrated into the Coadis Line range, Epure technology provides a solution to indoor air quality (IAQ) issues and removes airborne particles in order to protect the health of building occupants. Comfort Line ensures excellent IAQ by reducing airborne PM2.5 concentrations to below the WHO guideline value of 10 µg/m3.


Each unit in the range features a patented thermoplastic drain pan designed to reduce the leakage of air outside the unit and prevent the bypass of air around the coil. The pan's design also allows it to retain only a minimum of condensate, optimize pump operating time and improve safety in the event of coil maintenance.

Condensate drains out of the bottom of the sloped pan. Manually reversible drain adapters are placed near the rear or front of the unit. The pan is mounted in a drawer with the coil for easy removal. It can also be removed via the unit's underside.

Comfort Line is available with different two-pipe hydraulic coils to accommodate the multitude of water temperature ranges, in addition to the conventional Eurovent 7/12 range. As a result, the unit's size does not need to be increased to accommodate increasingly varying temperature ranges. An electric heater can easily be fitted in place after the hydraulic coil to create units with four-pipe coils and electric heaters.

Comfort Line has been designed in accordance with the CIAT Group's sustainable development programme and, in particular, its ecodesign principles. Each unit can be fully dismantled and is thus 94% recyclable. The life cycle assessment (LCA) for Comfort Line established that it has 13% less environmental impacts than the previous ranges.

# Daikin Altherma hybrid heat pump

## The cost-effective and energy efficient solution to gas boiler replacement

**Daikin's first hybrid heat pump system combines two proven technologies: an air-to-water heat pump and a condensing gas boiler, to create a highly energy efficient and cost effective domestic heating and hot water system that is ideal for gas boiler replacement.**

The annual energy efficiency of the Daikin Altherma hybrid heat pump is about 35% higher compared with a gas condensing boiler; currently considered as the best available technology for replacing traditional heating systems as part of home renovation projects.

For homeowners looking to replace their old gas boiler, the hybrid system is an obvious choice. It can be installed quickly and with minimal disruption, as very little work is needed inside the home. The indoor unit (both hydrobox and gas boiler) fits in the same space as the original gas boiler and uses existing radiators and pipework, which also reduces installation costs. In the longer term, the system's high efficiency can reduce energy consumption and lead to lower bills.

The hybrid heat pump is a great differentiator for Daikin installers, as the system can be used in any renovation project, regardless of the type of home and its location. The system can produce water flow temperatures from 25°C up to 80°C, making it suitable for any type of heat emitter, including existing radiators, and making it flexible enough to meet a wide range of space heating and hot water demands.

**More information** see REHVA Journal Issue 2/2013 pp. 20-25 for details of the performance.

# Daikin's fully flat cassette – Design and Genius in one

**Daikin has launched the fully flat cassette for its Sky Air and VRV commercial climate control systems. This new indoor unit has an iconic and unique design, providing high energy efficiency and comfort levels.**

### Blending design with function

The fully flat cassette is the first commercial indoor unit developed specifically for the European market and is the result of a collaboration between Daikin and renowned international product designer yellow design. The cassette is designed to blend seamlessly with modern commercial building interiors and is the first to fit completely within a standard European ceiling tile, enabling lights, speakers and sprinklers to be installed in adjoining panels.

Available in white or white and grey, the fully flat cassette blends design with function perfectly, with its flush fit, four-way air distribution, individual flap control and optional intelligent sensors (presence and floor sensor) that ensure it meets the highest demands of architectural design, while delivering excellent comfort and exceptional seasonal energy efficiency (up to A+). The fully flat cassette's 25dBA sound pressure makes it one of the quietest on the market.

### Daikin's new fully flat cassette – Design and Genius in one

With the launch of the fully flat cassette, Daikin is once again leading the way in the design and technology of climate control systems.

# Chillers and heat pumps from the GAC and GAH range are available with inverter compressors


GEA presents further-developed systems in the GEA GAC and GAH range. These air-cooled GAC chillers and GAH heat pumps are now equipped with inverter compressors. As improvement over their predecessor ranges, these new developments – thanks to their one or two integrated DC inverter scroll compressors – are highly energy-efficient, especially in their relevant partial-load operational ranges. In their rating classes, they achieve exceptional ESEER values, up to 4.8, and thereby reduce operational costs, amortization times, and $CO_2$ emissions. Additional benefits of this new inverter compressor technology include more exact temperature control, continuously variable regulation of compressor speed, and – as a result – longer service life. By virtue of the inverters, the soft-start function is already integrated and does not require selection as an option. Thanks to their inverters, both system variants – the GAC chillers and the GAH heat pumps – require no or only small buffer tanks. In heat pump operations, air-intake temperatures down to -15 °C are possible.

Since the hydraulic connection of these new inverter-controlled systems is the same as that in the predecessor range, design of the water cycle can take place as usual. These new compact units are available as chillers and heat pumps, each in seven capacity ratings from 16 to 75 kW of cooling/heating duty, with or without an integrated pump. In their standard models, they can be installed either outdoors or indoors via duct connection.

It is precisely in partial-load ranges of operation that the new GEA chillers / heat pumps with DC inverter scroll compressors are extremely energy efficient. They achieve an ESEER value of 4.8.

**Product Management contact**: GEA Heat Exchangers & GEA Air Treatment GmbH: tim.krambroekers@gea.com

# Giants and Mega Giants large capacity air cooled condensers and dry coolers from LU-VE

**EHVD Giants 198 – 2 340 kW, EHLD Giants 159 – 1 867 kW, XXLD Mega Giants 347 – 2 333 kW** – with "V" formation coils have been specifically designed to fulfil the typical requirements of industrial installations with particular reference to these applications: Refrigeration and Air conditioning; Power generation; Oil and gas industry; Industrial processes, Automotive industry, Waste treatment plants, Chemical and pharmaceutical industries.

The units guarantee the maximum performance with TURBOCOIL® heat exchangers and the lowest energy consumption with EC fan motors. The LU-VE patented SMART® structure (tested on vibrating platforms) coupled with the coil suspension Safetubes system® (full protection for the coil tubes) provides very robust units and simplified moving and installation.

## DRY and SPRAY System®

The most advanced solution to improve performance and minimizing dimensions of large-capacity air cooled condensers and dry coolers.

The extraordinary performance levels due to highly efficient water nebulization mean that this product is an alternative to traditional cooling towers with additional important advantages.

The "DRY and SPRAY®" products work as traditional dry units until the ambient air temperature is low enough to maintain the cooling capacity and the coolant temperature (or condensing pressure) at the planned conditions (Dry operation). The temperature passage from Dry to spray operation is a planning choice and usually is about 20°C. This innovative technology also enables, depending on the ambient air wet bulb temperature, a coolant temperature equal to or lower than the dry bulb temperature of ambient air with significant energy advantages. A sophisticated control system adjusts the speed of the fans and the nebulized water capacity as required.

**More information:** www.luve.it › HOME › PRODUCTS › Dry Coolers › XXLD Mega Giants

# Trane introduces chiller buyback program designed for smart equipment management

**The complete service offering supports customers' business needs and the system throughout its complete lifecycle from start-up to replacement**

Backed by a 100 years of extensive knowledge in cooling systems, Trane provides a strong service network to efficiently support installed systems and offer tailored equipment management solutions. This new program is designed to support the chiller replacement process to ensure: Single source responsibility for customer's maximum convenience

- Minimum disruption during transition
- Compliance with local environmental regulations
- Appropriate asset value for the existing equipment

Through the Chiller Buyback Program, Trane provides customers with a detailed decommissioning plan. The equipment meant for replacement or disposal is rigorously assessed to determine its condition and to derive the asset value. The plan is drawn up considering local environmental regulations for the disposal of oil and refrigerant, if required, and includes an estimate to cover the removal of the decommissioned equipment.

With the new Buyback Program, Trane now offers a full range of smart equipment management service solutions like Trane Select agreements. Trane Care and Trane Boost upgrade solutions and rental services to support the HVAC system throughout its complete lifecycle.

Trane, a leading global provider of indoor comfort solutions and services and a brand of Ingersoll Rand, launched the Buyback Program to help customers meet these challenges and facilitate the whole transition.

**More information:**
joan.schimml@irco.com or anne_blommaert@trane.com

# Trane keeps customers cool with more than 200 available rental units

Temporary cooling needs can arise at any time in a building's lifecycle. Because building owners and operators require quick action and support when it happens, Trane, a leading global provider of indoor comfort solutions and services and a brand of Ingersoll Rand, continuously expands its rental fleet.

Cooling is critical for most businesses, whether it is to create the right indoor environment for buildings or to provide reliable cooling for industrial processes. With Trane Rental Services, facilities can depend on reliable temporary cooling solutions for a variety of applications, including emergency and planned situations.

With more than 200 rental chillers currently available in Europe, Middle East and India, Trane can meet the specific temporary cooling requirements of its customers quickly and effectively.

Since launching the rental services, the fleet has more than doubled in a year. By 2014, it is projected to double again and reach more than 400 units. Trane offers a modern fleet of chillers that are specifically engineered and built for rental purposes.

Trane Rental Services brings solutions to a wide variety of facilities including healthcare, data centers, industrial, hospitality and commercial buildings. Trane has served customers' needs ranging from seasonal needs and special events to emergencies and planned shutdown. The units are selected for fast installation and easy operation.

After installation, an extensive service network of factory authorized Trane technicians ensures smooth operation throughout the duration of the rental period.

For more information, please visit the Trane Rental Services portal. The online portal enables customers to easily obtain information on chiller rental range and availability in different countries across Europe, the Middle East and India.

# Guidebook for Strong Implementation of the Energy Efficiency Directive (2012/27/EU)

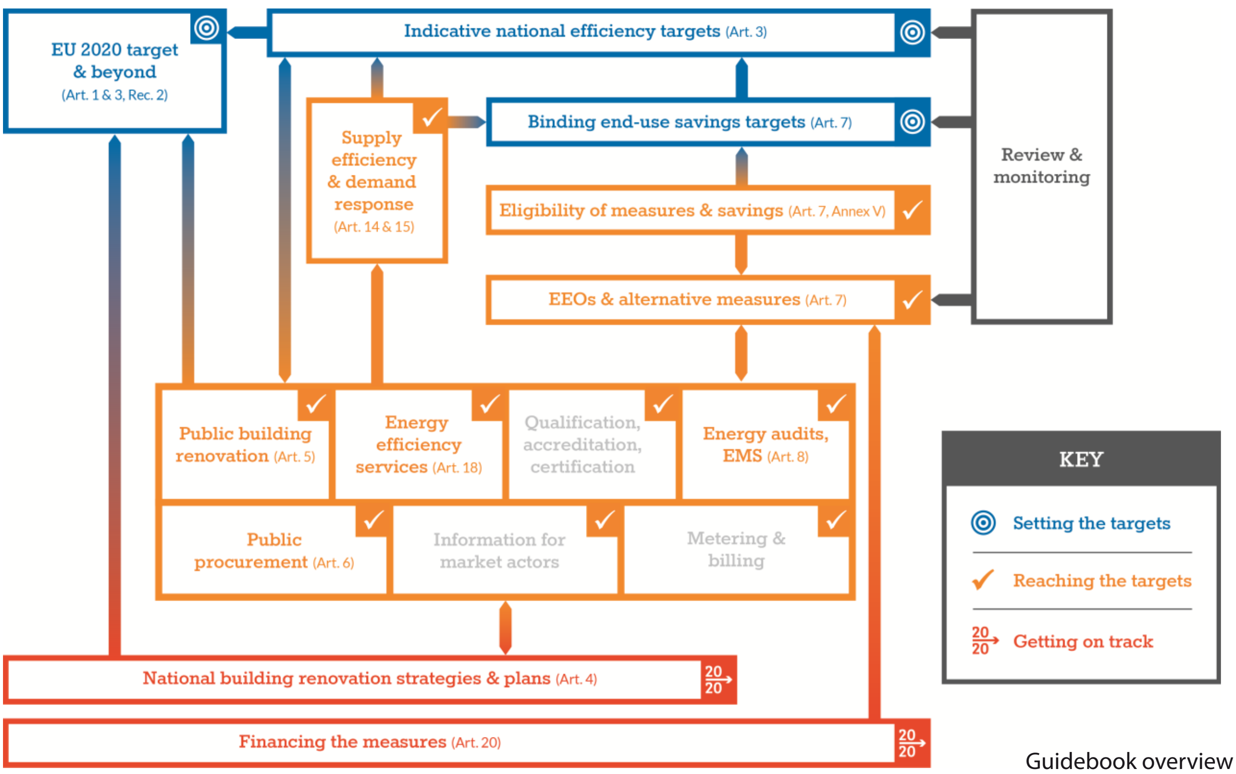

The Coalition for Energy Savings – with the contribution of BPIE et. al. – developed a comprehensive guidebook outlining the necessary steps to implement the Energy Efficiency Directive (EED, 2012/27/EU). In essence, it offers ways of navigating the Directive. The guide is intended to support ambitious implementation of the EED in order to achieve the EU's energy savings target and support efforts to increase energy efficiency beyond 2020.

The purpose of this guide is not to replace fundamental actions, such as a common implementation strategy, but instead to provide valuable and complementary input to the Commission's work. The guide is also meant to stimulate more transparency of the implementation process and facilitate a better understanding of the complex EU legislation by providing further clarifications, comparisons, recommendations and best practices examples.

Thus, the Guidebook is structured following a series of recurring themes which can be found in the EED such as: setting the targets, reaching the targets and getting on track. The first chapter is an overview of the EED, its aims and targets, the second one details key efficiency measures of the EED and recommendations for an efficient implementation, whereas the last part is a user's manual of financing strategies and national building renovation strategies.

*The Coalition for Energy Savings is an unprecedented gathering of business, professional, local authorities and civil society organisations. The Coalition's purpose is to make the case for a European energy policy that places a much greater, more meaningful emphasis on energy efficiency and savings, as the most available and accessible solution to the European Union's short- and long-term economic, social and environmental challenges. In particular it is arguing for the current 20% energy saving target to be binding.*

**To navigate the Guidebook**, go to http://eedguidebook.energycoalition.eu/



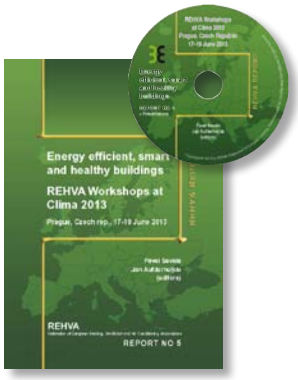

Guidebook overview map.

NEW!

# REHVA REPORT 5 – Workshops at CLIMA 2013

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**".

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** and **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 report include the workshops presentation and a summary of the discussions. An accompanying CD-ROM includes PDF versions of the book and full WS-presentations.

REHVA REPORT 5 is available on REHVA Guidebooks' Shop at **www.rehva.eu**.

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# Journal of Building Performance Simulation impact factor doubles!


The Journal of Building Performance Simulation is the official journal of the International Building Performance Simulation Association (IBPSA). It is an international refereed journal, publishing only articles of the highest quality that are original, cutting-edge, well-researched and of significance to the international community. The journal also publishes original review papers and researched case studies of international significance.

The wide scope of JBPS embraces research, technology and tool development related to building performance modelling and simulation, as well as their applications to design, operation and management of the built environment. This includes modelling and simulation aspects of building performance in relation to other research areas such as building physics, environmental engineering, mechanical engineering, control engineering, facility management, architecture, ergonomics, psychology, physiology, computational engineering, information technology and education.

All articles published in JBPS have undergone rigorous peer review, based on initial editor screening and anonymous refereeing by independent expert referees.

The journal's Impact Factor has recently increased to 1.524, now ranking JBPS 12/57 in Construction & Building Technology. This great achievement is testament to the high quality of papers being published in the journal.

The scope of topics includes the following:

- Theoretical aspects of building performance modelling and simulation.
- Methodology and application of building performance simulation for any stage of design, construction, commissioning, operation or management of buildings and the systems which service them.
- Uncertainty, sensitivity analysis, calibration, and optimization.
- Methods and algorithms for performance optimization of buildings and the systems which service them.
- Methods and algorithms for software design, validation, verification and solution methods.

**For more information**, visit the journal's homepage at www.tandfonline.com/jbps

# VDI-Guidelines published September – October 2013

### VDI 2067/10 "Economic efficiency of building installations; Energy demand for heating, cooling, humidification and dehumidification"

This standard describes the calculation of the energy demand of buildings and rooms whose conditions should be met and which therefore must be supplied with or dissipated of energy and materials. The material demands will be treated similarly to energy demands. The standard takes into account both radiation, transmission and ventilation processes. Influences of energy transfers to the room, technical equipment, energy supply and conversion are not subject of the standard. The calculation basis is a defined set of weather data.

### VDI 3805/18 "Product data exchange in the building services; Panel heating/cooling"

The standard describes the rules for the exchange of product data in the computer-aided process of planning technical building services for panel heating/-cooling components. It is based on the standard VDI 3805 Part 1.

### D VDI 3809/2 "Testing of building installations; Lifts for use by the fire brigade"

Firefighters' lifts are subject to special requirements, providing means of access and escape route for the fire brigade in case of fire. Life and physical safety of the firefighters in action depend on the safe and reliable functioning of such lifts. Requirements are specified, among others, in DIN EN 81-72. This standard is the first draft of a harmonised checklist allowing operators and testing institutions to carry out recurrent tests of such lifts.

### D VDI 2083/7 "Cleanroom technology; Ultrapure media; Quality, supply, distribution"

The standard deals with the specification of ultrapure media (steam, gases, chemicals) for contamination-controlled processes and with the distribution systems for such media. The standard provides a summary of knowledge regarding the design, construction, operation and monitoring of high purity supply systems, and supports planners, system suppliers and operators in their work. It is intended to supersede and replace VDI 2083 Part 7 and Part 10.

### D VDI 4700/1 "Terminology of civil engineering and building services"

This guideline deals with the application of filters in air-conditioning systems (A/C systems) in, e.g., residences and offices, in medical facilities, in pharmaceutical and food productions and in public buildings, service centers and commercial enterprises, schools and sports facilities.

This guideline adopts the technical specifications of the guideline SWKI VA101-01:2007-11.

### VDI 4707/2 "Lifts; Energy efficiency of components"

The series of guidelines VDI 4707 is the basis for an energy-efficiency rating of lifts. The guideline describes the classification of lifts on the basis of the energy efficiency of the lift components.

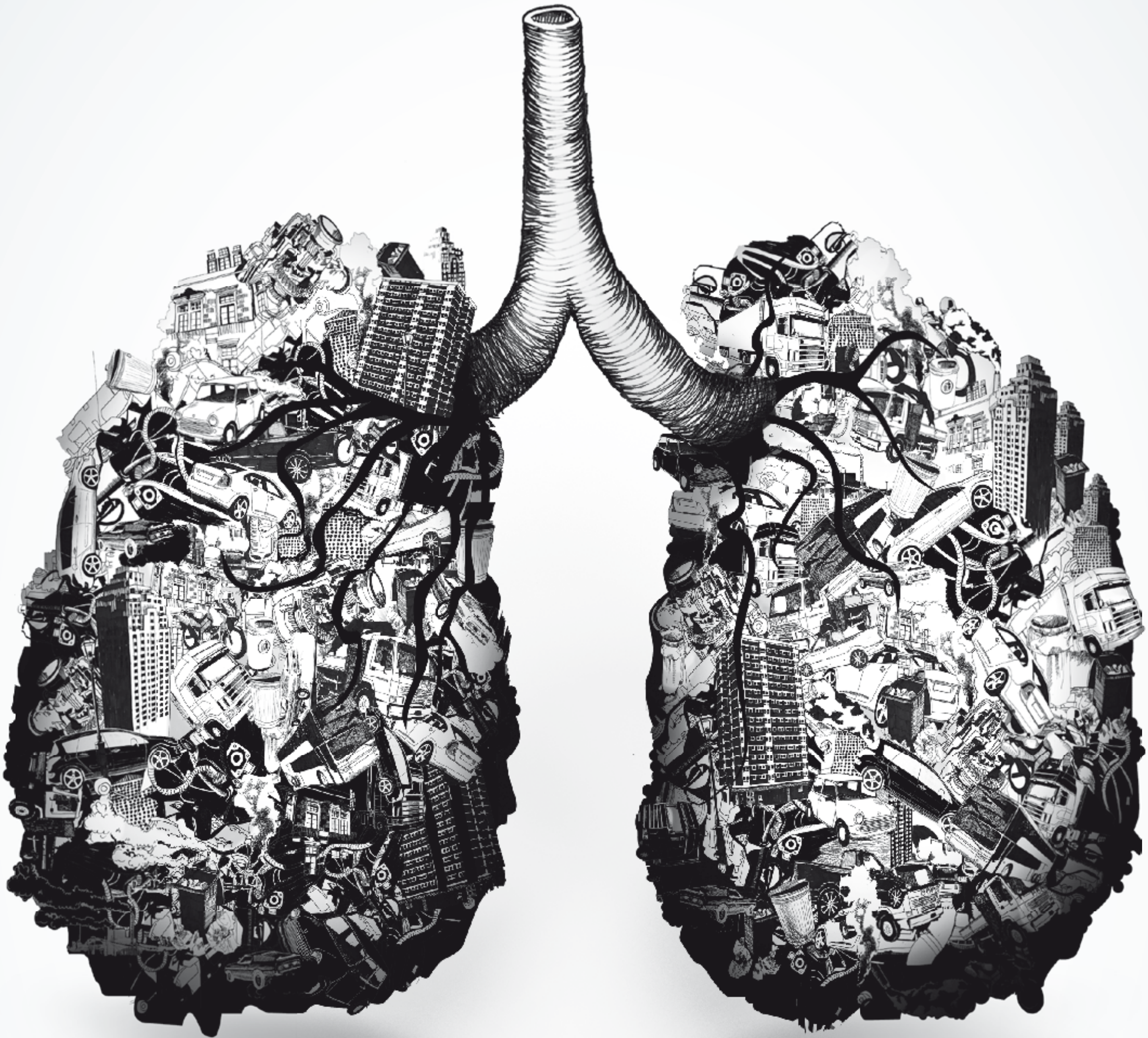
### VDI 6022/7.1 "Ventilation and indoor-air quality; Branch-specific guides; Waste treatment plants"

The standard is complementary, industry-specific information on VDI 6022 Part 1 for use in waste treatment plants. It applies to design, construction and operation of all HVAC systems and equipment and their centralized and decentralized components that influence the supply air in waste treatment plants according to Waste Law.

### VDI/GVSS 6202/1 "Contaminated buildings and technical installations; Demolition, refurbishing and maintenance"

The standard applies to activities of demolition, refurbishing, maintenance and servicing of building structures and building services, where contaminants are involved. It applies to the removal, coating and separation of contaminants and the consignment and handover of the waste generated to disposal. The guideline describes the essential aspects of the decontamination procedure from the census up to the disposal.

D = Draft Guideline



# Keep the city out

Our new combination filter, City-Flo XL, cleans air of both particles and molecules. The filter has been specially developed for buildings in urban environments and is extraordinarily effective against exhaust fumes, smells and ozone. Give your property new lungs!

**www.camfil.com**

camfil
CLEAN AIR SOLUTIONS

MECKA

# World Sustainable Energy Days

26–28 February, 2014
Wels, Austria

**The World Sustainable Energy Days (WSED), one of the largest annual conferences in this field in Europe, offering a unique combination of events on high energy efficiency in buildings and renewable energy heating. For more than 20 years, experts and decision makers from all over the world flock to Upper Austria to attend these events – in 2013, more than 800 experts from 61 countries participated!**

The World Sustainable Energy Days 2014 offer a unique combination of events:

## European Pellet Conference

The world's largest annual conference on pellets presenting technology and policy trends, markets, innovation, sustainability, finance, business models.

Including the

- World Pellet Business & Technology Forum
- B2B-Meetings & Pellet Networking Platform
- Pellet News World-Wide
- "Pellet trade show" (with more than 100 pellet related exhibitors at the trade show)

## The European Nearly Zero Energy Buildings Conference

The European conference for discussing high efficiency buildings supplied by renewable energy: technologies, business models, policies, financing, definitions & national action plans, best practice examples, cost optimality of energy efficiency and renewable energy in new construction and renovation.

## Conference WSED next (Energy Efficiency & Biomass)

A conference to present the work of young researchers in the field of biomass and in the field of energy efficiency. The event includes a young researchers award and a R & D Networking Platform for young researchers.

## Conference "Innovative Building Technologies"

A conference dedicated to the latest developments in technology solutions for sustainable buildings with an outlook on future buildings.

## Conference "Energy Efficiency Policies"

A conference offering an update on the implementation of the EU energy efficiency policies and how they can drive innovation and employment.

## B2B Meetings

Finding new business partners in bilateral meetings in the field of biomass & energy efficiency.

## Trade Show "Energiesparmesse"

Leading trade show on renewable energy and energy efficiency with 100,000 visitors and 1,600 exhibitors annually.

## Technical site-visits

Technical site-visits to best practice examples in Upper Austria are organised on wood pellets & wood chips (25 Feb.) and on Nearly Zero Energy Buildings (28 Feb.).

## Poster Presentation

The poster presentation offers the opportunity to display successful initiatives and projects on energy efficiency and renewable energy.

**The conference is organised** by the OÖ Energiesparverband, the energy agency of Upper Austria.

**More information:** www.wsed.at | office@esv.or.at

# Cold Climate 2015

October 20–23, 2015
Dalian, China

The 8th International Cold Climate HVAC Conference will be organized by Dalian University of Technology and co-organized by Tsinghua University and VTT Technical Research Centre of Finland.

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. The Cold Climate Conference is an official conference of the Federation of Scandinavian HVAC Associations.

The conference topics cover a wide range of issues including:

- Sustainable building energy saving
- Zero energy building
- Heating technology and policy
- Usage of renewable energy
- Ventilation and heat recovery
- Heat pump technology
- Building simulation
- Building energy saving in rural area

**More information:** www.coldclimate2015.org

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

# Windsor conference

WINDSOR CONFERENCE 2014
COUNTING THE COST OF COMFORT IN A CHANGING WORLD

April 10–13, 2014
Cumberland Lodge, United Kingdom

The 8th Windsor Conference focuses the academic endeavour of comfort research into the real world context of providing building designers, owners and users with clear and comprehensible measures of what the actual money, energy, carbon, health, well-being, productivity and comfort costs might be in applying different comfort stratagems to the challenging social, climatic, constructional and economic contexts around us.


Cumberland Lodge

Themes include:

**1) Comfort and productivity**
- The effect of climate and culture
- Comfort in mixed mode buildings

**2) Occupant behaviour**
- Models and methods, prediction and simulation
- Personal control and adaptive comfort
- Effect on IEQ and energy use

**3) Modelling:**
- Occupancy and productivity
- Comfort and overheating in buildings
- Adaptive opportunities
- The economics of comfort

**4) Simulation and monitoring**
- How to predict comfort and IEQ

**5) The future of comfort research**
- Impact of energy legislation on comfort
- Designing for comfort what are the barriers?
- The future form of comfort standards
- The cost and value of comfort / discomfort

**Full papers:** Deadline for submission of full papers for refereeing: 1st February 2014.

**More information:**
http://windsorconference.com | fergus@nceub.org.uk

REHVA 50 1963 2013 Federation of European Heating, Ventilation and Air Conditioning Associations

# REHVA – iSERV Technical Seminar

Feb. 13, 2014
Brussels, Belgium

iSERV CMB

REHVA's next seminar will be held at the Thon Hotel EU in Brussels, Belgium on the 13th February 2014 from 10.00 to 16.00. REHVA is organising its 2014 Technical Seminar together with the iSERV project consortium around the topic: ***Energy Efficient Operation of HVAC Systems***. iSERV is approaching to its end, so it is time to discuss project results and their further use in an EU-level seminar inviting also high level EC speakers.

The Conference will be covering topics such as energy efficient buildings, EU policies and implementation, energy efficient operation of HVAC systems the iSERVcmb project and a parallel discussions about the deployment of iSERV results the policy and industry perspective.

The speakers of the Conference are invited top experts of their field representing policy makers from European Commission, leaders from important organisations, scientists from top universities and professionals from member states of the European Union.

Come and share your experience and expectations. We will be delighted to see you at this occasion. It is also an occasion to network with others companies.

Lodging is available at the Thon Hotel EU. Advance registration is 125 € per person.

**More information and registration**:
www.rehva.eu | info@rehva.eu

REHVA 50 1963 2013 Federation of European Heating, Ventilation and Air Conditioning Associations

# REHVA Annual Conference 2014

April 30, 2014
Düsseldorf, Germany

## Energy efficient, smart and healthy buildings

**The REHVA Annual Conference is organized in cooperation with the VDI-Society for Civil Engineering and Building Services in the Maritim-Hotel Düsseldorf Airport, it takes place during the REHVA Annual Meeting.**

The 2014 REHVA Annual Conference will focus on **Energy efficient, smart and healthy buildings**.

The topics include:

- Green Buildings/nZEB
- Building Automation and Control Sytems
- Important Guidelines
- REHVA Research Projects

Many other interesting topics will be covered and some case studies will also be presented. The scope of the Conference will be to offer researchers, industry, building owners, end-users, consultants, engineers, architects and policy makers, a platform for the exchange of scientific knowledge and innovative technical solutions.


Build up your personal network with all the visitors of the Annual meeting and take part in the REHVA conference 2014!

**More information:** www.vdi.de/rehva-am-2014 | tga@vdi.de

**São Paulo** with more than 11 million inhabitants, stands out as a city that lives intensely and "doesn't stop." Having more than 150 000 seats for shows and concerts, 124 museums and more than 15 000 theater and cinema seats. A great party! A great opportunity to explore such alternative culture, discovering the city, its architecture and its inhabitants.

# RoomVent 2014

October 19–22, 2014
Sao Paulo, Brazil

The 13th SCANVAC Conference RoomVent 2014 will be held in Sao Paulo, Brazil, on October 19–22, 2014. The main theme of the next RoomVent is "New ventilation strategies with base in active and passive technology in building and for comfort in airplane".

### The topics of the scientific and technical sessions cover:

- Indoor Air Quality and Human Comfort
- Ventilation and Air Conditioning in Green Buildings
- Innovative strategies and components for ventilation and air conditioning systems
- Computer based design methods applied to Room Ventilation
- Airflow inside buildings and case studies
- Smoke and Contaminant Movement
- IAQ in Vehicles

**Organisers:**

IPT – Institute for Technological Research
USP – São Paulo University
State University of North Fluminense – Rio de Janeiro
Federal University of Minas Gerais – Belo Horizonte

**Technical visits** will be arranged during the Conference.

**Important dates:** Abstract submission will open on 16 February 2014 and close on 16 March 2014. Deadline for full paper submission is 20 April 2014. Registration will open 27 April 2014.

**More information:** www.roomvent2014.com

# Indoor Air 2014

**The 13th International Conference on Indoor Air Quality and Climate**

July 7–12, 2014
Hong Kong

***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.

- Paper submission deadline: January 31, 2014
- Final paper submission: April 1, 2014
- Registration open: January 1, 2014

ISIAQ

*Indoor Air 2014 is the official conference of the International Society for Indoor Air Quality and Climate, ISIAQ.*

*Grand hall of the conference venue, University of Hong Kong.*

**More information:**
www.indoorair2014.org | info@indoorair2014.org

# Aqua-Therm Russia

February – April, 2014
Moscow, Novosibirsk and
St. Petersburg, Russia

aqua THERM MOSCOW



## Aqua-Therm Russia takes your HVAC business to the new level:

- Russia: growing market which is ready for new companies and has lots of new clients
- Globally known brand Aqua-Therm – a guarantee for high ROI
- Beat the distance: meet all Russian clients in one place – just bring your brand innovations and experience to Russia (Central, North-West and Siberian regions)
- Expand your promotion and visibility: show your interest to the local market which has huge opportunities for development
- Grow your business through acquiring new clients in Russia

Take all the benefits and participate in Aqua-Therm exhibitions in Moscow, St. Petersburg and Novosibirsk!

After considerable success in Moscow the largest international HVAC & pool exhibition Aqua-Therm keeps on developing its brand across Russia. There is a growing demand and need for such an event in the regions among business audience.

Aqua-Therm goes where the business is. Two new launches in Siberia (Novosibirsk) and North-West region (St. Petersburg) are clear demonstration of it. Aqua-Therm events are promising to be the main professional events for HVAC & pool industry in each respective region and reflect the future pace of the sector's development. In addition to strong demand, both projects have a favorable economic background: population growth, increase of purchasing power, industry development and increase of the number of domestic building and construction projects.

Gregory Zaraisky, General Manager of Reed Exhibitions (Russia), organizer of Aqua-Therm, comments on the geographical expansion of Aqua-Therm:

"Vast territory is not the only factor that gives scope of doing business in Russia, but also its climate creates a natural and constant demand for heating, water supply, air-conditioning and ventilation. These geographical spots are the ideal location for launching regional Aqua-Therms that will allow many companies to focus on the regions and to be closer to the client".

The joint efforts of professional teams of organizers, Reed Exhibitions, Primexpo and ITE Group will form a perfect B2B platform. These new events will contribute to the further development of regional infrastructure, expansion of markets and promotion of technologies and equipment for HVAC & pool market of three largest regions of Russia.

**More information:**

- Aqua-Therm Moscow – February 4–7, 2014, Crocus Expo, www.aquatherm-moscow.ru
- Aqua-Therm Novosibirsk – February 19–21, 2014, Novosibirsk Expocenter, www.aquatherm-novosibirsk.ru
- Aqua-Therm St. Petersburg – April 9–12, 2014, Lenexpo, www.aquatherm-spb.com

# Mostra Convegno Expocomfort 2014

March 18 – 21, 2014
Fiera Milano, Italy


## "Smart plants – Smart cities" – The highly topical theme of MCE

MCE – Mostra Convegno Expocomfort – the biennial international exhibition dedicated to residential and industrial installations, air-conditioning and renewable energy, scheduled for 18th – 21st March 2014 at Fiera Milano, will offer a rich programme of conferences to put a spotlight on one of the most important issues facing the future of our cities, where "Smart" buildings are the cornerstones of a new way of living under the banner of energy efficiency and conservation to increase positive impacts on the territory and people's life. An opportunity not to be missed by professionals (over 155 000 in 2012). So far more than 1 500 exhibiting companies have signed up, 37% of rebooking made by foreign exhibitors from 52 countries.

MCE – Mostra Convegno Expocomfort with the support of the Scientific Committee – made up of experts from the most authoritative trade associations and federations in the reference sector, and chaired by a representative of the Polytechnic of Milan, Department of Architecture, Built Environment and Construction Engineering – providing topical issues that will act synergistically with a wide exhibition area.

**Three institutional conference sessions** to thoroughly investigate the future of sustainable planning, ranging from installation technologies through relevant case histories to the future of the market:

**1.** The First Conference Session "Comfort Technology – Designing and Installing integrated systems for energy efficiency", Wednesday 19 March 2014, will deeply illustrate Italy scenarios with a special focus on technical and regulatory aspects of the next generation of buildings, where the installation technology provides a wide range of functions incorporated into innovative control systems.

**2.** The Second Conference Session held on Thursday, 20 March 2014, – in collaboration with Associations, Universities, Bodies, and Institutions – will also meet a positive response on an international level, providing an invaluable occasion to examine some of the most relevant International case studies offering an overview of cutting-edge designs to improve the energy performance, reduce energy consumption, combine functionality and advanced building management control systems.

**3.** The Third Conference Session and last day of the conference, scheduled for Friday, 21 March 2014, will focus on the market potential to highlight the most promising advanced technology, namely heat pumps, high efficiency boilers, energy storage, as well as the new regulatory framework, and to interpret business opportunities in favour of all professionals in the industry.

The conference calendar will integrate with a list of training meetings and workshops promoting cutting-edge technology, organized by the main trade associations, such as AICARR, REHVA, ASHRAE and many others, and those set up by the exhibiting companies. An important role at MCE will be played by the synergy between "Percorso Efficienza & Innovazione" (Efficiency & Innovation Path), an initiative aimed to show off a selection of the most innovative and highly efficient products and solutions on display, and "Oltre la Classe A" (Beyond Class A), an overall showcase to highlight the highest excellence in energy efficiency.

www.mcexpocomfort.it is the reference point for professionals who surf the web and want to be updated on MCE – Mostra Convegno Expocomfort. A virtual showcase constantly providing a full panorama of news about the exhibition, initiatives promoted by exhibiting companies and all the information for planning a visit to MCE.

### REHVA and AICARR seminar at MCE

**Towards nearly zero retrofitted buildings**
Wednesday 19 March 2014 at 14.30 – 17.30
Milan, Italy

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

# Events in 2013 - 2015

## Conferences and seminars 2013

| | | | |
|---|---|---|---|
| December 4-6 | 44 International Congress of HVAC&R | Belgrade, Serbia | www.kgh-kongres.org |

## Conferences and seminars 2014

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|---|---|---|---|
| January 18-22 | ASHRAE 2014 Winter Conference | New York, NY, USA | www.ashrae.org/membership--conferences/conferences |
| February 13 | REHVA-iSERV Technical Seminar | Brussels, Belgium | www.rehva.eu |
| 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 |
| March 18-19 | International Workshop Quality of Methods for Measuring Ventilation and Air Infiltration in Buildings | Brussels, Belgium | www.aivc.org/News/Newsflash_20131009.html |
| March 19 | REHVA - AiCARR Seminar - Towards nearly zero retrofitted buildings | Milan, Italy | www.rehva.eu |
| April 2-3 | 8th International Conference Improving Energy Efficiency in Commercial Buildings (IEECB'14) | Frankfurt, Germany | http://iet.jrc.ec.europa.eu/energyefficiency/conference/8th-international-conference-improving-energy-efficiency-commercial-buildings-ieecb%E2%80%9914 |
| April 3-4 | 4th CIBSE ASHRAE Technical Symposium 2014 - "Moving to a New World of Building Systems Performance" | Dublin, Ireland | www.cibse.org/symposium2014 |
| April 7-8 | ASHRAE High Performance Buildings Conference | San Francisco, California | www.hpbmagazine.org/hpb2014 |
| April 10-13 | 2014 Windsor conference-Counting the Cost of Comfort in a Changing World | Windsor, United Kingdom | http://nceub.org.uk |
| April 28-29 | 2014 Euroheat & Power Annual Conference and 60th anniversary | Brussels, Belgium | www.buildup.eu/fr/events/38110 |
| April 30 | REHVA Annual Conference | Dusseldorf, Germany | www.rehva.eu |
| May 8-10 | TTMD XI. International HVAC+R Technology Symposium 2014 | İstanbul, Turkey | www.ttmd.org.tr/sempozyum2014 |
| 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 |
| June 28-July 2 | ASHRAE 2014 Annual Conference | Seattle, WA, USA | http://ashraem.confex.com/ashraem/s14/cfp.cgi |
| July 7-12 | Indoor Air 2014 | University of Hong Kong, Hong Kong | www.indoorair2014.org |
| August 31-Sep 2 | 11th IIR-Gustav Lorentzen Conference on Natural Refrigerants - GL2014 | Hangzhou, China | |
| September 10-12 | ASHRAE/IBPSA-USA Building Simulation Conference | Atlanta, GA, USA | http://ashraem.confex.com/ashraem/emc14/cfp.cgi |
| September 21-24 | Licht 2014 - Den Haag Holland | Den Haag, The Netherlands | www.licht2014.nl |
| September 24–25 | 35th AIVC Conference - 4th TightVent Conference - 2nd venticool Conference | Poznań, Poland | www.aivc.org |
| October 18-19 | CCHVAC Congress | China | |
| October 19-22 | Roomvent 2014 | Sao Paulo, Brazil | www.roomvent2014.com.br |

## Exhibitions 2014

| | | | |
|---|---|---|---|
| January 21-23 | AHR Expo | New York, NY, USA | www.ahrexpo.com |
| February 4-7 | Aqua-Therm Moscow | Moscow, Russia | www.aquatherm-moscow.ru/en/ |
| Feburary 27-March 1 | ACREX 2014 | Pragati Maidan, 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/ |

## Conferences and seminars 2015

| | | | |
|---|---|---|---|
| January 24-28 | ASHRAE 2015 Winter Conference | Chicago, Il, USA | |
| April 16-18 | International Conference Ammonia and $CO_2$ Refrigeration Technologies | Ohrid, Republic of Macedonia | |
| May 7-9 | REHVA Annual Conference | Riga, Latvia | www.hvacriga2015.eu |
| October 20-23 | Cold Climate HVAC | Dalian, China | www.coldclimate2015.org |

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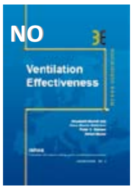
REHVA

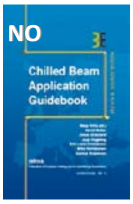
Federation of European Heating Ventilation and Air-conditioning Associations

# REHVA GUIDEBOOKS

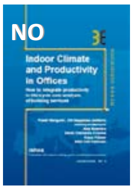
## REHVA Guidebooks are written by teams of European experts




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.

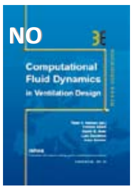



Chilled beam systems are primarily used for cooling and ventilation in spaces, which appreciate good indoor environmental quality and individual space control. Active chilled beams are connected to the ventilation ductwork, high temperature cold water, and when desired, low temperature hot water system. 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.

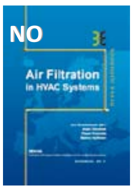



Indoor Climate and Productivity in Offices Guidebook shows how to quantify the effects of indoor environment on office work and also how to include these effects in the calculation of building costs. Such calculations have not been performed previously, because very little data has been available. The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

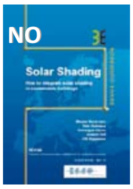

This Guidebook describes the systems that use water as heat-carrier and when the heat exchange within the conditioned space is more than 50% radiant. Embedded systems insulated from the main building structure (floor, wall and ceiling) are used in all types of buildings and work with heat carriers at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



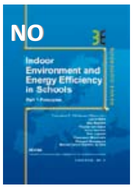

CFD-calculations have been rapidly developed to a powerful tool for the analysis of air pollution distribution in various spaces. However, the user of CFD-calculation should be aware of the basic principles of calculations and specifically the boundary conditions. Computational Fluid Dynamics (CFD) –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



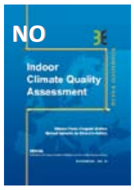

Air filtration Guidebook will help the designer and user to understand the background and criteria for air filtration, how to select air filters and avoid problems associated with hygienic and other conditions at operation of air filters. The selection of air filters is based on external conditions such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



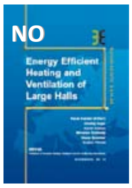

Solar Shading Guidebook gives a solid background on the physics of solar radiation and its behaviour in window with solar shading systems. Major focus of the Guidebook is on the effect of solar shading in the use of energy for cooling, heating and lighting. The book gives also practical guidance for 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.

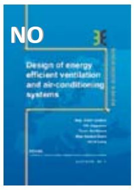



This new REHVA Guidebook gives building professionals a useful support in the practical measurements and monitoring of the indoor climate in buildings. Wireless technologies for measurement and monitoring has allowed enlarging significantly number of possible applications, especially in existing buildings.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

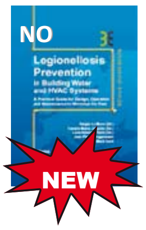



This guidebook is focused on modern methods for design, control and operation of energy efficient heating systems in large spaces and industrial halls. The book deals with thermal comfort, light and dark gas radiant heaters, panel radiant heating, floor heating and industrial air heating systems. Various 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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