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Indoor Environment and Product certification

Designing an energy efficient and comfortable building

Evaluation of indoor environment and energy consumption in dwellings before and after their refurbishment

Ventilative cooling design for a large office building

The new Eurovent energy efficiency label for central ventilation units

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Harmonised assessment procedures for the Building Energy Performance declaration or certification are essential to support our industry towards (Nearly) Zero Energy Performing Buildings by or after 2020

The outcome of COP21 in Paris, last December, adds to the urgency to achieve an energy efficient build environment. All countries around the globe have the duty to reach the targets formulated in Paris. Does this lead to more Zero Energy Buildings or Positive Energy buildings? That depends on the way we assess the energy performance and determine the cost effectiveness. Yes, the answer will be positive; if investors, building developers and real-estate investors are willingly to weigh their investment to reach ZEB or PEB level over a longer period and award the added value due to this rating in a correct way.

JAAP HOGELING
Editor-in-Chief

The EPB-overarching standard, the EN ISO 52000-1, offers the backbone to assess the overall energy performance of a building in a correct way. Supporting the decarbonizing of the building sector. This is the goal of the holistic approach as chosen by CEN/TC371 and the ISO/TC163&205 Joint Working Group for the Energy Performance of Buildings (EPB). An approach which reconciles climate and energy needs. With this EN ISO 52000 EPB series of standards and other CEN-EPB standards, the building industry is expected to be in a much better position to be rewarded for energy efficiency improvements with the best available technology and practice. These EPB series of standards will enable to assess the overall energy performance of a building. This means that any combination of technologies can be used to reach the intended energy performance level. The competition between different technologies is best served by this holistic approach as this is a key driver for technological innovation and change. Countries using this approach for several years have experienced large-scale implementation and cost savings on a variety of new technologies. This includes innovative thermal insulation concepts, windows, heating, cooling, lighting, ventilation and domestic hot-water, building automation and control, and renewable energy systems. What does this mean for our business? For new building and system design we have to be more innovative to reach the zero energy performance level, towards the energy positive buildings.

In this issue of the REHVA Journal the importance of certified performance product data supporting the development of high performance buildings is presented The next issue will focus on the EPB standards that are expected to be published for Formal Vote around October 2016. ■

Designing an energy efficient and comfortable building

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It's not often you get to work on a project with an enthusiastic, knowledgeable client, a renowned architect and a very resourceful contractor.

The building has a gross area of 17 000 m², and contains a basement with 4 levels above grade. The spaces are distributed in the following manor:

- Server room, classrooms, a parking garage and mechanical and electrical rooms in the basement,
- The 1st and 2nd floors contain a mix of classroom studios as well as office and support facilities;
- The 3rd and 4th floor contains the main administrative offices, faculty offices and ancillary support spaces.

Early on, it was decided that occupant comfort and energy conservation would be a priority. The goal was to provide comfort levels at 10% PPD (Percentage of Person Dissatisfied) or less for each space and at the same time consume the least amount of energy against both California's Title 24 requirements and ASHRAE 90.12007 for LEED points.

Engineering the Architecture

The place to start in creating comfortable spaces is with the architectural design and not the conditioning systems. IBE spent considerable time working with the architects, analysing different glazing alternatives and investigating the inside surface temperature for the glass as this drives the mean radiant temperature (MRT) in the occupied spaces. A dynamic comfort simulator was used that could analyse space conditions for a single day, month or year. Having a better understanding of the building shade characteristics and thermal conditions, the overall thermal comfort was improved in addition to reducing energy consumption by implementing some or all of the investigated strategies.

Claremont McKenna College is located in Claremont, California at 34.1 degrees Latitude. Using a software program, a sun path diagram was created to show the total solar radiation on south and west facing surfaces of a 90 degree structure. The sun path diagram reveals the maximum solar radiation potential for September and July are 450 W/m² (144 Btu/h ft²). and 530 W/m² (168 Btu/h ft²) respectively. The design peak days selected for the analysis were July 30th for the western facing windows and September 24th for the southern facing windows.

On the fourth floor of the southern façade of the college there are 0.45 m (1.5 ft.) long fins protruding from both sides of the windows. There is also a 0.45 m overhang above the windows.

The material characteristics of the fins are very important. The material should have a high reflective factor to reflect solar radiation from being absorbed into the shade. In Claremont California the peak solar intensity is 530 W/m² (168 Btu/h ft²). By allowing only minimal radiation to hit the windows, the solar gain to the space is reduced significantly. At the same time, the solar radiation penetrating the fins must be utilized to enhance the natural day lighting of the spaces.

The inside surface of the fins must also be carefully selected., If the surface has a higher reflectance than any radiation reflected from the glass, after being allowed to hit the glass, could be reflected back into the building from the shade. If the inside surface of the fins is not reflective, the solar radiation reflected from the glass will be absorbed by the fins.

The glazed surfaces of the college were carefully selected as the glass had to perform to reduce solar loads, yet permit natural day light to enter the spaces. During the winter the glazing must have a low U value to reduce heat losses. A low U value is most often obtained by having a coating on either the second or third surface of the double glazed construction. The ideal glazing is one with a balance between a high visible light transmittance and low shading coefficient. This is often a difficult compromise to maintain a clear appearance yet achieve the required shading performance.

The glazing type used in the analysis for the College was an insulating glass with a low shading coefficient of 0.32 and high visible transmittance of 62%, a winter night-time U value of 1.65 W/m² K and a summer U value of 1.42 W/m² K.

System choice

The choice of an appropriate conditioning system was based upon the required comfort compliance requirements. But the different characteristics of classrooms and offices would lead to two different conditioning systems.

Classrooms

Based upon previous design for academic buildings such as Cooper Union, we had some excellent operational feedback that would help us select a system for CMC. Each classroom was designed for 30 students, with and without computers. Experience in designing academic buildings over the years requires a flexible solution, taking into consideration the amount of students attending classes and at what time of day will the classes be held. The basis of the design is a variable volume ventilation air supply; we chose to provide 20 CFM of outside air for each person present. By providing 34 m³/h the ventilation rate qualifies for the LEED point for extra ventilation. The cooling provided by supplying 34 m³/h per student and with a maximum of 30 students in the room is nearly sufficient to maintain a space temperature of 23,5°C. But we were looking for comfort compliance so a radiant ceiling was introduced mainly for heating during the brief and relatively mild winters in California. The choice of a radiant ceiling was based upon the system being able to control radiant

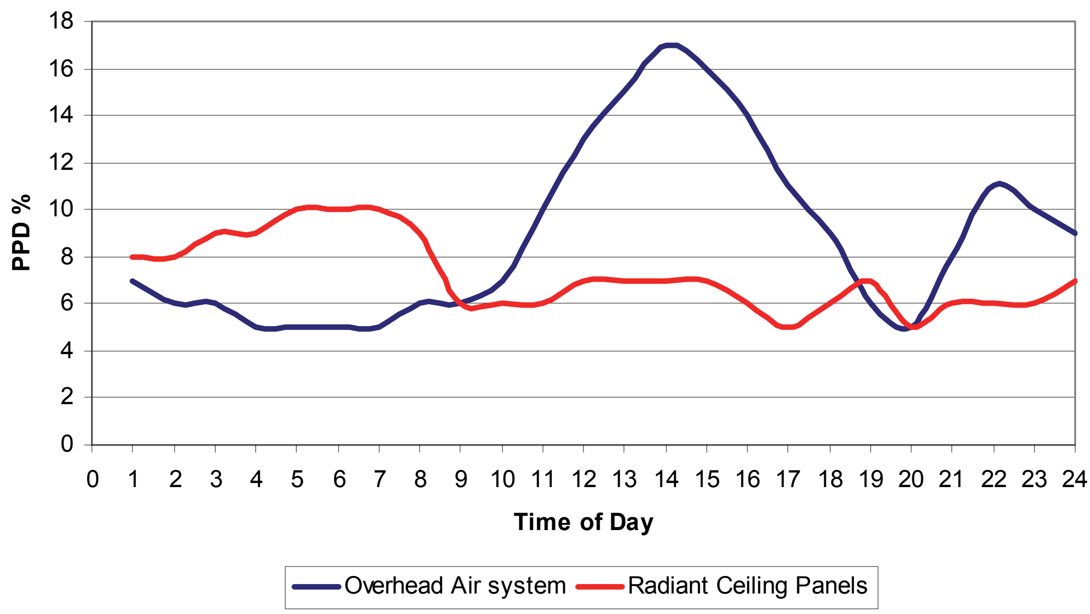


Figure 1. Percentage of people dissatisfied for different air conditioning methods for the classroom.

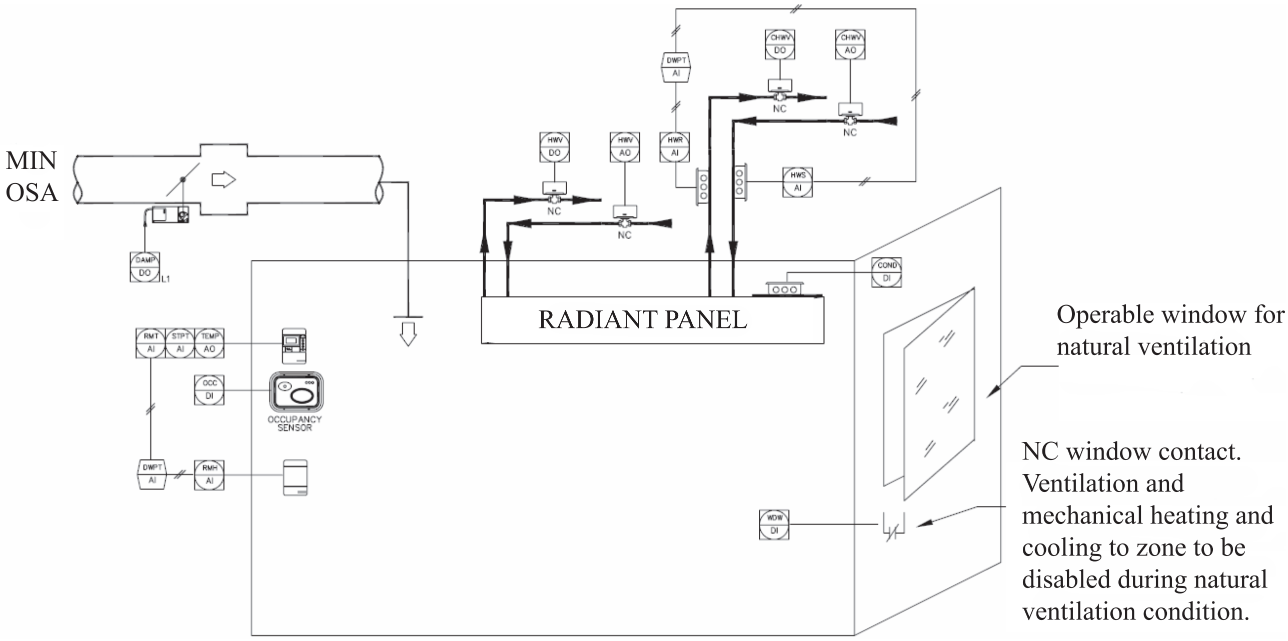


Figure 2. Controls for the classrooms and meeting rooms at CMC.

temperatures in the space, especially for the first lesson of the day and with only a minimum of students present. The radiant ceiling would provide heat to the space and control space radiant temperatures and the ventilation air would be supplied in amounts determined by individual space CO_2sensors. Another spin off from this methodology is the reduction in fan power for the ASHRAE 90.1 energy performance. Once the choice for a radiant ceiling was made, investigations then took place to look at the utilization of cooling from the radiant ceiling. It was basically the same scenario as heating, if the class was partially occupied the ventilation air would be reduced and the cooling and radiant temperature control would be performed by the radiant ceiling.

The results show that comfort conditions comply with ASHRAE standard 55 when a radiant ceiling is introduced as part of the conditioning system for the classrooms.

Offices

We decided to use active beams to condition the offices and administrative spaces at CMC. The choice was based upon our quest for occupant comfort and individual control in each space. Constant volume primary air is supplied to each beam; the sensible cooling from the primary supply air is only about 15–20% of the space sensible cooling load. The larger portion of the cooling load is provided by the control of cooled water flowing through the beam. By putting the control emphasis on the water side control of the system, the response time is improved and this increases the efficiency of the system.

Figure 3. One of the meeting rooms at CMC which is conditioned in the same manner as the classrooms.

Figure 4. Typical office space with floor to ceiling glass.

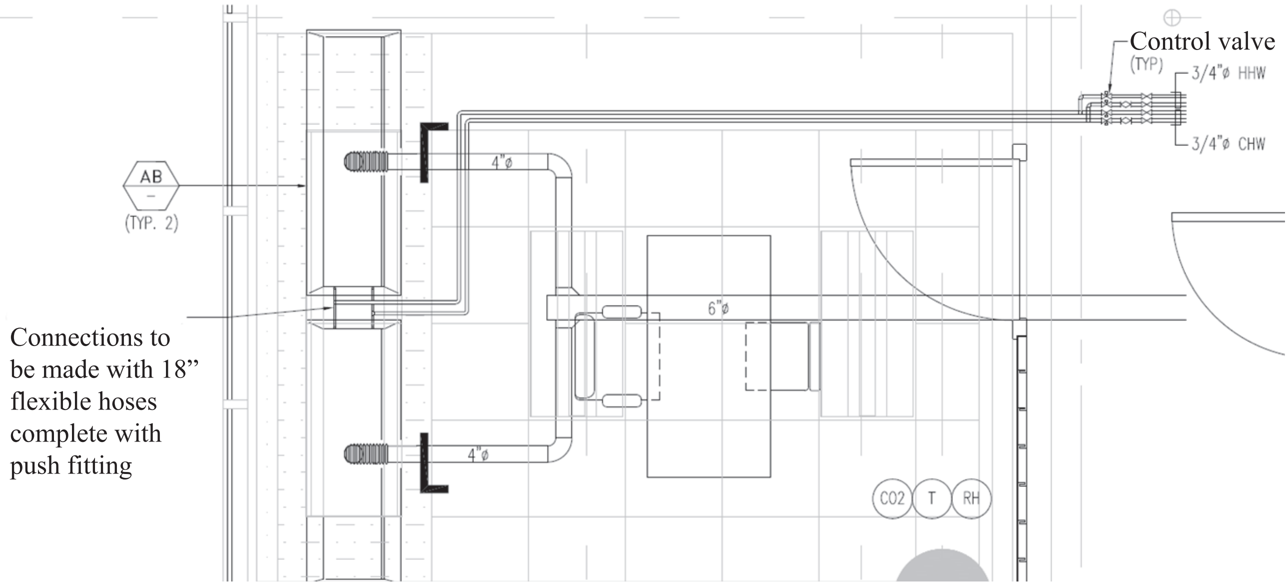


Figure 5. A plan view of the active beams and primary air connections for each space. The temperature, humidity and CO_2 sensors are also shown for each space.

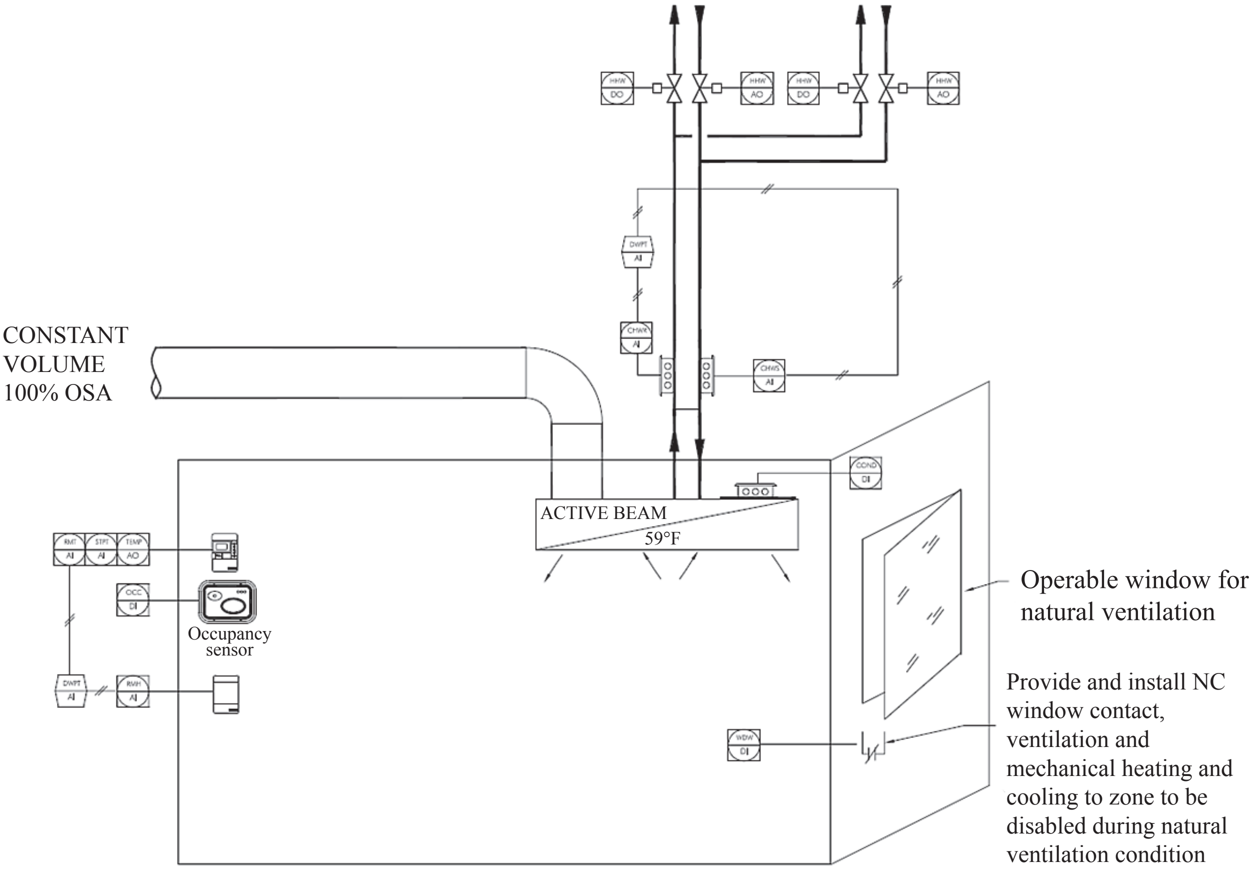


Figure 6. Control systems for offices conditioned by active beams.

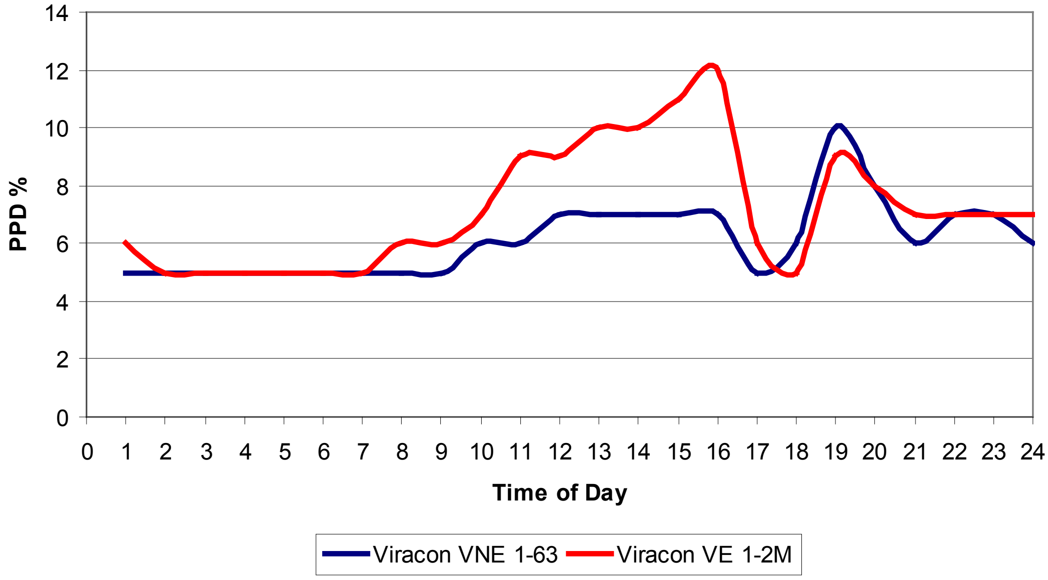


Figure 7. Percentage of people dissatisfied for two different glass types for the corner office.

Energy efficiency

A central cooling and heating plant was provided to serve this building. The central plant is located at the basement level to the north of the building.

The chiller plant consists of two 560 kW frictionless chillers. Each chiller has a variable speed primary pump. The chillers also have the capability of having their speed varied to improve efficiency. Condenser water for the chillers is cooled by a single cooling tower having variable speed fans. The condenser water loop is constant volume.

There are two variable volume chilled water loops:

1. There is a 5.5°C loop that transports water to the air handling units, CRAC units and fan coils in the IDF rooms.
2. The second loop has a variable supply temperature from 12.8°C to 14.4°C for the active beams and the radiant ceiling panels.

Two boilers each with a 580 kW capacity provide water at a constant volume to a common header.

There are two variable volume heating hot water loops:

1. There is an 80°C loop that transports water to the air handling units.
2. The second loop has a variable supply temperature for the active beams and the radiant ceiling panels.

Energy Analysis

An energy model was constructed to explore the building's performance against the California Energy Code (Title 24). This code provides a measuring stick based upon the size and use of a building.

The Reference Baseline building shell is comprised of metal frame wall with R13 batt insulation, insulated glazing with a T24 maximum shading coefficient and roofing with a R19 insulation.

Lighting systems were specified to meet Title 24 allowances of 15,5 W/m².

The Reference Baseline mechanical system was an overhead VAV system and a central heating and cooling plant as allowed by Title 24 standards.

Figure 8 shows the EnergyPro output for the energy analysis. The reference Standard Design is a building of the same size and usage built in accordance with the prescriptive requirements of Title 24. By taking the performance approach, we do not need to follow the prescriptive requirements as long as our proposed building out performs the standard building.

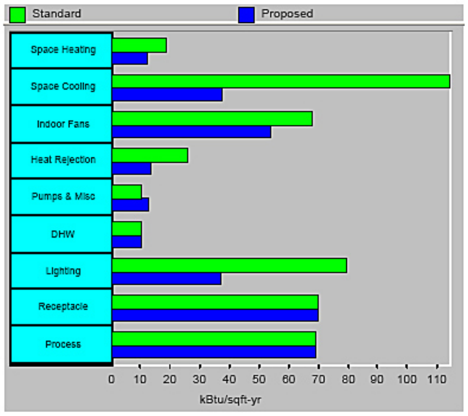
Based on the preliminary model, the proposed building is performing 32.3% better than the standard model, although the value of 37.9% better than Title 24 is used for Savings by Design as this excludes process loads.

PERFORMANCE CERTIFICATE OF COMPLIANCE Part 2 of 3 **PERF-1**

PROJECT NAME	DATE
Kravis Hall ECM 3	5/29/2009

ANNUAL TDV ENERGY USE SUMMARY (kBtu/sqft-yr)

ENERGY COMPONENT	Standard Design	Proposed Design	Compliance Margin
Space Heating	18.45	11.78	6.67
Space Cooling	113.98	37.22	76.76
Indoor Fans	67.55	53.54	14.01
Heat Rejection	25.75	13.28	12.47
Pumps & Misc.	9.92	12.36	-2.44
Domestic Hot Water	9.94	9.94	0.00
Lighting	79.07	36.90	42.17
Receptacle	69.76	69.76	0.00
Process	68.70	68.70	0.00
TOTALS:	463.13	313.49	149.64



Percent better than Standard: 32.3% (37.9% excluding process)

BUILDING COMPLIES

Figure 8. Annual TDV Energy Use Summary (kBtu/sqft.yr) compare with kWh/m^2 per year.

The building includes the following features to increase the performance of the building to exceed Title 24 minimum standards by 37.9 percent:

- High performance lighting systems in classrooms, seminar rooms, meeting room and offices, with occupancy sensors and daylight harvesting sensors.
- High performance glazing
- High efficiency frictionless chillers
- Wall insulation increased to R19 and roof insulation increased to R30.
- Daylight harvesting sensors.

For the LEED submittal the percentage of Energy savings was 63.5% and the cost savings were 46.7%, which was good for 10 LEED points. ■

Evaluation of indoor environment and energy consumption in dwellings before and after their refurbishment

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The current study investigates the impact of building renovation on the energy consumption, thermal comfort, indoor air quality and occupants´ satisfaction. Two sets of experiments were carried out. Indoor air quality was investigated in three pairs of dwellings while energy evaluation and investigation of the thermal comfort were carried out in six pairs of residential buildings. Each pair of the dwellings consisted of two buildings with identical construction; however, the building pairs were mutually different. One of the buildings was recently renovated, while the other one was in its original condition. Both objective measurements and subjective evaluation using questionnaires have been used. Temperature, relative humidity and CO_2 concentration were measured in the apartments in winter and summer period. Energy performance and thermal comfort were investigated in the heating season. The study indicates that the large-scale renovations may reduce energy consumption of the building stock. However, without considering the impact of energy renovation on environmental quality, the implemented energy saving measures may reduce the quality of the indoor environment in many apartments, especially in the winter season.

Introduction

Buildings are at the pivotal centre of our lives. The characteristics of a building, its design, its appearance, feel, and its technical standards not only influence our productivity, our well-being, our moods and our interactions with others, but they also define the amount of energy consumed by a building [1].

Energy retrofitting of the existing European building stock provides both significant opportunities and challenges. It is an important topic not only in the field of energy conservation, but it may influence the quality of life as well. People spend more than 90% their time indoors, with a significant portion of this time spent at home [2], therefore the potential impact of energy saving measures on indoor environmental quality should not be neglected. This is especially the case in countries where the trend is to reduce air infiltration by tightening the building. Changes caused by renovation can be negative or positive, and some measures will not influence indoor environmental quality at all [3].

The parameters of the indoor environment that have an impact on the energy performance of buildings as well as input parameters for the building systems design and energy performance calculations are well specified by Standard EN 15 251(2007). It defines the global comfort as the sum of different aspects, i.e. thermal comfort, indoor air quality, visual comfort and acoustic comfort. The standard also recommends parameters of indoor temperatures, ventilation rates, illumination levels and acoustical criteria for the design, heating, cooling, ventilation and lighting systems. It is mainly applicable to moderate thermal environments, where the objective is to reach the satisfaction of the occupants [4]. The impact of energy retrofitting on the indoor air quality is rarely considered. The indoor air quality may be often compromised due to decreased ventilation and infiltration rate.

This study provides an insight in the energy performance of the Slovak residential buildings and investigates impact of building renovation on indoor environmental quality.

Indoor air quality and air exchange rate evaluation

Methodologies

The study was performed in three pairs of residential buildings. One of the buildings in each pair was renovated and the other was in its original state. The energy-retrofitting included thermal insulation of facade, replacement of windows with energy efficient ones and hydraulic balancing of the heating system. The non-renovated buildings were mostly in their original state. However, new plastic frame windows have been already installed over the last years in most of the apartments in these buildings. Natural ventilation was used in all buildings. Exhaust ventilation was present in bathrooms and toilets [5].

Experimental measurements were performed during the heating season in 2013/2014 and in summer 2014. Temperature, relative humidity and the concentration of CO_2 were measured in bedrooms of the apartments using a HOBO U12-012 data logger (Onset Computer Corp., USA) and CARBOCAP CO_2 monitors (GMW22, Vaisala, Finland). The data were recorded in 5 minute intervals for one week in each building [6]. The locations of the instruments were selected with respect to the limitations of the carbon dioxide method [7]. The measurements were conducted in 94 apartments in the winter (45 apartments in original buildings, 49 in renovated ones) and in 73 apartments in the summer season (35 apartments in original buildings, 38 in renovated ones). Data from night periods between 20:00 and 6:30 were used for calculation of air change rates. Occupancy and physical state of residents were also included into the process of calculation [8].

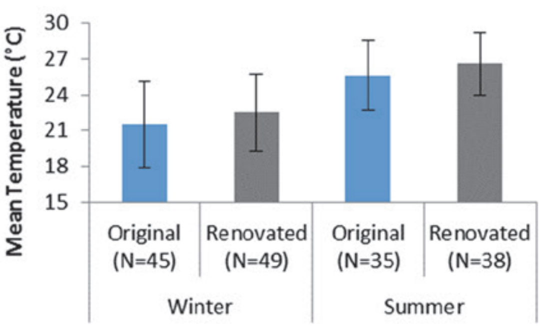
At each visit, the residents were asked to fill in a questionnaire regarding some building characteristics, occupant behaviour and habits, sick building syndrome symptoms and occupants' perception of indoor air quality and thermal environment. The occupants of the renovated buildings were also asked questions about altered habits after renovation [5].

The CO_2 concentration was used to calculate the air exchange rate during 5–8 nights in each bedroom. The occupants' CO_2 emission rate was determined from their weight and height available from the questionnaires [9].

Results and discussion

Indoor air quality

According to ISO 7730 and ASHRAE Standards, the recommended range of the indoor temperature during the winter conditions is between 20°C and 24°C [10, 11]. In the winter season the overall mean indoor air temperature was higher in the renovated buildings (22.5°C) compared to the original dwellings (21.5°C), (**Figure 1**). The indoor temperature in bedrooms was within the recommended range for most of the time in both the original (78%) and the renovated (91%) dwellings. Longer periods with average temperatures below 20°C were observed in the non-renovated buildings (18%) than in the renovated ones (2%).



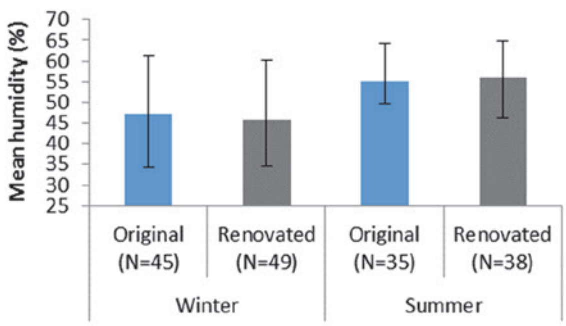


Figure 1. Average indoor temperature (left) and humidity (right) in the bedrooms of the investigated during the winter and summer season. Ends of the whiskers characterises the minimum and maximum values.

The recommended indoor temperature during summer conditions ranges between 23°C and 26°C [10, 11]. In summer the overall average temperature was 25.7°C in the original dwellings and 26.6°C in the renovated dwellings (**Figure 1**). According to the results obtained from the whole measurement period 49% of apartments in the original building and 71% of apartments in the renovated dwellings were out of the recommended range with higher indoor temperatures than 26°C. The rest of the apartments met the criteria of the guidelines.

The recommended indoor relative humidity is between 30% and 60% [11]. The mean relative humidity across almost all the apartments met the prescribed range (**Figure 1**). In winter only two apartments in the original buildings and one apartment in the renovated dwellings reported higher average relative humidity than the recommended maximum. In summer except four apartments in the original buildings as well as in the renovated ones all the apartments met the criteria on the indoor relative humidity.

In the winter the average CO_2 concentration during the nights across all apartments was higher in the renovated buildings than in the original ones. In 83% of apartments located in the renovated buildings the average CO_2 concentration was higher than 1 000 ppm, while this was the case in 75% of apartments in the original buildings. The fractions of apartments where the 20-min running average CO_2 concentrations exceeded 1 000, 2 000 and 3 000 ppm are shown in **Table 1**. In the summer the average night-time CO_2 concentrations were similar in both types of buildings [5].

Table 1. Night-time CO_2 concentrations and fractions of apartments with average CO_2 above 1000 ppm and with at least one 20-minute period with CO_2 above three cut-off values in the investigated buildings.

	Winter		Summer	
	Original N=45	Renovated N=49	Original N=35	Renovated N=38
Mean CO_2 during night (ppm)	1425	1680	845	815
Average CO_2 >1 000 ppm (%)	71	80	43	40
20-min period CO_2 >1 000 ppm (%)	75	83	43	40
20-min period CO_2 >2 000 ppm (%)	17	32	0	5
20-min period CO_2 >3 000 ppm (%)	4	8	0	0

According to results obtained from questionnaire surveys the residents in the non-renovated buildings did not indicate severe problems with the perceived air quality. During the winter, a greater fraction of the occupants indicated poor air quality in the renovated buildings compared to the non-renovated buildings (**Figure 2**). In the summer, most of the subjects in the renovated buildings found the indoor air quality good while occupants in the original buildings indicated medium to good indoor air quality in the bedrooms [5].

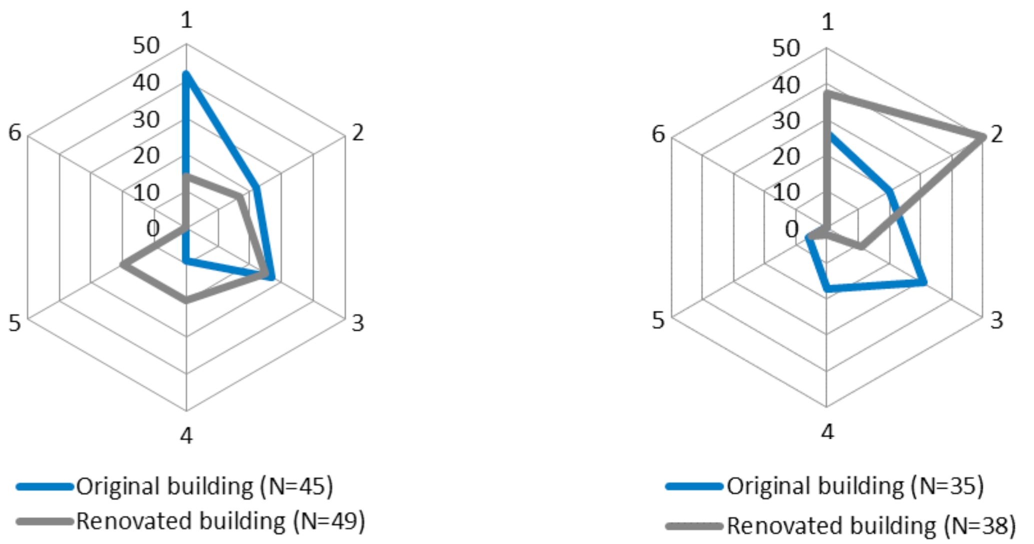


Figure 2. Summary of answers to the question "How unpleasant do you think the indoor air quality is in your bedroom during night/in the morning?". Answers were from 1 – perceived air quality was not a problem, to 6 – poor indoor air quality. One occupant in each apartment answered during winter (left) and summer (right) [1].

Air exchange rate

The average air exchange rate across the apartments in the original buildings (0.79 h^{-1}) was significantly higher than in the renovated buildings (0.48 h^{-1}) in winter. The average air exchange rates were above the minimum recommended value (0.5 h^{-1}) in 63% of apartments located in the original dwellings, unlike in the renovated ones (42%). In the summer the average air exchange rates were similar in both types of buildings [5]. The majority of the evaluated apartments in the non-renovated (97%) as well as in the renovated dwellings (94%) exceeded the minimum criteria for the air exchange rates (**Figure 3**).

Energy renovation may change the indoor environment in the dwellings. It may directly lead to lower ventilation rates and higher concentrations of indoor pollutants [12]. Ventilation rates are also influenced by the occupants´ ventilation habits. In the present study 22% of the occupants in the renovated buildings indicated that they ventilate more often during the winter than before renovation. This may indicate increased CO_2 concentrations and poorer indoor air quality associated with renovation works. The results from the summer further support this observation; 47% of residents indicated that they have changed their ventilation habits and ventilated more often than they did before renovation. People ventilate more often at higher ambient temperatures. This leads to higher ventilation rates in summer than in winter [13, 14]. The larger fraction of occupants in the renovated homes changed their ventilation habits in the summer compared to winter. This may partly explain the lower CO_2 concentrations and better perceived air quality in the renovated buildings than in the original buildings in the summer, as opposed to the winter [5].

Thermal comfort and energy evaluation

Methodologies

This part of the study was performed in six pairs of residential buildings. In each pair of the buildings was renovated and the other was in its original state. Each pair of the dwellings contained from identical apartment buildings in term of construction systems. The following Slovak structural systems were chosen: TA 06 BA, BA NKS, ZTB, BA NKS P.1.15, P.1.14, P.1.15. Building refurbishment included three energy efficiency strategies: thermal insulation of facade and roof, replacement of windows in common premises, hydraulic balancing of the heating system. The non-renovated buildings were mostly in their original state. However, in the residential part of the buildings, approximately 90% of the windows have been already replaced with energy efficient (plastic) ones [15].

Energy audit was carried out to investigate the energy performance of the residential buildings. It included inspection, evaluation and analysis of existing situation of the selected buildings. Energy need for heating was calculated for each investigated dwelling according to EN ISO 13790. Also the real data of energy consumptions were collected from the housing associations maintaining the selected buildings. The detailed steps of energy auditing are shown in publication by Dahlsveen et al [16].

The data collected from energy monitoring were processed in ENSI EAB software. Energy-Temperature diagram (ET-diagram) performed by this software was used for data analyses. It presents ET-curves tailored for quick calculations of the energy performance in original and new buildings.

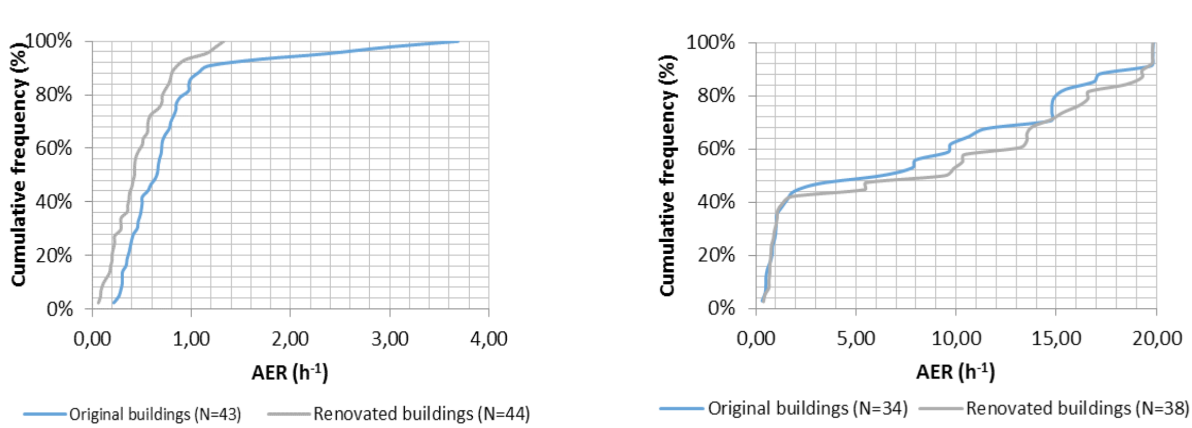


Figure 3. Cumulative percentage of air exchange rates in the original and the renovated buildings during winter (left) and summer (right).

For the purpose of the subjective evaluation two types of questionnaires were created (questionnaires used in the original and the renovated buildings). The questionnaires contained questions about basic information on the inhabitants, building characteristics, thermal comfort and local discomfort as well as about occupants´ ventilation habits. The occupants of the renovated buildings were also asked questions about altered heating and ventilation habits after renovation [15].

The evaluation of thermal environment was performed using PMV (predicted mean vote) and PPD (percentage of dissatisfied) indices. The survey asked subjects about their thermal sensation on the ASHARE seven-point scale from cold (–3) to hot (+3). Fanger's equations were used to calculate the PMV of a large group of occupants (N=244 in original; N=236 in renovated dwellings). It also took into account the occupants' physical activity (metabolic rate), the thermal resistance of their clothing, air temperature, mean radiant temperature, air velocity, and partial water vapour pressure [10].

The field measurements of indoor temperature and relative humidity were performed in the living rooms of selected apartments (N=8 in original; N=12 in renovated buildings), in period of the heating season from October 2011 to April 2012. The data were recorded in 15 minute intervals by using HOBO U12 loggers.

Results and discussion

Energy consumption and monitoring

a) Energy evaluation

The energy need for heating was calculated for each pair of the residential buildings [15]. **Table 2** shows a detailed summary of the real energy consumptions, energy needs for heating and the classification of the investigated buildings into energy classes according to the Slovak regulations. The energy saving potential was higher than 30% across all investigated structural systems with the highest percentage of difference in energy need for heating (52%) in case of T06 BA residential buildings. The real data of energy consumption were alike the results from calculation except for two structural systems, ZTB and BA NKS-S P.1.15. Noticeable difference between calculated and real values might be caused by standardized climatic conditions for Bratislava which were used in the calculation method. The real conditions are usually different from the standardized ones. In our study the real outdoor temperature was changing day to day during the heating season. As it was expected, the energy retrofitted dwellings were classified into higher energy classes than the original ones.

b) Energy monitoring

Energy monitoring was based on periodic (weekly) recording of the energy consumption data and meas-

Table 2. Summary of real energy consumption, energy calculation and energy classification of the residential buildings.

Structural system	State of building	Real energy consumption (kWh)	Difference	Energy need for heating (kWh)	Difference	Floor area (m^2)	Energy class for heating
T06 BA	Original	307433	55%	352148	52%	3723	D
	Renovated	138889		169846			B
BA NKS	Original	388956	39%	368329	34%	3980	D
	Renovated	238703		241607			C
ZTB	Original	722910	15%	843437	51%	9094	D
	Renovated	611930		409814			B
BA NKS S P.1.15	Original	476440	28%	530000	40%	6110	D
	Renovated	341469		319871			B
P.1.14	Original	367970	43%	360571	38%	4680	C
	Renovated	209278		224244			B
P.1.15	Original	239192	51%	343533	51%	3421	D
	Renovated	117890		181263			B

urements of the corresponding mean outdoor temperature. The ET-curve for each pair of the buildings was created to compare the results between the actual state of energy consumption in the original buildings and the optimal energy consumption in the retrofitted ones. The ET-curve was created for each investigated building type. **Figure 4** shows an example of ET-curves for the structural systems T06 BA and P.1.14.

The solid line represents buildings in the original condition and the dot line characterises the retrofitted buildings. The curve consists of two parts. The sloping line presents energy consumption of the heating system and the horizontal one shows energy consumption of the domestic hot water (DHW). The energy of the delivered DHW was not inquired into detail. It was calculated based directly on floor area. This method is characterised by the assumption that there is a linear relationship between the DHW demand and the floor area of the building [17].

Thermal comfort

The greater fraction of occupants indicated slightly warm and warm thermal sensation in both types of buildings, with higher percentages of "warm (+2)" thermal environment in the renovated dwellings (50%) compared to the original ones (30%). Regarding the thermal preferences of occupants´, higher percentage of respondents preferred warmer thermal environment in the non-renovated dwellings (31%) compared to the responses from occupants in the retrofitted buildings (8%). The majority of occupants were satisfied with

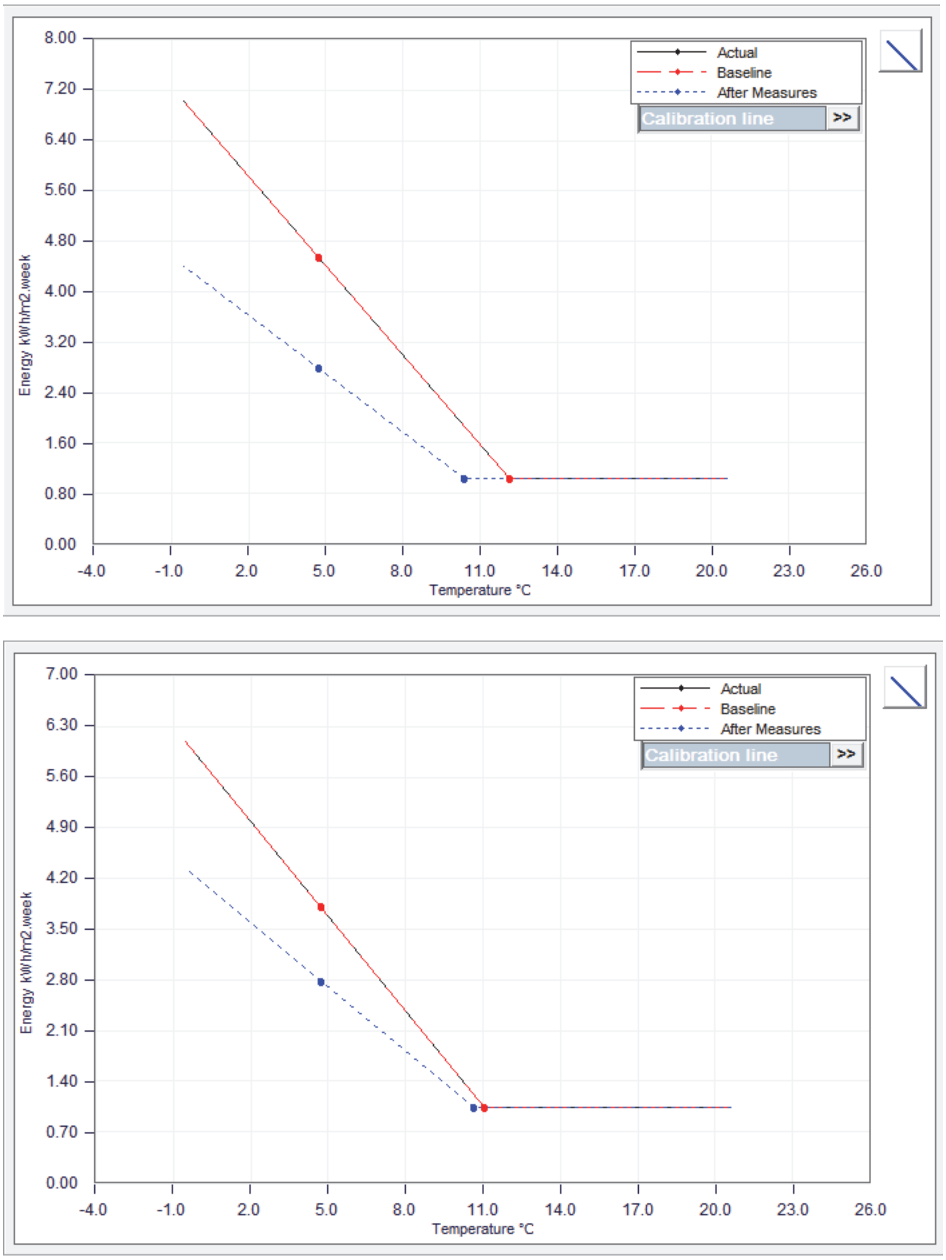


Figure 4. ET-curve for the the structural systems T06 BA (top) and P.1.14 (bottom).

the ordinary state of the air temperature in both types of the dwellings (**Table 3**), [15].

Indoor air temperature and relative humidity were classified by categories according to EN 15 251 (**Figures 5 and 6**). The overall mean air temperature was lower in the original dwellings (22.8°C) compared to the renovated ones (23.7°C). In case of the non-renovated buildings the air temperature was fluctuating between Category I and Category III, with mainly presented temperature range from 22°C to 24°C. In buildings after renovation the temperature was ranging from 23°C to 25°C. The measured relative humidity corresponded to Category II. Visible decrease of the relative humidity occurred from 1.2 2012 to 15.2 2012 when the outdoor temperature was ranging between –5°C and –10°C. The relative humidity was between 30% and 50% in the retrofitted buildings and it was mostly corresponding to Category III. The percentage of the time when the measured data were out of the limit are negligible in both types of the buildings [18, 19].

Table 3. Thermal sensation (left) and the thermal preferences (right) in the investigated residential buildings.

Thermal sensation	Original buildings (N=244)	Renovated buildings (N=236)
Mean	0.8	1.4
SD	1.1	0.9
Hot (+3)	2%	5%
Warm (+2)	30%	50%
Slightly warm (+1)	34%	28%
Neutral (0)	23%	15%
Slightly cool (–1)	9%	2%
Cool (–2)	2%	1%
Cold (–3)	1%	0%

Thermal preference	Original buildings (N=244)	Renovated buildings (N=236)
Mean	0.2	0
SD	0.6	0.4
Want warmer (1)	31%	8%
No change (0)	61%	85%
Want cooler (–1)	8%	7%

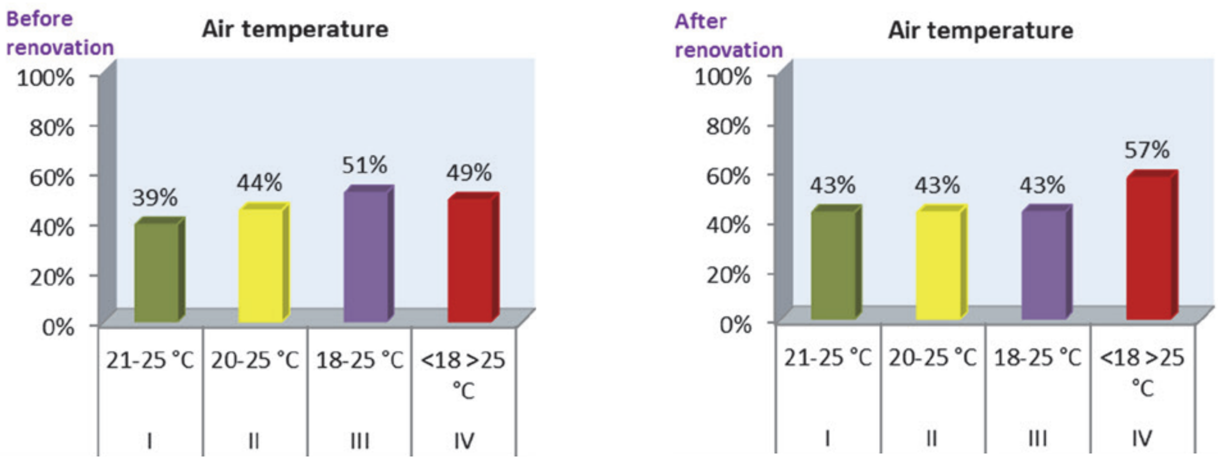


Figure 5. Classification of the air temperatures according to EN 15 251 in the original (left) and retrofitted (right) residential buildings.

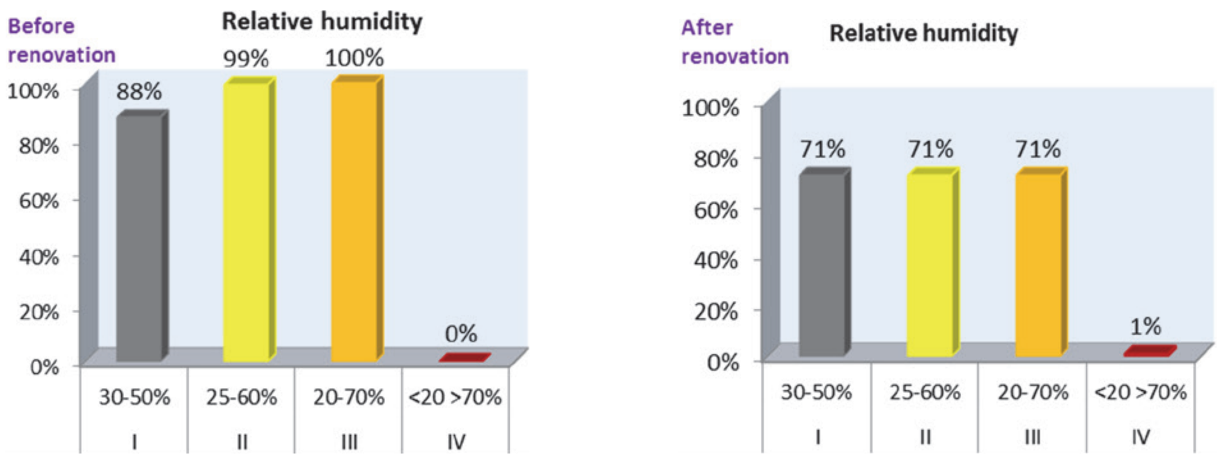


Figure 6. Classification of the relative humidity according to EN 15 251 in the original (left) and retrofitted (right) residential buildings.

Conclusion

Energy retrofitting can contribute significantly to reduce energy consumption of buildings. On the other hand, without consideration of its effects on indoor environmental quality and people as well as without properly made renovation plan it may reduce the quality of the indoor environment in the apartments, especially in the winter season. Unless measures are taken against decreasing ventilation rates during the reconstruction process (e.g. installing exhaust ventilation or mechanical ventilation), the occupants need to ventilate more in order to improve the indoor air quality to the level it was before the reconstruction. ■

Acknowledgements

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Ventilative cooling design for a large office building

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In the last two decades, the use of natural ventilation in office buildings has been slowly increasing. The best contemporary designs combine natural ventilation with conventional mechanical cooling. When properly designed and implemented these hybrid approaches maximize natural ventilative cooling potential while avoiding overheating during the warmer months.

Keywords: natural ventilation, hybrid ventilation, computational fluid dynamics (CFD), thermal simulation, EnergyPlus.

Introduction

In the mild to warm climate of southern Europe office buildings without operable windows require mechanical cooling during most of the year. This need is the direct result of poorly designed facades that allow for excessive solar heat gains, combined with high internal gains and low exposed thermal mass. These characteristics lead to excessive cooling energy demand in a context of increased public awareness of the environmental and operational costs of building energy consumption. As a result, most current building thermal codes limit the predicted annual energy demand for heating, ventilation and air conditioning systems (HVAC). In the building design phase these predictions result from thermal simulation models with variable levels of detail and approximations. The most complex buildings require models with several thermal zones and, in some cases, tri-dimensional computational fluid dynamics simulations (CFD). In addition to the verification of code compliance, thermal and airflow simulations are used to predict the performance of complex building systems. In tall office buildings natural ventilation is complex system due to the need to compensate for wind velocity increase with height. Many recent designs use a hybrid approach that combines natural ventilation with traditional HVAC solutions. If properly implemented this combined approach maximizes energy savings while avoiding overheating during the warmer months and cold draft complaints in the colder days.

The next pages describe the role of thermal and airflow simulation in the design process of a recently completed hybrid cooling system of an office tower in Lisbon (Portugal), using natural ventilation in combination with a traditional overhead HVAC system. **Figure 1** shows the proposed seventeen-story building (total floor area of 23 000 m²) that includes a small public park in the ground level. The surrounding area is composed by high-density mid to high-rise buildings.

Regulatory framework

As in all EU member states, the Portuguese building thermal and energy consumption code stems from the current version of the EPBD (2010). The code promotes the use of natural ventilation in low-rise buildings by allowing for prescriptive compliance based on minimum ventilation opening areas in each room (5% of floor area). For buildings with more than four stories the code requires performance based compli-

Figure 1. Rendered views of the building (Northwest, South and interior).

ance, typically demonstrated using dynamic thermal simulation or wind tunnel studies. High rise buildings with hybrid cooling and ventilation systems must achieve the following performance standards:

- The building must be able to operate in natural ventilation mode for 70% of the occupied time in a typical year (natural ventilation with no mechanical cooling or heating).
- During the natural ventilation period the maximum CO_2 level cannot exceed 1 250 ppm in more than 10% of the days (each day is evaluated using an 8 h daytime average CO_2 level).

The building energy rating is obtained by dividing the predicted annual energy consumption by the predicted consumption for a building with the same form but standard façade and building systems (no natural ventilation, external shading, no daylight responsive systems), an approach that follows ASHRAE 90.1. In this rating, buildings with hybrid cooling and ventilation have the advantage of using extended space temperature set points in the simulation: 19–27°C, compared to 20–25°C for the reference building and buildings with mechanical ventilation.

Thermal and airflow simulation

The building has a complex corrugated skin that creates two perpendicular distinct orientations in each façade. This geometry brings particular design challenges:

- For each main façade orientation, defining which of the two orientations should be opaque or glazed.
- Defining the required shading systems for orientations with high solar incidence that needed to be glazed (due to valuable views towards the river).
- Assessing the increase in pedestrian level wind velocity in the ground level public park.

In addition to façade optimization the use of a hybrid cooling system created additional design challenges:

- Selecting the most adequate natural ventilation strategy (single sided or cross-ventilation).
- Positioning and sizing the ventilation openings.
- Predicting the natural ventilation system performance.
- Predicting the energy saving potential.

To analyse this diverse set of questions we used three interconnected simulation tools: Ecotect, thermal simulation (EnergyPlus) and computational fluid dynamics (CFD, PHOENICS). The dynamic thermal simulation (EnergyPlus) incorporates results from the other tools: the facade geometry was optimised using *Ecotect* and the wind driven airflow velocities that drive the single-sided natural ventilation system were predicted by CFD (**Figure 2**). These CFD simulations were also used to assess the effects of the obstruction created by the new building on the ground level wind velocity.

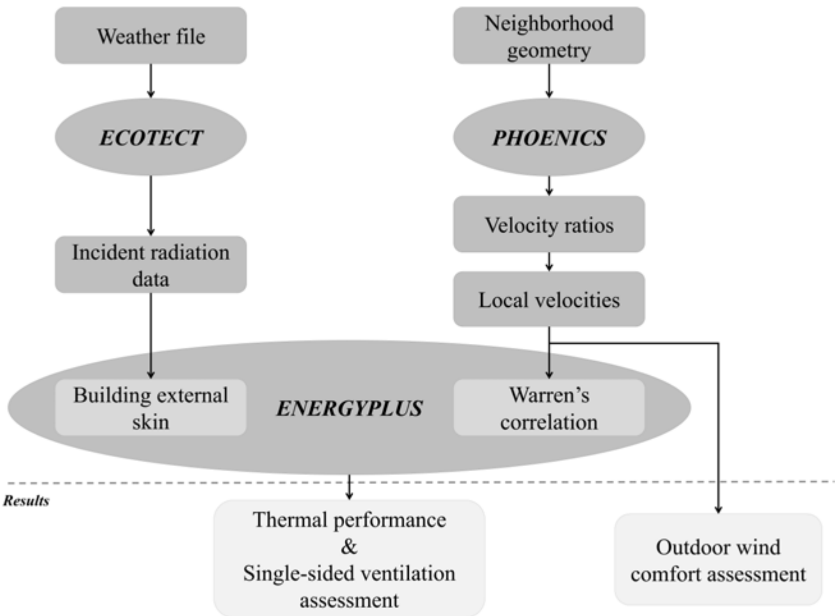

Figure 2. Interrelated simulation tools used in this study.

Pedestrian wind comfort criteria

The construction of a high-rise building in an urban area that was previously vacant always results in narrower pedestrian level wind flow paths that normally increases the maximum wind speeds that pedestrians are subjected to. Since there is no Portuguese standard to assess these problems this study uses the Dutch standard NEN-8100 to evaluate this problem (Willemsen et al., 2007). This standard defines three qualitative classes of comfort (good, moderate and poor) whose wind speed limits depend on the expected outdoor activity (traversing, strolling or sitting). The analysis was based on CFD simulation and focused on six locations in the adjacent plaza.

Optimization of building skin

The base optimization of building skin used the 3D analysis tool *Ecotect* to predict annual cumulative solar incidence for the two perpendicular orientations that exist in each façade. In each façade, the orientation with more than 300 kWh/m² of incident solar radiation was selected to be opaque. The result of this analysis is shown in **Figure 3** (the grey bars indicate the closed portions of the façade). In the southern facing facades, the cumulative solar incidence is high in both orientations. In these cases, the orientation with the worst view was opaque and an external shading system was proposed for the orientation with the best view (the effect of the shading system is shown in red in **Figure 3**).

Natural ventilation strategy and airflow simulation

The use of cross-ventilation in high-rise buildings can be problematic because the large pressure differences that develop across different facades easily lead to excessive internal air velocities. In this building, the geometry and expected internal layout with many single offices steered natural ventilation strategy into a single-sided geometry (SS). The wind driven component of the SS ventilation was modelled using the simple expression proposed by Warren in 1985:

$$Q_w = 0.1 \cdot A \cdot U_L \quad (1)$$

Where U_L is the velocity parallel to the façade. For a given incoming wind speed and direction this velocity depends on the building and surrounding geometry. The ratio between the undisturbed wind velocity (available in the local weather data file) and U_L was calculated in a set of CFD simulations. Equation 1 was implemented in EnergyPlus that was used to predict the building thermal and natural ventilation performance and size the conventional HVAC system.

CFD simulation

The CFD simulations used the commercial software package of PHOENICS, to predict airflow around and near the building facade for eight wind directions (cardinal and intercardinal). The geometries for each alternative wind direction were obtained by rotating the

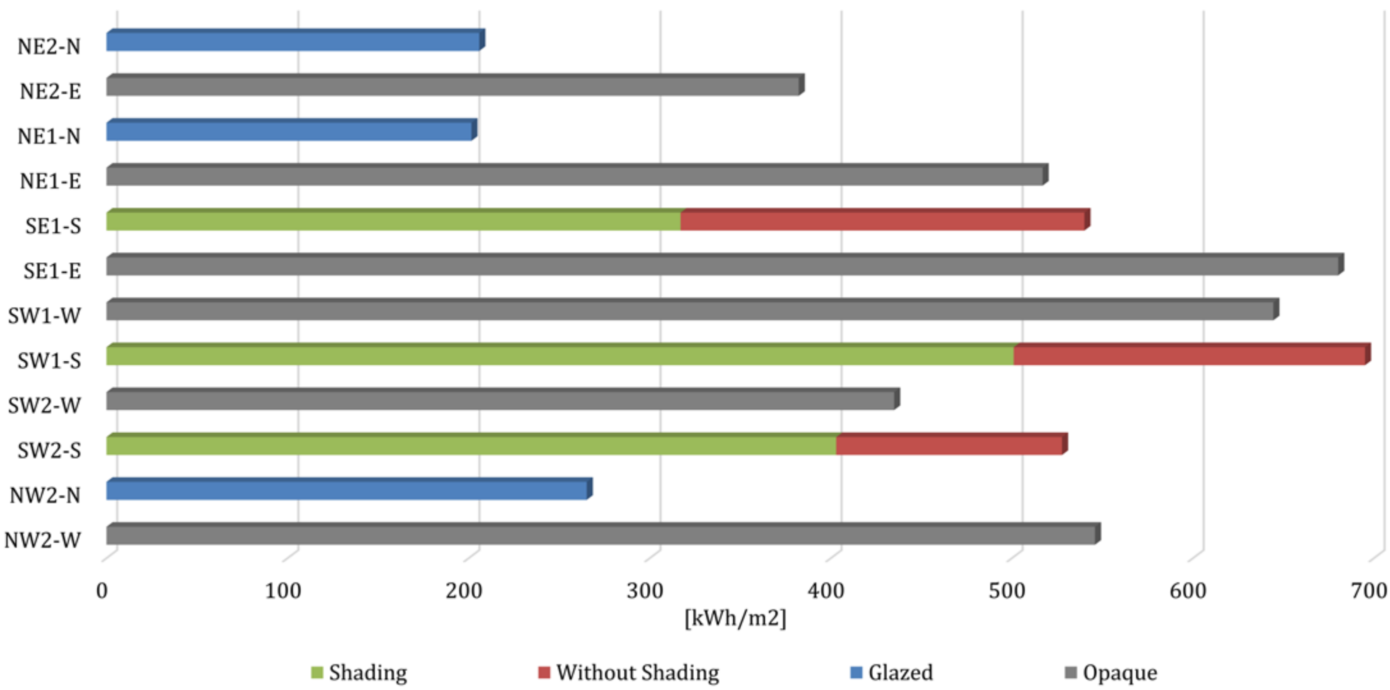

Figure 3. Predicted incident solar radiation for the twelve orientations in the façade.

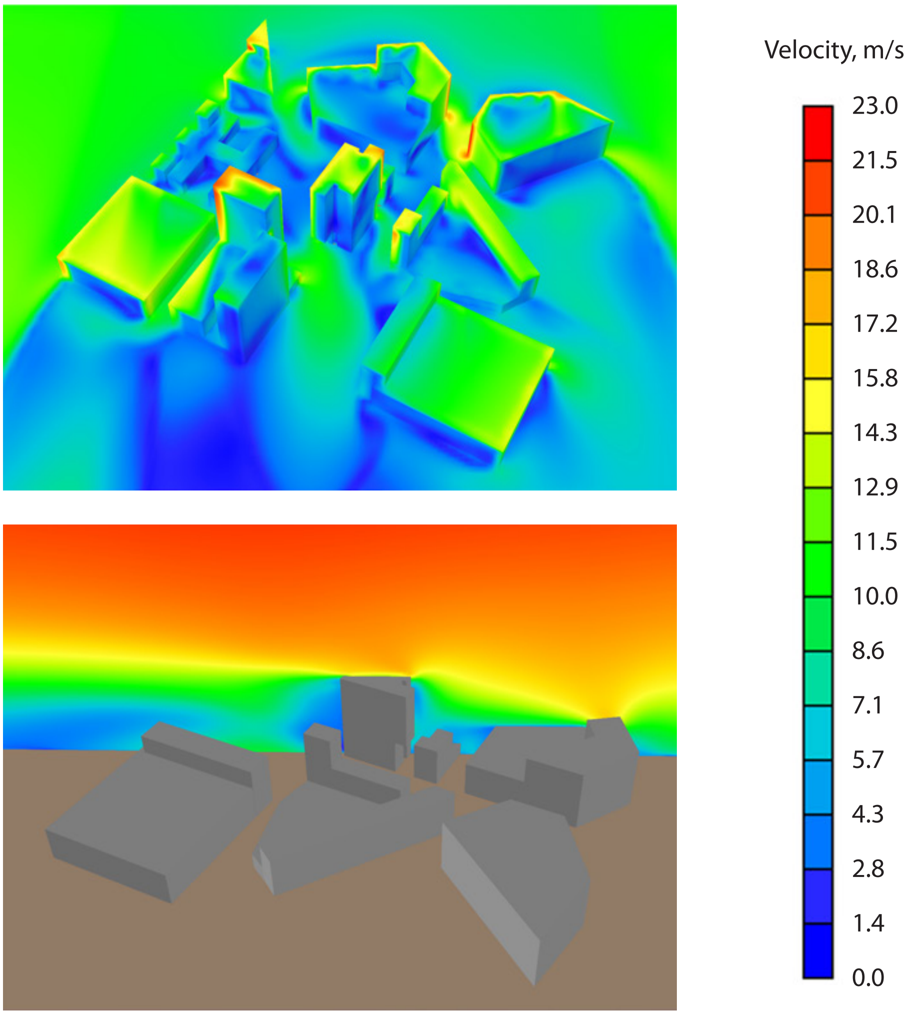

Figure 4. Predicted wind velocities for North incoming wind direction (Top and East views).

neighbourhood/building model inside the simulation domain (45°). The simulations use the k-ε turbulence model, which has been extensively tested for this type of flows (Martins, et al., 2012, Carrilho da Graça et al., 2004, 2012). A logarithmic inflow wind profile was used at the inlet with a wind speed of 10 m/s at a reference height of 10 meters. The bottom of the simulation had a roughness of 0.75 (Blocken et al., 2008). In each simulation the average wind velocities generated near the façades and in the adjacent outdoor spaces were calculated in total of 23 planes. In the façade planes located in three heights (low, mid and high floors) of each main using a control surface spaced 30 cm from the wall and had a height of 4 m by a length of 10 m (spanning two adjacent offices). In the adjacent park, five control surfaces were distributed in North, East, South, West and centre locations.

The pedestrian wind comfort assessment showed that 75% of the adjacent park area achieves an A grade classification (good). Unfortunately, the combination of the new building and an existing tower results in airflow acceleration near the Southern edge of the park where the predicted outdoor comfort index reaches D (moderate comfort for traversing).

Thermal simulation

The dynamic thermal simulations were performed in the open source thermal simulation tool EnergyPlus (average precision of 1.5°C, Mateus et al., 2014). **Table 1** shows the four increasing efficiency simulation scenarios considered in this study.

Table 1. EnergyPlus scenarios description.

Scenario	Description
I	Fully glazed exterior facade
II	I+50% glazed exterior facade
III	II + South shading
IV	III + SS natural ventilation

The forth scenario has bottom hang inward opening windows with a height of 1.5 m and a width of 0.95 m. The simulation used a simplified geometry model of a single floor with periodic boundary conditions (Lerer et al., 2013). The opaque portion of the façades integrates the natural ventilation openings, allowing for the use of an uninterrupted fully glazed section in the transparent orientation. The net opening area of the window is 0.5 m² resulting in an opening to office floor area ratio of 3.8% (below the minimum prescriptive compliance opening area of 4%). The internal set point temperature for scenarios I to III was 20°C – 25°C. As discussed above, scenario IV used an extended range of 19°C – 27°C (as allowed for hybrid buildings). **Figure 5** shows the predicted HVAC energy consumption for each scenario. The overall building optimization process results in a 60% reduction in HVAC energy consumption (total variation between scenario I and IV). The natural ventilation system is responsible for half of this reduction (30% of the HVAC energy consumption). In order to insure 100% thermal comfort hours a mechanical cooling and ventilation system is needed for 24% of the occupied hours. EnergyPlus was also used to simulate and demonstrate compliance with the regulations. The indoor CO_2 levels simulation results indicate that, as expected for a narrow plan building, the natural ventilation system can maintain indoor air quality for 100% of the annual occupied hours.

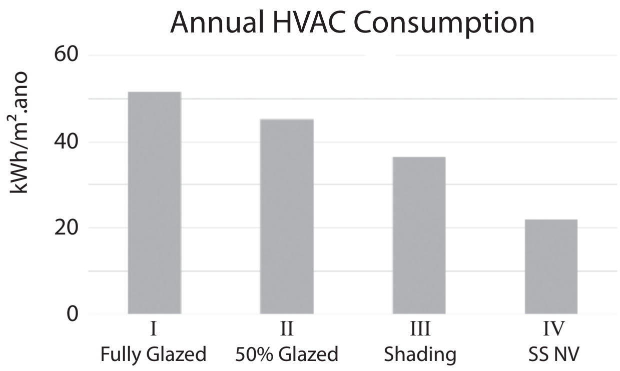

Figure 5. HVAC consumption for an averaged floor.

Conclusion

In most European climates, natural ventilation offers the most potential for reducing CO_2 emissions associated with cooling of office buildings. In spite of the present and other existing examples of natural ventilation use, its potential lies largely untapped. In the present case, this reduction is 30%, approximately half of the total reduction obtained in this optimization study. The combined simulation approach used in the design was able to reduce the uncertainties that are usually associated with natural ventilation systems. ■

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The new Eurovent energy efficiency label for central ventilation units

The energy efficiency requirements for air handling units are increasing. Apart from the increased customer needs, legal energy efficiency requirements regarding central ventilation units have tightened too. According to the Ecodesign Directive for ventilation units (EU) No 1253/2014, new minimum energy efficiency requirements shall apply from January 2016.

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The purpose of an energy label is to indicate to customers or users the energy quality of a product in order to help them with their purchase decision. The Eurovent Energy Efficiency Labelling for central ventilation units has become firmly established in Europe. After using the former Eurovent Energy Label /1/ for a six-year period, the new legal minimum energy efficiency requirements with regard to these products make an update of the energy labelling imperative. Moreover, the requirements of the Ecodesign Directive have been incorporated in the new Eurovent Certification and the energy classifications. The new energy efficiency classes apply from January 2016. Furthermore, a new Eurovent energy efficiency class A+ is being introduced, characterising devices with the currently highest available energy efficiency level. In the lower efficiency range, the classes "C" and "D" correspond roughly to the legal minimum requirements for ventilation units.

In general, the Eurovent calculation process for the definition of the energy label has not undergone significant changes. The criteria for the calculation of the energy label are still the thermal efficiency and the pressure drop of heat recovery, the air speed in the cross-section area of the ventilation unit as well as the efficiency of the fans in their operating points. The possibility of compensation between the individual requirements as well as the consideration of different climate zones remained unchanged. Changes have been implemented regarding the energy requirements for the achievement of efficiency classes as demonstrated in **Table 1**.

Table 1. Criteria for the definition of the Eurovent energy label classes for air handling units.

Class	max. air speed (m/s)	min. efficiency HRV (%)	max. pressure drop HRV per airway (Pa)	min. efficiency level ventilator NG_{ref}
A+	1.4	83	250	64
A	1.6	78	230	62
B	1.8	73	210	60
C	2.0	68	190	57
D	2.2	63	170	52
E	–	–	–	–

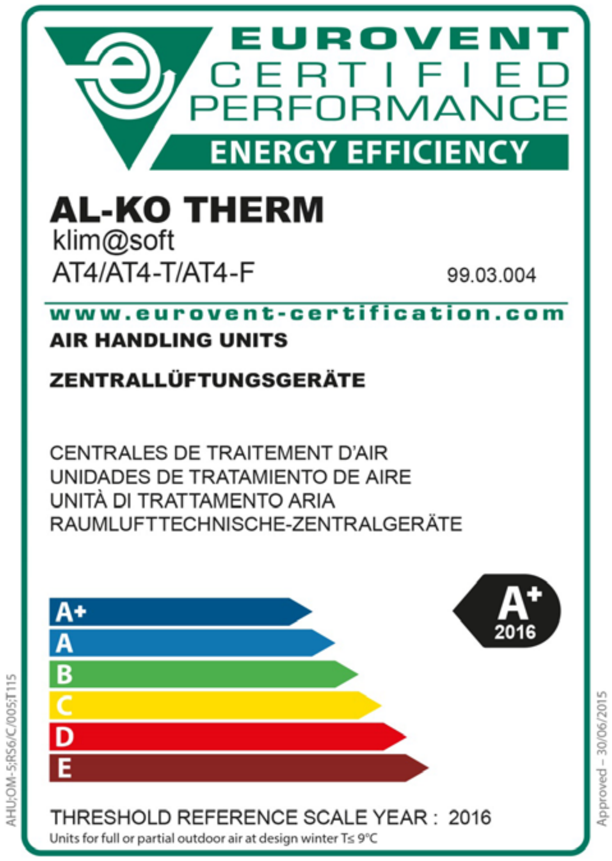
For ventilation units of the highest efficiency class "A+" ambitious criteria apply. It should be noted here that the required temperature efficiency of at least 83% can no longer be described in economic terms with all available heat recovery processes. While it can be realised with rotary heat exchangers and reverse flow exchangers (only in the lower air flow range), these values cannot be depicted economically with the heat transfer systems and cross-flow plate heat exchangers with the available technology today.

Table 2. Simulated operating costs for air handling units of the same performance from different energy efficiency classes.

Costs	Efficiency class according to Eurovent					
	A+	A	B	C	D	
Eta-HRV	83%	78%	73%	68%	63%	(--)
$PM_{V,ZUL}$	6.98	7.21	7.44	7.83	8.56	(kW)
$PM_{V,ABL}$	6.04	6.23	6.43	6.76	7.4	(kW)
Electricity	30 834	31 829	32 847	34 552	37 796	(€)
Cooling	4 606	4 698	4 697	4 877	5 216	(€)
Heating	1 879	5 153	8 383	11 491	14 325	(€)
Total	37 320	41 660	45 927	50 920	57 337	(€)
Saving	35%	27%	20%	11%		

The legal minimum efficiency for ventilation units from 2016, equipped with a heat recovery system (HRE > 63%) corresponds approximately to class "D". Appliances which feature a plate or rotary heat exchanger according to the Ecodesign Directive (HRE > 67%) correspond approximately to class "C". The provision for complying with the legal minimum Ecodesign requirements is also reviewed by Eurovent during the annual recertification process.

How can the best way to use an energy label be established for customers or users? The presentation of the energy and eventually economic differences between appliances in single efficiency classes demands a comparison of the life cycle costs, i.e. the calculation of the total operating costs of an air handling unit over a time period of e.g. 5 years. **Table 2** shows results of such calculations for air handling units of different energy efficiency classes. All appliances have an air supply performance of 14,500 m³/h and operate 5 days a week, 12 h daily (supply air winter = 22 °C, supply air summer = 18 °C). Electricity and thermal energy costs were estimated as follows: Electricity 13 cent/kWh, Heating 0.065 cent/kWh, Cooling 0.040 cent/kWh. The qualities of heat recovery and air supply were changed in air handling units.



Eurovent energy label class A+ (2016).

Table 2 shows that approximately 10% of the operating costs can be saved for air handling units per better energy class. This means that when an appliance belonging to energy class A is used instead of one belonging to class C, around 20% of energy costs are saved. However, this statement cannot be generalized as the sample calculation applies only to standardized operating hours and defined energy costs. An assessment of profitability requires that investment costs be included too in order to arrive eventually at the right purchase decision. ■

Certified Performance Database as a tool for quality and compliance

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The fields of Heating, Ventilation, Air-Conditioning and Refrigeration (HVAC&R) have been experiencing a very challenging regulatory and normative background in the past years. In this context it is often hard for manufacturers, consultancies and end-users to have a clear view of the quality and compliance of HVAC&R components, products and systems. The Eurovent Certified Performance (ECP) certification has been used for now more than 20 years to provide guidance on the real performance of HVAC products in the European market.

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European database of certified performance for HVAC&R components, products and systems

All certified references and performances are listed in an online directory freely available (www.eurovent-certification.com). This directory gathers more than 300 certified trademarks and more than 50,000 references.

For each product category characteristics and certified performances are listed according to the same data structure and the latest European and international standards. This allows finding and comparing the certified data easily and with the assurance that the data have been checked.

Example of use

The availability of such database allow to get reliable and exhaustive set of performances which can be used to assess some trends of the market over time.

As an example the evolution of the energy efficiency of Fan Coil units can be seen in the **Figure 1** below. A Eurovent energy efficiency classification was created in 2011 for these products based on their average energy consumption at three different speeds[1]. It can be seen that there is a clear trend towards better energy efficiency as the energy classes are moving from classes E and D to C, B and A.

1 For a detailed description of the Eurovent energy efficiency classification for Fan Coils units see RS 6/C/002-2015 and RS 6/C/002A-2015 available at www.eurovent-certification.com

Another example can be found regarding the energy efficiency of air filters. For these products a Eurovent energy classification has been put in place since 2012. This classification is based on the estimated annual energy consumption derived from the average pressure drop of the filter[2]. A more classical way to assess the energy consumption of an air filter is to look at its initial pressure drop. The **Figure 2** below shows the evolution of both the mean initial pressure drop and the mean annual energy consumption for the certified F7 bag filters of a constant panel of manufacturers between 2011 and 2015.

Unlike what has been seen for Fan Coil Units the evolution of the mean energy efficiency is not linear during this period: the energy consumption and the initial pressure drop increases to reach a maximum in 2013 and then it decreases until 2015. This behaviour can be explained knowing the standardization context behind. A revised version of the European testing standard was introduced in 2012 and applied in the Eurovent certification programme first in 2013. This revised version introduced stricter requirements for F7 filters related to the discharge efficiency (see EN 779:2012). In order to fulfil this new requirement European manufacturers had to improve the filter media in order to increase the filtration efficiency. As a consequence the mean pressure drop of the filters increased. After the introduction of the new standard the pressure drop started to decrease as manufacturers are seeking to propose to their customers more energy efficient products.

Other use of certified performance database

Database of certified data can be used in many instances: tax incentives, national implementation of EPBD, building energy labels, green public procurements, white certificates. As certified performances provide confidence in the quality and the compliance of the products they can be required in voluntary schemes (e. g. building energy labels, green public procurements, white certificates) or being considered with an advantage over non certified products in regulatory schemes (e.g. national implementation of EPBD).

Example of such use can be found in the French Building energy efficiency calculation method which applies a penalty for non-certified heat-pumps and air to air heat exchangers. Consultancies use approved software in order to assess the compliance of a building

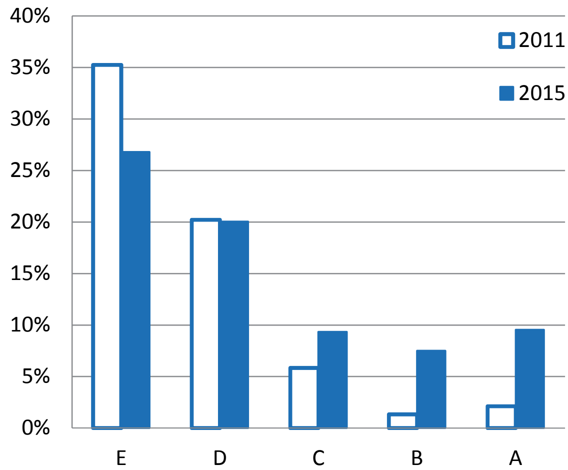

Figure 1. Evolution of the distribution of the energy efficiency class for Fan Coil units between 2011 and 2015.

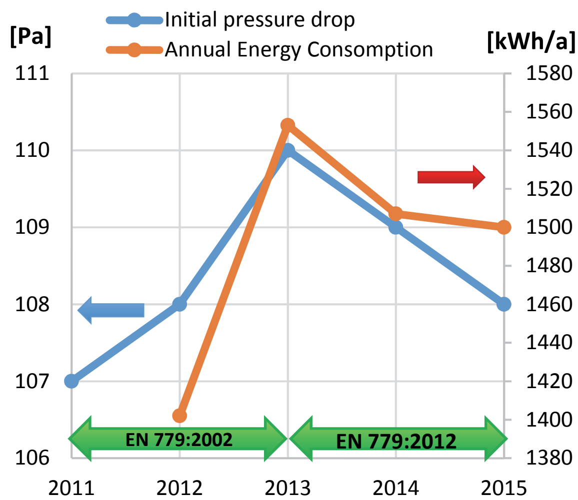

Figure 2. Evolution of the energy efficiency for F7 bag filters between 2011 and 2015.

with the French EPB regulation (RT 2012). This software is linked to database of products which are fed directly with Eurovent certified performance data.

Conclusion

The challenging normative and regulatory background in the fields of HVAC&R induces a complex environment. Assessing the quality and compliance of products is therefore more and more difficult for end-users. In this context the Eurovent Certified Performance online directory provides an easy and straightforward way to get up to date, trustful and exhaustive data. Such information can be (and are already) used in various voluntary and regulatory compliance schemes. ■

2 For a detailed description of the Eurovent energy efficiency classification for Air Filters see RS 4/C/001-2015 available at www.eurovent-certification.com

New challenges for heat pump certification

FRANÇOIS-XAVIER BALL
Managing Director
Eurovent Certita Certification

There is no doubt that the heat pump technology has now reached a prominent position in Europe in the field of heating, air conditioning and hot water production and the number of marketed units is expected to keep on increasing on next years. Just as an example, in France, the biggest market in Europe at the moment regarding heat pumps, more than half of all newly built houses are equipped with heat pumps. Even though the currently low prices of oil make power driven products less competitive at first view than previously compared to other solutions relying on fossil fuels, this is more than balanced by the need to reduce the carbon print and to improve energy efficiency. This development has triggered a proliferation of new products and technologies, the performances of which it is all the more important to be able to compare and ascertain. This is the duty of product certification and moreover, the broader and more competitive the market is, the more efficient and reliable the certification must be. It is proposed in this paper to show how the different certification schemes managed by Eurovent Certita Certification are responding to the current situation and to describe some recent breakthroughs.

Product certification, what for?

Product certification is a conformity assessment whereby a third party- the certification body - issues a statement that fulfilment of specified requirements has been demonstrated for a given product [1]. Typically in the field of HVAC-R this encompasses the voluntary certification of the performances of products which are published by the certification body after implementation of a process including verification tests and assessment audits. The first aim of product certification is to provide confidence to the market and all the stakeholders thanks to an assessment carried out by an independent third party. As a result it actually enables to compare the properties of products on the basis of the same reference standards and incentive schemes used to foster energy efficiency are often referring to certification. As far as recognition and independence are concerned, it is critical to distinguish third part certification from other schemes. Accreditation against ISO 17065 [2], the relevant international standard, is the ultimate, internationally recognized proof of the competence and impartiality of a certification body. It can be seen as the certification of certification bodies and is viewed by the European Commission as "*part of an overall system, including conformity assessment and market surveillance, designed to assess and ensure conformity with the applicable requirements*" [3].

Different certification marks for different expectations

Eurovent Certita Certification (ECC) is a top European accredited third party certification body active in the field of indoor climate, ventilation and air quality as well as refrigeration and food cold chain. We have been certifying heat pumps for years, which is shown on the market by the 2 voluntary certification marks (**Figure 1**).

Figure 1. The 2 certification marks granted by Eurovent Certita Certification for heat pumps.

The Eurovent Certified Performance (ECP) mark has been granted by our company since 1995 and has gained a very large international recognition: 66% of HVAC-R products sold in Europe are ECP certified.

The NF mark is a French mark of conformity owned by AFNOR, the French member of CEN and has been used for more than 60 years in the framework of hundreds of certification programmes. The programme related to heat pumps [4] has been developed and managed since its inception by ECC.

The reason for proposing different certifications for a single family of products is that the 2 schemes are responding to different market expectations. Indeed, although it is based on European product and testing standards, the NF mark is tailored to the needs and demands of the French market, including specific input for the thermal regulation. Whereas the ECP mark [5] is providing its wide international recognition on a larger market which uses the same set of European standards.

On top of that, Eurovent Certita Certification has recently developed a European Heat Pump certification programme, "**Euro Heat Pump**" which is a bridge between the NF Heat Pump programme and the ECP mark. It allows to obtain both certifications through a single entry point and using the same set of verifications. We are thus offering to manufacturers a cost effective, one stop certification.

A brief history of Heat pump certification by Eurovent Certita Certification

Recent events and breakthroughs which happened for the different programmes managed by ECC are shown on **Table 1**, with some of them being further commented elsewhere in the paper.

A world of proliferating technologies

To pay heed to various climates and respond to quite different demands related to residential buildings but also collective ones or industrial facilities, manufacturers are using the whole range of available technologies when producing and marketing heat pumps. This is seemingly a never ending process where what is at stake is increasing the versatility of products whilst improving their energy efficiency. The development of certification must follow the same pace and be in line with the evolution of technologies, lest its link with the market is severed.

Table 1. A brief history of Heat pump certification: recent milestones.

Date	Event
2007	Introducing ESEER(European seasonal energy efficiency ratio) in the Eurovent Programme for Chillers and Heat Pumps.
	Launching the NF Heat Pump programme.
2012	Extending certification to dual service heat pumps.
2013	Extending certification to gas heat pumps.
	Introducing certification of seasonal performances.
2014	First certification of hybrid systems.
2015	Extending certification to heat pumps producing collective sanitary hot water.
	Creation of the Euro Heat Pump programme, first certificates granted on spring 2015. An agreement between Eurovent Certita Certification and DIN CERTCO enables to grant up to 3 quality marks through a single entry point.

Table 2 shows the different technologies of heat pumps and related products currently covered by the certification programmes managed by Eurovent Certita Certification.

Table 2. Technologies and operation modes under the scope of programmes managed by ECC.

Technologies of heat pumps	Operation modes
Air to air	Heating and cooling modes
Air to water	Dual mode: space heating and sanitary hot water production
Water to water	
Brine to water	
Gas fired absoption and adsorption heat pumps	
Swimming pool heat pumps	
Production of collective sanitary hot water Hybrid systems using heat pumps	
Other related thermodynamic devices	
Rooftop units	
Variable refrigerant flow (VRF)	

For certification programmes to cover all these technologies or operation modes, just using the relevant standards and updating the test methods are not enough, otherwise for instance one would end up asking for an irrealistic number of verification tests. This is where the know- how of the certification body and the expertise of its network of laboratories are crucial to set up the appropriate balanced process providing confidence in the certified values on the basis of a time and cost acceptable programme. An example of such an approach is given, *infra*, for heat pumps operated in dual mode.

The Ecodesign whirl

To reduce energy consumption the European union has decided to introduce requirements for energy efficiency and to set up energy labelling with new energy classes. The corresponding general framework is given in the two European Directives 2009/125/EC [6] and 2010/30/EU[7], and requirements are further described in a number of regulations, including the Ecodesign Regulations Nos 813/2013 [8] and 814/2014[9] for space heaters and combination heaters on the one hand and water heaters and water storage tanks on the other hand. These regulations have deep consequences on the market, where the less performant products will gradually vanish.

For heat pumps one of the major changes is the introduction of seasonal performances which take into account the fact that during the whole year a thermodynamic system works according to the needs at part load conditions and for specific climates.

Thus, since 2013, nominal performances (EER for cooling mode and COP for heating mode) according to EN 14511[10] standard are gradually been replaced by seasonal performances (SEER and SCOP respectively) according to EN 14825 [11] standard.

To enable comparing results from different technologies, a seasonal energy efficiency is introduced, using a conversion coefficient *CC* to express it in terms of primary energy.

For instance, for heat pump space heaters and heat pumps combining space heating and hot water production, the seasonal space heating energy efficiency is expressed as:

$$\eta_s = \frac{SCOP}{CC} - \sum F(i),$$

where CC = 0.5 and $F(i)$ are corrective factors.

For heat pumps, the provisions related to Ecodesign and Ecolabelling have been in force since September 26th, 2015 and will be strengthened and enlarged from 2017 onwards.

Coping with these regulatory changes is a real challenge for product certification because in many cases new test methods have to be used to determine the efficiency in terms of seasonal performance.

Eurovent Certita Certification manages its certification programmes so as to anticipate regulatory evolutions and especially revise reference documents to be in line with the implementation of the Ecodesign and Ecolabelling directives.

Here are some recent examples:

- 2010: thresholds for sound power levels (indoors and outdoors) are introduced for NF Heat pumps,
- From January 1st, 2013: for ECP certified air conditioners ≤ 12 kW, SEER and SCOP have to comply with the eco-design thresholds,
- Autumn 2014: SCOP and η_s can be certified for NF Heat pumps,
- December 2014: the ECP programme for chillers and heat pumps includes the certification of SCOP and η_s.

Versatile products and hybrid systems

One of the most notable and growing current trends is the development of versatile systems achieving several different functions, for instance space heating and hot water production as in the case of dual mode heat pumps. Some of them are using different types of energy, such as typically hybrid heat pumps combining a fuel or gas boiler and a heat pump. These latter systems can in some cases be controlled so as to switch from one type of energy to another depending on the outdoors temperature or on the power cost, allowing therefore to optimize the energy efficiency and the overall operating costs. The first “NF Multi energy” certificates have been granted on November 2014

These breakthroughs offer a real challenge to product certification, because the great quantity of components (heat pumps, storage tanks, exchangers…) and of their possible combinations can result in a very large amount of marketed systems which are quite long and expensive to test. Among the array of means Eurovent Certita Certification is using to address this issue, one of the most promising is the use of predictive models.

If we take the example of certified dual mode heat pumps, the systems are first classified by ranges, depending on the technologies of the main components and on their sizes (see **Figure 2**).

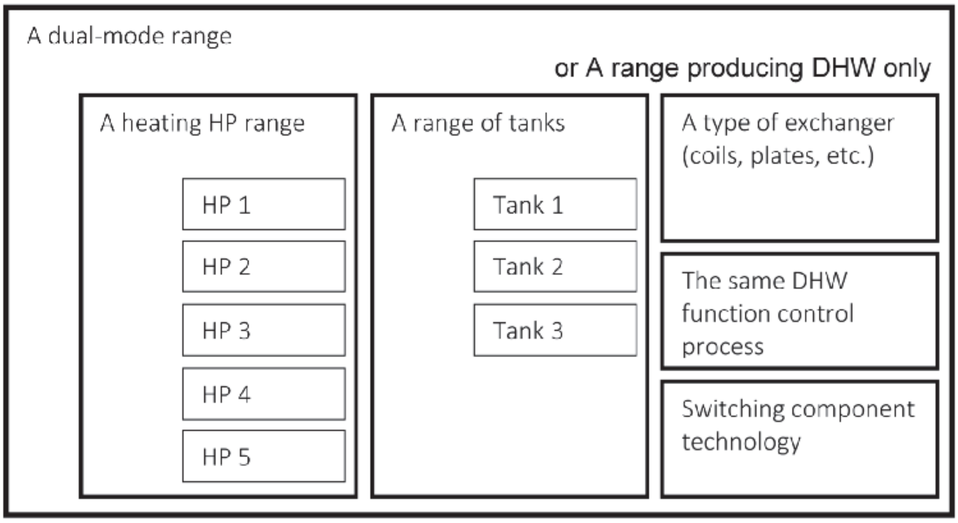

Figure 2. definition of ranges of NF certified dual mode range or domestic hot water (DHW) heat pumps.

For a given range of models, the performances are determined from testing one model and using simulation for the other models. Once the simulation tool has been validated on the basis of an appropriate assembly of test results, it allows to decrease dramatically the number of needed tests.

A truly European coverage

It was once said that Europe will not be actually built when all European people speak one single language, but when they all speak several European languages. To some extent it is such an approach which is followed by Eurovent Certita Certification: we promote certification at the European level while acknowledging local recognition of influential brands, in keeping with the demands of the market. It is the reason why the Euro-HP programme was launched under the Eurovent Certified Performance brand on 2015, on the basis of NF Heat Pump specifications, with dozens of manufacturers having now their heat pumps performances published on our web site [5]. This is also underlying the cooperation agreement Eurovent Certita Certification has signed on 2015 with the German certification body DIN CERTCO to broaden its certification offering as summarized on **Figure 3**. In the framework of this agreement, the first DIN Plus certificates were granted on November 2015.

Figure 3. A one-stop shop for 3 certification marks.

The overall result of this continuous certification development is shown on **Table 3** where the numbers of certified models are given per technology of heat pumps.

Table 3. Models of certified heat pumps per technology (Dec.2015).

Type	Number of models certified by Eurovent Certita Certification
Space heating or cooling	
Air/air	2,860
Air/Water	13,400
Water/Water	3,660
Glycol Water/Water	305
Dual service	505
Rooftop units	470
Variable Refrigerant Flow	185
Total number	**21,385**

Conclusion

Product certification is a key point on the heat pump market as it is necessary to bring confidence between all stakeholders. However to deliver in a fully satisfactory way, it has to evolve in line with the development of new technologies and systems and to anticipate regulatory constraints as well as market expectations. Eurovent Certita Certification has taken up this challenge and is the leading European certification body for heat pumps on a business area where Ecodesign requirements and market surveillance are focused on transparent and reliable product performances. ■

References

[1] ISO/IEC 17000: 2004- Conformity assessment — Vocabulary and general principles.

[2] ISO/IEC 17065: 2012 - Conformity assessment — Requirements for bodies certifying products,processes and services.

[3] Regulation No 756/2008 of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products and repealing Regulation No 339/93. *Official Journal of the European Union – L218, 13.8.2008 –p. 30 - 47.*

[4] http://www.certita.fr/en/certita-mark/nf-heat-pumps

[5] http://www.eurovent-certification.com

[6] Directive 2009/125/EC of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products. *Official Journal of the European Union* – L 285, 31.10.2009, p.10-35.

[7] Directive 2010/30/EU of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products. Official Journal of the European Union – L 153, 18.6.2010, p. 1–12.

[8] 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. Official Journal of the European Union – L 239, 06.09.2013, p.136-161.

[9] Regulation (EU) No 814/2013 of 2 August 2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for water heaters and hot water storage tanks. Official Journal of the European Union – L 239, 06.09.2013, p.162-183.

[10] EN 14511 – 1 to -4: 2013 - Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling.

[11] EN 14825: 2012 - Air conditioners, liquid chilling packages and heat pumps,with electrically driven compressors,for space heating and cooling - Testing and rating at part load conditions and calculation of seasonal performance.

Certified thermal performance testing provides value for money and has a proven positive impact on the actual system cost

Looking at value for money through myopic eyes blinds reality to expectation, decrease your payback time with Eurovent certification. This article demonstrates the impacts of system economics and how by focusing on the first cost, melts away those perceived benefits like snow on a sunny day.

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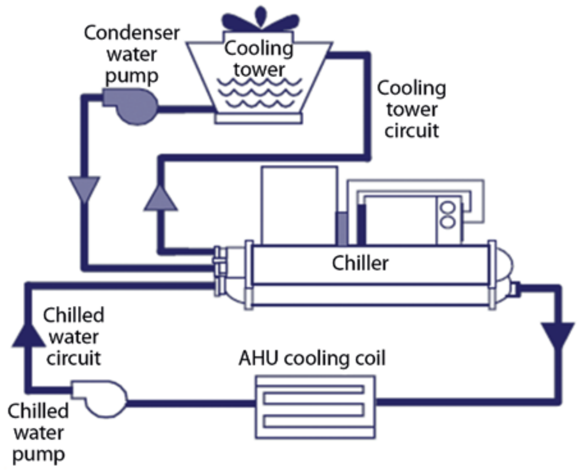
The principle "value for money" is probably as old as human trade and whilst it sounds simple and straight forward, we consider that in reality it is not always straight forward for what a customer expects. Indeed, verification of the real value can be a challenge; verification of quantities, dimensional data, weight, etc. are comparatively easy to assess, but what about the performance of a cooling tower operating in a HVAC plant?

Before we address the problem of performance verification, let us analyse the impact of an underperforming cooling tower using a numerical example of an industrial HVAC application operating year round with a load variation from 100% in summer to 80% in winter. The cooling tower for this application would be selected for a summer condition to cool 52 l/s of water from 32°C to 27°C at an entering wet bulb temperature of 21°C. The cooling capacity to be rejected would be **1,090 kW** in this case.

The cooling tower delivering the required performance, let us designate it as "**Model 100**", would be 3.6 m long, 2.4 m wide and 3.5 m high with an absorbed fan power of 28.5 kW, a 30 kW fan motor would be installed and the overall sound power level of "Model 100" being 93 dB(A).



Now let us analyse this model compared to a cooling tower which would only deliver 80% of the required duty. This cooling tower (we will designate it as "**Model 80**") could be 20% smaller in physical size or alternatively, it would have the same physical dimensions as "Model 100", however the required fan power is only 20 kW and hence the fan motor installed would only need to be 22 kW. This example focuses on the last option for ease of comparison. In addition, the declared overall sound power level for "Model 80" would be 91 dB(A) instead of 93 for "Model 100". Also the "Model 80" could be available at a slightly lower price.

The question: "Which unit gets ordered" is rhetoric unless the customer knows that "Model 80" under-performs. In order to know that, however, it is not sufficient to look at dimensional data and face values for fan power and sound.

Before we discuss how such verification can be achieved, let us see what the effect of an underperforming "Model 80" provides. What will happen at design conditions and more importantly, what will be the knock-on economics effect on an annual base?

Performance at design conditions.

For the 1,090 kW, which has to be dissipated at 21°C wet bulb, "Model 80" will supply water 1.2°C warmer than that designed. It will take a wet bulb of 19.3°C to supply the required 32°C / 27°C water temperatures. Two deductions can be drawn from that:

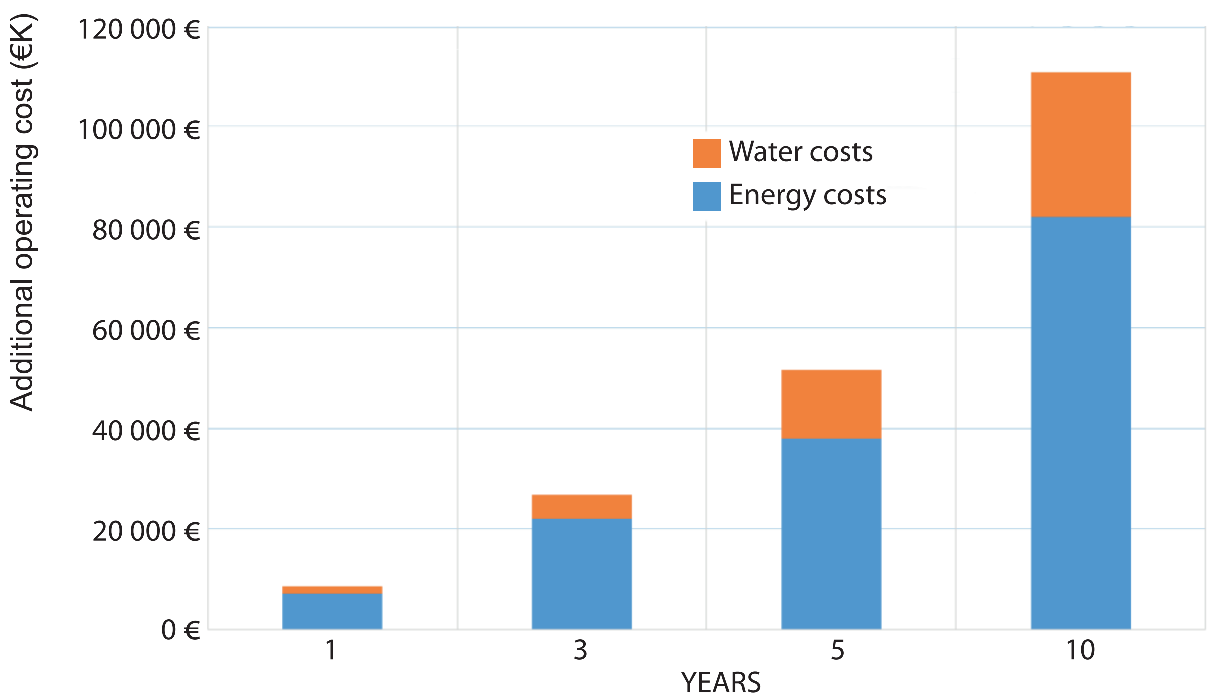
- The installed chiller will not totally stop due to excessive high pressure; due to the 1.2°C warmer water the chiller will unload and capacity will suffer, however it will not fail. Final result will be some loss of comfort or in the case of industrial applications, some slowdown of the production process will for sure take place.
- In typical Mid European climates there will be less than 100 hours when the wet bulb temperature is higher than 19.3°C spread over a few summer days.

Based on those deductions, it is fair to say that on first sight the underperformance does not create a catastrophe or send alarm bells ringing. In fact, there may be several years of bad summers, where design water temperature conditions are never exceeded. So, after all, could it be said that the problem is not so big?

The magnitude however can only be answered if we look at the annual economic impact. With the information we have up to now, we can only say: "Yes, you can get away with offering cooling towers, which deliver only 80% of the required performance". The chances that an operational problem occurs due to the capacity shortage are nil and unless a performance test reveals the true situation, the chances you getting caught are very small.

Under such conditions the likelihood that manufacturers may take risks when stating the performance of their cooling towers is high. Owners may not even challenge their performance data due to the fact that

Cumulative 10 year additional operating cost for 'Model 80' compared to ' Model 100'



Note: Both energy & water costs include an assumed 3% year on year inflation rate price increase

they say: "We never had a problem before." However, we know now that, whilst it may be so that the problem is not noticed, it does not mean that it is not there!

Performance year round.

What we do not know yet is: What is the magnitude of the problem? As mentioned before, we can only answer this question, if we look at the economic annual impact of underperformance. For that we will use the "Models 100 and 80" from the previous example and the industrial HVAC year round load profile varying from 100% capacity requirement in the summer to 80% in the winter. Both cooling towers will use variable frequency drives and run with a concentration factor of 2.5.

The fan kWh requirement for "Model100" will be 55,540 kWh and for "Model 80" it will only be 50,800 kWh, due to the smaller fan motor of the underperforming "Model 80". However, look at the electrical energy needed for the chiller: For the "Model 100" we need 1,114,360 kWh, but for "Model 80" the chiller requirement goes up to 1,178,700 kWh, which is almost 6% more. If we therefore add up the chiller and fan kWh the "Model 80" still needs 5% more electrical energy on an annual base. At a typical cost rate of 0.12 €/kWh this represents an annual operating cost addition of 7,152 €.

In addition to that, there is more water consumption for "Model 80" because the chiller has to work harder hence more waste energy has to be dissipated and more water will evaporate. In our example "Model 80" will consume per annum 500 m^3 water more. If we take the very modest cost for water supply, sewage and chemicals (3 €/m^3), this adds another 1,500 € per year.

The total operating cost for water and electricity for the system with "Model 80" is 8,652 €. This is probably about half the first cost of the new cooling tower. It is clear that an initial small price advantage of the "Model 80" which may exist; melts away those perceived benefits like **snow on a sunny day**.

Conclusion

Value for money does not just come by looking at dimensional data and published values of certain consumables and emissions. What needs to be challenged is the self-declared thermal performance especially if it has never been independently tested or certified. An acceptance test according to a recognized standard is the minimum needed to take out the guesswork in believing the declared thermal performance, but for that the cooling tower needs to be purchased and installed. What now if the tower fails in the test? Penalties, compensations? For sure long and unpleasant discussions, possibly legal action and at the end of all of that the owner is still stuck with a faulty cooling tower.

The smart way to handle this problem is to select a cooling tower which has Eurovent Certified Performance (ECP mark) via 3rd party controlled outside or internal lab testing.

Only then the owner is sure prior to purchase that they will not have higher operation costs due to underperformance.

Certified thermal performance testing removes risk to obtain system economics and removes guess work, it also removes the problems of litigation, penalties & compensation should an already purchased product be found to underperform, because by then it's too late!

Look for the Eurovent Certified Performance mark to make that intelligent Cooling Tower selection decision. ■

European Certification of HVAC&R products

ERICK MELQUIOND
President
Eurovent Certita Certification

Discover a top European Third-party certification body dedicated to guaranteeing worldwide consumers comfort and satisfaction via product performance certification.

Today, professionals face new challenges in complying with the objectives of carbon footprint reduction and addressing the constraints of building code regulations that require precise calculations based on performance data.

In addition, with the rising costs of energy and the growing demand for cooling in buildings, supermarkets, or data centers, monitoring energy consumption is becoming key to reduce both the financial and environmental impact.

In this challenging and fast-moving context, reliable product performance has become a main driver for business decisions and product investments. When it comes to reducing the energy bill, third-party certification offers a real value.

Trusted as a highly skilled and experienced partner, Eurovent Certita Certification has positioned itself as the number one Third-Party certification provider in Europe in the field of Indoor Climate, Ventilation and Air Quality, Process Cooling & Food Cold Chain.

Based on a voluntary scheme, our certification is open to all manufacturers as well as to distributors who can apply via our Brand Name scheme. We deliver independent and reliable expertise for residential, commercial, and industrial applications. We certify product performances according to both European and international standards, and our certification processes include yearly factory assessment audits, software audits, and third-party product testing.

Whether in response to the rapid growth of hybrid systems involving multiple energy sources or technologies, or to new directives and regulations, Eurovent Certita Certification's mission is to continuously adapt its programmes, methods, and protocols to meet the expectations of the market and its stakeholders.

Consultants, buyers and contractors benefit from a fair and competitive market, supporting the dimensioning of energy efficient projects

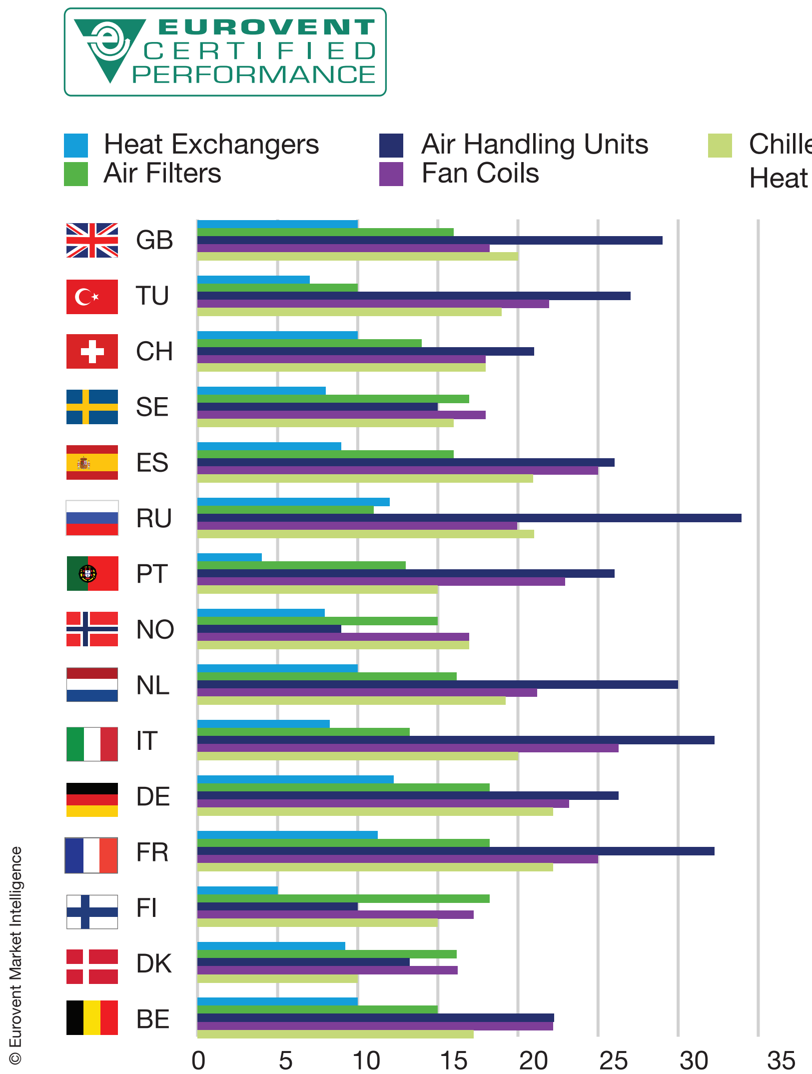
Commercial buildings consume 40% of all electrical energy; with the introduction of the Energy Performance Building Directive (EPBD) in Europe, reducing energy consumption is one of the challenges consultants and contractors have to face. Dimensioning projects that assess the energy consumption of buildings and highlight its true cost quickly illustrate the power and value of certified data.

The purpose of Eurovent Certita Certification is to create common set of criteria for rating products, that apply to all manufacturers, thus increasing the integrity and accuracy of data while ensuring the needed level of transparency to guarantee a fair and competitive comparison. With over 95,000 models certified, our database provides professionals with all the information needed to dimension equipment and match the technical constraints of the specifications with the financial target of the project.

Third-Party certification enables compliance monitoring to achieve environmental goals

Performance data certified by Eurovent Certita Certification is instrumental for State authorities to enable compliance monitoring. It provides valuable data to document and track market information. Eurovent Certita Certification is an accredited certification body, trusted to deliver a consistently reliable and impartial service which meets the appropriate, internationally recognised standards.

MANUFACTURERS THAT SELL EUROVENT CERTIFIED PRODUCTS - 2014 (in number) - Examples for 5 family products



Third-Party certification offers guarantees of integrity, independence, impartiality and competence while remaining compliant with European Competition Laws.

Product performance certification delivered by Eurovent Certita Certification plays a key role to ensure transparency and deliver high quality and reliable data

Our commitment in adding value along the renewable energy decision chain goes one step further and extends to **installers, household buyers or contractors** for whom we are implementing on-line tools to support them at every stage of their projects, from the quotation to the filing for local incentives or tax rebates.

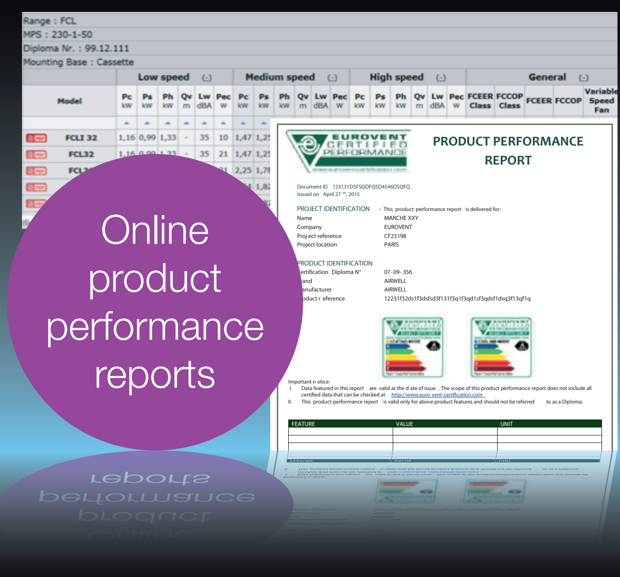
Regardless of whether the expected benefits are technical, financial, competitive, organizational or process-oriented, there are many reasons to look at Eurovent Certita Certification.

With this special ACREX issue of the REHVA Journal, we welcome the opportunity to present 20 years of Third-Party performance certification expertise and know-how. ■

Integrity, Independence and Impartiality

- We operate with the commissions responsible for the harmonisation and the integrity of our certification programmes, including authorities, end-user groups, scientific and technical bodies, and manufacturer associations.
- All 30 laboratories and testing agencies that are a part of the Eurovent Certita Certification process are regularly assessed according to ISO 17025. They are located in 11 countries worldwide.
- Our testing protocols include independent tests, manufacturing audits, selection software checks, product sampling, product purchasing, cross data coherence algorithms per product family, and product dismantling after testing.

By a simple, 24/7 connection to our website **www.eurovent-certification.com** you can download **Product Performance Reports** that provide detailed performance features and values such as the **COP (Coefficient Of Performance)** or the **Sound Power Level.**



EUROVENT CERTIFIED PERFORMANCE
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CERTIFICATION PROGRAMMES

FOR DOMESTIC, COMMERCIAL AND INDUSTRIAL FACILITIES

Indoor Climate	Ventilation & Air Quality	Process Cooling & Food Cold Chain
European Heat Pumps	Air to Air Plate Heat Exchangers *	Cooling Towers
Chilled Beams *	Air to Air Regenerative Heat Exchangers *	Cooling & Heating Coils
Close Control Air Conditioners *	Air Handling Units *	Drift Eliminators
Comfort Air Conditioners *	Air Filters Class M5-F9 *	Liquid Chilling Package & Heat Pumps *
Rooftop (RT) *	Residential Air Handling Units (RAHU)	Heat Exchangers *
Fan Coils Units *		Remote Refrigerated Display Cabinets
Variable Refrigerant Flow (VRF) *		

* All models in the production have to be certified

▼ Indoor Climate

European Heat Pumps

Scope of certification

- Electrically driven heat pumps for space heating (incl. cooling function)
- Electrically driven heat pumps used for heating swimming pool water (outdoors or inside)
- Dual-mode heat pumps, i.e. designed for space heating and domestic hot water production,
- Gas absorption heat pumps (incl. cooling function)
- Engine-driven gas heat pumps (incl. cooling function).

Certification requirements

- Qualification campaign : 1 audit/factory + tests depending on products declared
- Repetition campaign: 2 machines/year + 1 audit/year/factory

Main certified characteristics and tolerances

- Heating and/or Cooling capacities *Ph* and/or *Pc* [kW], Electrical Power inputs *Pe* [kW] and Coefficient of performance *COP*
- Design capacity *Pdesignh*, Seasonal Coefficients of Performance *SCOP*, $SCOP_{net}$ and Seasonal efficiency η_s
- Minimum continuous operation Load Ratio *LRcontmin* [%], *COP* at LRcontmin and Performance correction coefficient at LRcontmin *CcpLRcontmin*
- Temperature stabilisation time *th* [hh:mm], Spare capacity *Pes* [W], Energy efficiency for water heating [COP_{DHW} & WH] or Global performance coefficient for a given tapping cycle COP_{global}, Reference hot water temperature θ'_{WH} and Maximum effective hot water volume V_{MAX} [l]
- Daily consumption for the draw-off cycle in question (Qelec)
- Annual consumption (AEC)
- Sound power levels *Lw* [dB(A)]

ECC Reference documents

- Certification manual
- Operational manual OM-17
- Rating standard RS 9/C/010

Main testing standards

Thermal performance:

- Heat pumps with electrically driven compressors
- Space heating & cooling: EN 14511-1 to 4; Seasonal performance: EN 14825
- Domestic hot water: EN 16147
- Direct exchange ground coupled heat pumps: EN 15879-1
- Gas-fired heat pump : EN 12309-1 to 5

Acoustics:

- Heat pumps and dehumidifiers with electrically driven compressors: EN 12102
- ISO 3741: Reverberant rooms or ISO 9614-1: Sound intensity, measurements by points

▼ Indoor Climate

Chilled Beams

CERTIFY ALL

Scope of certification

This Certification Programme applies to all Active and Passive Chilled Beams. Chilled Beams are presented by ranges but all ranges must be certified. This applies to all product ranges which have either catalogue leaflets with product details including technical data or similar product information in electronic format.

Certification requirements

For the qualification procedure (yearly): 3 units are selected from regular production and tested in the independent Laboratory selected by Eurovent Certification.

For the repetition procedures: the number of units selected is limited to 1 unit/range.

Obtained performances shall be compared with the values presented in the catalogues or electronic selection from manufacturer's website.

Certified characteristics & tolerances

Cooling capacity: 3 conditions are required.

- Active: 80 – 100 – 120% of the nominal air flow rate (for 8°C temperature difference)
- Passive: 6 – 8 – 10°C temperature difference

Tolerance = 12% for the 3 single values; 6% for the average value.
Water pressure drop : tolerance = maximum (2 kPa ; 10%)

ECC Reference documents

- Certification manual
- erational Manual OM-12
- Rating Standard RS 2/C/007

Testing standards

- EN 14518: "Testing and rating of Passive Chilled Beams"
- EN 15116: "Testing and rating of Active Chilled Beams"

Comfort Air Conditioners

CERTIFY ALL

Scope of certification

This certification programme includes:
- AC1: comfort air cooled AC and air to air HP with cooling capacity up to 12 kW, except double duct and single duct units.
- AC2: comfort units with cooling capacity from 12 to 45 kW
- AC3: comfort units with cooling capacity from 45 to 100 kW

This programme applies to factory-made units intended to produce cooled air for comfort air conditioning (AC1, AC2, AC3). It also applies to units intended for both cooling and heating by reversing the cycle. For the AC1 programme units out of Regulation 206/2012 are excluded.

Participating Companies must certify all production models within the scope of the programme they enter. However concerning multi-split air conditioners, only systems with maximum two indoor units are included, same mounting type, capacity ratio 1+/- 0.05.

Certification requirements

For the qualification & yearly repetition procedures: AC1 : 8% of the units declared are selected and tested by an independent laboratory, and 30% of the selected units are tested at part load conditions. AC2 & AC3: 10% of the units declared are selected and tested by an independent laboratory.

Certified characteristics & tolerances

- Capacity (cooling and heating) –5%
- Efficiency (EER and COP) –8%
- Seasonal Efficiency (SEER and SCOP): –0% (the product is downgraded (or rerated) as soon as partload efficiency is out of tolerance
- A-weighted sound power level +0 dB (A)
- Auxiliary power +10%

Minimum continuous operation Load Ratio: LRcontmin [%], COP/EER at LRcontmin and Performance correction coefficient at LRcontmin CcpLRcontmin.

ECC Reference documents

- Certification manual
- Operational Manual OM-1
- Rating Standard RS 6/C/001 - RS 6/C/001A - RS 6/C/006

Testing standards

- EN 14511 • EN 14825 • EN 12102

▼ Indoor Climate

Close Control Air Conditioners

CERTIFY ALL

Scope of certification

This Certification Programme applies to factory-made units intended for Close Control Air Conditioning. This programme includes units with cooling capacities up to 100 kW under the specified test conditions.

Participating companies must certify all production models within the scope of the programme.

Certification requirements

For the qualification & repetition procedures: 10% of the units declared will be selected and tested by an independent laboratory.

Certified characteristics & tolerances

Air-Cooled and Water-Cooled Close Control Air Conditioners

- Total cooling capacity : –8%
- Sensible cooling capacity :–8%
- EER : –8%
- A-weighted sound power level : +0 dB

Chilled-Water Close Controls Air Conditioners

- Total cooling capacity : –8%
- Sensible cooling capacity : –8%
- Effective power input : +8%
- A weighted sound power level : +0 dB
- Water pressure drop :+10%

ECC Reference documents

- Certification manual
- Operational Manual OM-1
- Rating Standard RS 6/C/001
- Rating Standard RS 6/C/004
- Rating Standard RS 6/C/006

Testing standards

- EN 14511
- EN 12102 - EUROVENT 8/1

Rooftop (RT)

CERTIFY ALL

EUROVENT CERTIFIED PERFORMANCE ENERGY EFFICIENCY CHECK ENERGY CLASS ON www.eurovent-certification.com

The Eurovent rooftop certification (RT) program covers air-cooled and watercooled packaged rooftop units below 100 kW in cooling mode, with an option to certify units from 100 kW to 200 kW. The Rooftop program participants represent the five main European rooftop manufacturers.

Eurovent certifies indoor and outdoor sound levels, cooling and heating capacity and efficiency. Certified performances provide transparency and fair comparison between manufacturers. It is also the basis for the reliable study of HVAC system energy performance.

Currently the program evolves towards part load efficiency (SEER, SCOP) and certification of performance simulation tool data. Current work done on EN 14825 aims to address rooftops in the calculation hypothesis. The software certification is a key item to comply with existing and coming certification of building energy calculations in the EU countries.

Mr Philippe Tisserand
Product Manager for rooftop & commercial unitary for Trane EMEIA – Chairman of Eurovent Rooftop program compliance committee

Scope of certification

- This Certification Program applies to air-cooled and water cooled rooftops rated below 100 kW.
- Models with cooling or heating capacity ranging from 100 kW to 200 kW can be certified as an option.
- Models of rooftops using gas burners for heating shall be only certified for cooling.

Certification requirements

- For the qualification and repetition procedures (yearly) between 1 & 3 units are selected and tested by Eurovent Certification, depending on the number of products declared.

Certified characteristics & tolerances

- Capacity (Cooling or Heating): –5%
- EER or COP: -8%
- Condenser water pressure drop: +15%
- A-weighted Sound Power Level: +3 dBA.
- Eurovent Energy Efficiency class (cooling and heating)

ECC Reference documents

- Certification manual
- Operational Manual OM -13
- Rating Standard RS 6/C/007

Testing standards

- EN 14511 for Performance Testing
- EN 12102 for Acoustical Testing

Indoor Climate

Fan Coils Units

CERTIFY ALL

EUROVENT CERTIFIED PERFORMANCE ENERGY EFFICIENCY CHECK ENERGY CLASS ON www.eurovent-certification.com

Scope of certification

This Certification Programme applies to Fan Coil Units using hot or chilled water. It concerns both non ducted and ducted fan coils:

- Non ducted units: Fan Coil Units with air flow less than 0.7 m³/s and a published external static duct pressure at 40 Pa maximum.
- Ducted units: Fan Coil Units up to 1 m³/s airflow and 300 Pa available pressure.
- District cooling units and 60 Hz units can be certified as an option

Participating companies must certify all production models within the scope of the programme. Selection tools (software) are checked.

Certification requirements

Repetition procedure: the number of units to be tested each year will be proportional to the number of his basic models listed in the Directory, in an amount equal to 17% for Fan Coil Units with a minimum of one test.

Certified characteristics & tolerances

- Capacity* (cooling, sensible, heating): –5%
- Water pressure drop*: +10%
- Fan power input*: +10%
- A-weighted sound power: +1 / +2 dB(A)
- Air flow rate: –10%
- Available static pressure 0 Pa for medium speed and –5 Pa for other speeds
- FCEER & FCCOP
- Eurovent energy efficiency class

(*) **At standard and non standard conditions**

ECC Reference documents

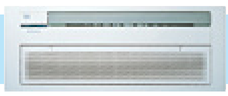
- Certification manual
- Operational Manual OM-1A
- Rating Standard RS 6/C/002
- Rating Standard RS 6/C/002A

Testing standards

- Performance testing: EN 1397:2015
- Acoustic testing: EN 16583:2015

Variable Refrigerant Flow (VRF)

CERTIFY ALL



VRF systems have shown the highest growth amongst cooling systems during the past 10 years and indeed the highest potential for the next 10 years.

Until recently, VRF systems were the only type of direct expansion cooling system that was not covered by a dedicated Certification programme.

The Eurovent Certification scheme was therefore critical.

It was my privilege to Chair the Launching committee from the first meeting to its introduction. Whilst it took 2 years to complete, I believe it was worth the time and effort.

We at Toshiba are pleased as a manufacturer to work with Eurovent Certification Company as they guarantee the consistency of thermal testing and they increase the integrity of the products on the market.

Nick Ball
Toshiba EMEA
Engineer Director

Scope of certification

The certification programme for Variable Refrigerant Flow (VRF) applies to:

- Outdoor units used in Variable Refrigerant Flow systems with the following characteristics:
- Air or water source, reversible, heating-only and cooling-only.

VRF systems with data declared and published as combinations are excluded from the scope.

Heat recovery units are included in the scope but the heat recovery function is not certified.

High ambient systems are included in the scope but tested under standard conditions as specified in RS 6/C/008.

Certification requirements

- Qualification: units selected by Eurovent Certification shall be tested in an independent laboratory selected by Eurovent Certification.
- Repetition procedure: units selected from regular production shall be tested on a yearly basis.

Certified characteristics & tolerances

- Outdoor Capacity (cooling and heating): –8%
- Outdoor Efficiency (EER, COP): –10%
- A-weighted sound power level: 2 dB

ECC Reference documents

- Certification manual
- Operation manual OM-15
- Rating Standard RS 6/C/008

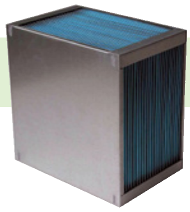
Testing standards

- EN 14511
- EN 12102

▼ Ventilation & Air Quality

Air to Air Plate Heat Exchangers

CERTIFY ALL



Scope of certification

This Certification programme applies to selected ranges of Air to Air Plate Heat Exchangers. Participants shall certify all models in the selected range, including:

- cross flow, counter-flow and parallel flow units
- all sizes
- all materials
- all airflow rates
- all edge lengths
- plate heat exchanger with humidity transfer

Heat Exchangers with accessories such as bypass and dampers shall not be included.

Manufacturers shall declare production places and provenance of products is randomly chosen. The programme does not cover other types of Air to Air Heat Exchangers like Rotary Heat Exchangers or Heat Pipes. Combination of units (twin exchangers) are also included in the scope of the program.

Certification requirements

For each range to be certified, 3 units for qualification and 1 for yearly repetition will be selected by Eurovent Certita Certification and tested in an independent Laboratory.

Certified characteristics & tolerances

- Dimensions: ± 2 mm
- Plate spacing: ± 1% or ± 1 plate
- Temperature efficiency Dry: −3 percentage points
- Temperature efficiency Wet: −5 percentage points
- Humidity efficiency: -5%
- Pressure drop: +10%, minimum 15 Pa

ECC Reference documents

- Certification manual
- Operational Manual OM-8
- Rating Standard RS 8/C/001

Testing standards

- EN 308

Air to Air Regenerative Heat Exchangers

CERTIFY ALL

Scope of certification

This Certification Programme applies to all ranges of Air to Air Regenerative Heat Exchangers (RHE) including sealing systems. Units sold without casing and sealing systems are also included. Participants shall certify all models in the ranges, including:

- all classes: condensation (non hygroscopic, non enthalpy) RHE, hygroscopic enthalpy RHE, hygroscopic sorption RHE
- all RHE geometry (wave height, foil thickness)
- all sizes (rotor diameters and rotor depths and surface areas of Alternating Storage Matrices - ASM)
- all materials
- all airflow rates
- all different types of sealing (if available)

Certification requirements

For the qualification procedures 1 unit per class of rotor will be selected and tested by an independent laboratory. For yearly repetition, 1 unit will be selected.

Certified characteristics & tolerances

- Temperature Efficiency: −3% points
- Humidity Efficiency: −5% points (min. tolerance 0.2 g/kg in absolute humidity of leaving supply air)
- Pressure Drop: +10% (min 10 Pa)
- Outdoor Air Corrrection Factor (OACF): 0.05
- Exhaust Air Transfer Ratio (EATR): +1% point

ECC Reference documents

- Certification manual
- Operational Manual OM-10
- Rating Standard RS 8/C/002

Testing standards

- EN 308
- ARI 1060

▼ Ventilation & Air Quality

Air Handling Units

CERTIFY ALL

Swegon has participated in the program for Air Handling Units from the start. The first priority at that time, and still is, was to find a way for fair competition. This is a long term struggle were we try to cover all aspects from manufacturing to software performance predictions and its agreement with tests. We discuss and take decisions about mandatory performance in software printout, rules for the energy labelling, how to test and what to apply in the, on site, auditor check. Customers should go for Eurovent certified products, to get reliable data, and then they can cut the main cost and take care of the environment by minimising the use of energy.

Committee chair:
Mr Gunnar Berg
Development Engineer, Swegon

Scope of certification

This Certification Programme applies to selected ranges of Air Handling Units.

Participants shall certify all models in the selected product range up to the maximum stated air flow.

A range to be certified shall include at least one size with a rated air volume flow up to 3 m^3/s.

Certification requirements

For the qualification procedure: the selection software will be verified by our internal auditor. A visit on production site will be organized. During that visit, the auditor will select one real unit per range, as well as several model boxes that will cover all mechanical variations.

The selected units will be tested and performances delivered by the selection software will be compared to the performances measured in an independent laboratory.

For the repetition procedures, the auditor will annually check the software conformity against the production data, and tests will be repeated every 3 to 6 years.

Certified characteristics & tolerances

- External Pressure: 4% or 15 Pa
- Absorbed motor power: 3%
- Heat recovery efficiency: 3%-points
- Heat recovery pressure drop (air side): max. of 10% or 15 Pa
- Water coil performances (heating/cooling): 2%
- Water coil pressure drop (water side): max. of 10% or 2 kPa
- Radiated sound power level casing: 3 dB(A)
- Sound power level unit openings:
  - 5 dB @ 125 Hz
  - 3 dB @ 250 – 8 000 Hz
- Casing Air Leakage : same class or higher

ECC Reference documents

- Certification manual
- Operational Manual OM-5
- Rating Standard RS 6/C/005

Testing standards

- EN 1886: "Ventilation for buildings – Air handling units – Mechanical performance"
- EN 13053: "Ventilation for buildings – Air handling units – Rating & performance for units components and sections"

▼ Ventilation & Air Quality

Air Filters Class M5-F9

Today, people spend most of the time inside of buildings. Hence, indoor air quality is a key factor to human health. Air filters removing fine dust from the air stream are the key component in building heating, ventilation and air conditioning systems to supply air of the required cleanliness and to ensure a high level of indoor air quality. With the air filter certification program, reliable and transparent filter data are ensured to customers. On a yearly base, four different filters are selected out of the product range of each participant for testing at independent laboratories according to EN 779:2012, verifying the initial pressure drop, the filter class and the initial and minimum efficiency, as well as the energy efficiency class to Eurovent document 4/11. Additionally, with the new energy efficiency label, Eurovent provides valuable data to enable users to select the most energy efficient air filters.

Committee chair:
Dr. Thomas Caesar
Head of Filter Engineering Industrial Filtration Europe
Freudenberg Filtration Technologies SE & Co. KG

Scope of certification

- This Certification Programme applies to air filters elements rated and sold as "Medium or Fine Air Filters M5-F9" as defined in EN 779:2012 and with a front frame size of 592 x 592 mm according to standard EN 15805.
- When a company joins the programme, all relevant air filter elements shall be certified.

Certification requirements

- For the qualification procedures: 6 units will be selected and tested by an independent Laboratory selected by Eurovent Certification.
  Then each year 4 units will be selected & tested

Certified characteristics & tolerances

- Filter class: no tolerance.
- Initial pressure drop: +10% + 5 Pa (minimum 15 Pa)
- Initial efficiency for F7 to F9: 10% – point
- Discharge efficiency for F7 to F9: 10% – point
- Annual energy consumption +10% +60 kWh/a

ECC Reference documents

- Certification manual
- Operational Manual OM-11
- Rating Standard RS 4/C/001

Testing standards:

- EN 779:2012
- Eurovent 4/21

Residential Air Handling Units (RAHU)

Scope of certification

This programme applies to balanced residential AHUs (supply and exhaust) with heat recovery systems such as:

- Air-to-air **plate** heat exchangers
- Air-to-air **rotary** heat exchangers
- **Heat-pumps** with a nominal airflow below 1 000 m³/h.

Certification requirement

- Qualification test campaign: 1 test per heat recovery type.
- Repetition test campaign: 1 test every 2 years for each heat recovery type.
- Units are sampled directly from selling points.

Certified performances

- Leakage class
- Aeraulic performances:
- Airflow/pressure curves
- Maximum airflow [m³/h]
- Electrical consumption [W]
- Specific Power Input SPI [W/(m³/h)]
- Temperature efficiency / COP
- Performances at cold climate conditions
- SEC (Specific Energy Consumption) in [kWh/(m².an)]
- A-weighted global sound power levels [dB(A)]

Tolerances

- Leakage class 0
- Airflow +/-10%
- Temperature efficiency –3%-point
- Temperature efficiency at cold climate –6%-point
- COP / EER –8%
- A-weighted global sound power levels +2dB(A)
- Electrical consumption +7%
- Specific Power Input SPI +7%

ECC Reference documents

- Certification manual
- Operation manual OM-16
- Rating standard RS 15/C/001

Testing standards:

- European standard EN 13141-7:2010

Cooling Towers

The importance of air conditioning and industrial cooling is constantly increasing in modern architecture and industrial process cooling. The human perception of comfort and the new challenges to reduce the electrical power consumption and CO_2 footprint have designers striving for optimal system performances with the highest possible efficiencies. Reliable thermal performances are crucial to ensure these best efficiencies which are typical for cooling circuits driven by evaporative cooling equipment. On a yearly basis, one random picked cooling tower of each Eurovent-CTI certified product line will be full scale thermal tested by applying the CTI standard 201.

Eurovent Certita Certification guarantees the consistency of thermal testing and manufacturing of European and non-European companies that subscribe to the program.

Committee chair:
Mr Rob Vandenboer
Product Manager, Quality Manager
Evapco Europe, BVBA

The first ECC / CTI collaborative certification program for Cooling Towers

The Eurovent Certification Company (ECC, Brussels, Belgium) is pleased to announce the Certification programme for cooling tower thermal performance developed in cooperation with the Cooling Technology Institute Est.1950 (CTI, Houston, Texas, USA). The scope of the program includes standardized model lines for open circuit cooling towers, typically factory assembled. Standardized model lines are composed of individual models that are required to have published thermal rating capacities at corresponding input fan power levels.

Thermal performance certification via this program offers a tower buyer assurance that the capacity published for the product has been confirmed by the initial and on-going performance testing per the requirements of the program using CTI STD-201. It also offers for regulators of energy consumption related to cooling towers, that the capacity of the towers has been validated. Minimum energy efficiency standards such as ASHRAE 90.1, which requires cooling tower energy efficiency validation by the CTI certification process, are used by governments and by green building certification programs such as LEED™.

Scope of certification

This Certification Programme for Cooling Towers applies to product ranges (or product lines) of Open-Circuit series and Closed Circuit Cooling Towers that:

- Are manufactured by a company whose headquarter or main facility are located in Europe, Middle-East, Africa or India. After getting the Eurovent Certification, the CTI certificate could be requested.
- Have already achieved and hold current certification by the Cooling Technology Institute (CTI) according to CTI STD-201.

Certification requirements

For the qualification & yearly repetition procedures our internal auditor visits the production place and reviews the conformity of Data of Records. One unit per range is selected and tested by an independent test agency.

Certified characteristics & tolerances

- Certified characteristic shall be per CTI STD-201
- Entering wet bulb temperature: 10°C to 32.2°C (50°F to 90°F)
- Cooling range > 2.2°C (4°F)
- Cooling approach > 2.8°C (5°F)
- Process fluid temperature < 51.7°C (125°F)
- Barometric pressure: –91.4 to 105.0 kPa (27” to 31” Hg)

ECC Reference documents

- Certification manual
- Operational Manual OM-4-2015
- Rating Standard RS 9/C/001-2014

Testing standards

- CTI STD-201 RS
- ECC OM-4-2015

Process Cooling & Food Cold Chain

Cooling & Heating Coils

Heating Cooling Coils (HCCs) which enable the conditioning of different zones and flexibility in application in buildings are generally employed in compact and central station AHU. To meet the required extra capacity in various processes, they are also used as heating or cooling devices.

With the application of these coils to high energy efficient heat recovery systems, the entire system becomes more compact as well as it avoids occupation of large spaces. Besides, they can be applied to Variable Air Volume (VAV) systems used for conditioning of hospitals, shopping centers and convention facilities.

The Certification programme for the HCCs has increased integrity and accuracy of the industrial performance ratings which provides clear benefits for end users who can be confident that the product will operate in accordance with design specifications. Also, by means of this certification programme users can collect reference data on the fundamental characteristics of the HCCs, such as capacity, pressure drop, mass flow complying with the standard of EN 1216.

Committee chair:
Engin Söylemez
R&D Test Engineer, Friterm A.Ş

Scope of certification

The rating standard applies to ranges of forced circulation air cooling and air heating coils as defined in ENV1216.

Certification requirements

- Qualification and repetition procedures: units declared will be selected and tested by an independent laboratory.
- The number of units will depend on the variety of coil material configurations and their applications for the applied range.
- The selection software will be verified in comparison with the test results.

Certified characteristics & tolerances

- Capacity: –15%
- Air side pressure drop: +20%
- Liquid side pressure drop: +20%

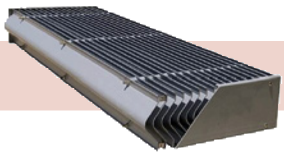
ECC Reference documents

- OM-9
- RS 7/C/005

Testing standards

- ENV 1216

Drift Eliminators



Scope of certification

The Certification Programme for Drift Eliminators applies to Drift Eliminators used for evaporative water-cooling equipment.

Certified characteristics & tolerances

The following characteristics shall be certified by tests:

- For counter-flow and cross-flow film fill, the average drift losses of the two tests at 3.5 m/s are less than 0.007% of circulating water flow rate.
- For cross-flow splash fill, the average drift losses of the two tests at 3 m/s are less than 0.007% of circulating water flow rate.

No tolerance will be applied on the average drift losses.

ECC Reference documents

- Certification manual
- Operational Manual OM-14
- Rating Standard RS 9/C/003

Testing standards

- CTI ATC-140

Liquid Chilling Package & Heat Pumps

Certification is a strong way to supply safe information in the right language

Offering guaranteed performances to customers has always been a fundamental benefit thanks to the accredited independency of this certification program. Today the need for certified performances is emphasized by several directives and it is essential for customers to:

- demonstrate the high performance efficiency of their buildings,
- compare safety performances of the products selected with the requirements of the regulations implementing ERP Ecodesign & labelling directives,
- be sure of the return of their investment or energy savings,
- have the ability to compare fairly between chillers, heat pumps or other type of heaters.

In addition to being certified, performances must be seasonal, in line with the new regulations, and assessed according to the new harmonized standards as soon as they apply.

This program is also a great opportunity for fruitful exchanges between independent laboratories, certification body and manufacturers. It also facilitates the understanding and application of new regulations or standards in a regulatory context in perpetual evolution.

A certification is a guarantee of fair competition (for customers/manufacturers). It also helps increase the number of applications using RES, and represents a commitment in the reduction of consumption and emissions.

Didier Perales
Manager of Technical Relations & Concept Projects
CIAT Group France

ECC Reference documents

- Certification manual
- Operational Manual OM-3
- Rating Standard RS 6/C003 - RS 6/C/003A

According to New Regulations for Space heaters Eco Labelling No 811/2013 - ErP No 813/2013.

Seasonal efficiency for heating (η_s) for Chillers & Heatpumps with a design capacity below 70kW is certified since 26 September 2015. (For units above 70kW it is optional).

Scope of certification

- This programme applies to standard chillers and hydronic heat pumps used for heating, air conditioning and refrigeration.
- They may operate with any type of compressor (hermetic, semi-hermetic and open) but only electrically driven chillers are included.
- Only refrigerants authorised in EU are considered. Chillers may be air cooled, liquid cooled or evaporative cooled.
- Heating-only hydronic heat pumps, 60 Hz units and Higher capacities (between 600 kW and 1500 kW) units can be certified as an option.

Certification requirements

Qualification and repetition: a certain number of units will be selected by Eurovent Certification and tested every year, based on the number of ranges and products declared.

Certified characteristics & tolerances

- Cooling & heating capacity and EER & COP at full load: < –5%
- Performance SCOP & Seasonal Efficiency for Heating η_s: automatically rerated when Part Load efficiency criteria fails
- Seasonal Efficiency ESEERfor cooling: automatically rerated when Part Load efficiency criteria fails
- A-weighted sound power level: > +3 dB(A) (> +2 dB(A) for units with Pdesignh below 70kW)
- Water pressure drop: +15%

Testing standards

- Performance testing: EN 14511
- Seasonal Performance testing: EN 14825
- Sound testing: EN 12102

Heat Exchangers

CERTIFY ALL

EUROVENT CERTIFIED PERFORMANCE ENERGY EFFICIENCY CHECK ENERGY CLASS ON www.eurovent-certification.com

The purpose of the Eurovent "Certify-All" certification programme for heat exchangers is to encourage honest competition and to assure customers that equipment is correctly rated.

The programme covers 3 product groups:

— Unit Air Coolers
— Air Cooled Condensers
— Dry Coolers

The "Certify-All" principle ensures that, for heat exchangers, all models in the three product categories are submitted for certification, not just some models chosen by the manufacturer.

A product energy class scheme has been incorporated into the certification programme, based on 7 classes from "A++" to "E" in order to provide a guide to the best choice of product: this enables the user to minimize life-cycle costs, including running costs which account for a much superior sum than the initial investment cost.

Committee chair:
Stefano Filippini
Technicalmanager - LUVE

Air coolers for refrigeration

Dry coolers

Air cooled condensers

Scope of certification

The Eurovent Certification Programme for Heat Exchangers applies to products using axial flow fans. The following products are excluded from the Eurovent Certification Programme for Heat Exchangers:

- Products units using centrifugal type fans.
- Units working at 60 Hz

In particular, the following products are also excluded from the Eurovent Certification programme for Dx Air Coolers and Air Cooled Condensers:

- Products using R717 refrigerant (ammonia), CO_2, and refrigerants with high glide like R407C or without correction factors
- Product ranges of Dx Air Coolers where maximum standard SC2 is below 1.5 kW.
- Product ranges of Air Cooled Condensers where maximum standard capacity under DT1 15K is below 2.0 kW

Certification requirements

- Qualification: units selected by Eurovent Certification shall be tested in an Independent Laboratory selected by Eurovent Certification.
- Repetition procedure: units selected from regular production shall be tested on a yearly basis.

Certified characteristics & tolerances

- Standard capacity –8%
- Fan power input +10%
- Air volume flow ±10%
- External surface area ±4%
- Energy ratio R
- Energy class

For Dry Coolers:

- Liquid side pressure drop +20%

For Air Cooled Condensers and Dry Coolers:

- A-weighted sound pressure level: +2 dB(A)
- A-weighted sound power level: +2 dB(A)

ECC Reference documents

- Certification manual
- Operational Manual OM-2
- Rating Standard RS 7/C/005

Testing standards

- Thermal Performance EN 328
- Thermal Performance EN 327
- Thermal Performance EN1048
- Acoustics EN 13487

Remote Refrigerated Display Cabinets

CERTIFY ALL

EUROVENT CERTIFIED PERFORMANCE ENERGY EFFICIENCY CHECK ENERGY CLASS ON www.eurovent-certification.com

Remote refrigerated display cabinets (RRDC) are the appliances for selling and displaying chilled and/or frozen foodstuff to be maintained within prescribed temperature limits.

Typically, food and beverage retailers are the direct customers of the refrigeration industry while the supermarket's customers are the end users of food and beverage retailers.

Food and beverage retailers ask for food safety and also for appliances with high-energy efficiency, supermarket's customers ask for food safety. Refrigeration industry has to face the hard challenge of satisfying both needs.

How is it possible to assure that the refrigeration appliances perform accurately and consistently to the reference standards? How is it possible to assure that what is rated by the manufacturer is properly rated?

There is only one way: It is necessary to join a globally recognized and industry respected certification program.

Eurovent Certita Certification program for RRDC is the only certification program in Europe that can assure that performance claims have been independently measured and verified. The factory audits and the product's performances tested in an independent and third-party laboratory make the difference!

Since 2011, Eurovent Certita Certification has also launched a voluntary energy label certification scheme, anticipating what only nowadays EC DG Energy is doing in the framework of Ecodesign and Energy Label Regulations. What better way to rate RRDC's energy consumption and to promote their energy efficiency?

What would you trust more: a self-declaration by the Manufacturer or what an independent, globally recognized and forerunner certification program is able to assure? Which one is better?

Maurizio Dell'Eva
Project manager
EPTA S.p.A. – MILANO (ITALY)

Scope of certification

- 100 basic model groups divided in 5 categories of remote units : semi-verticals and verticals (with doors); multi-deckers; islands; service counters; combi freezers.
- At least two references per basic model group representing 80% of sales shall be declared.
- One Bill of Material for each declared reference.

Certification requirements

- Qualification: sampling and test of one unit & Audit of one factory.
- Repetition test of one unit per brand every 6 months & Annual audit of each factory.

Certified characteristics & tolerances

- Warmest and coldest product temp. ±0.5°C
- Refrigeration duty (kW) 10%
- Evaporating temperature –1°C
- Direct elec. Energy Consumption (DEC) +5%
- Refrigeration elec. Energy Cons (REC) +10%
- M-Package Tclass : ±0.5°C
- Total Display Area (TDA) –3%

ECC Reference documents

- Certification manual
- Operational Manual OM-7
- Rating Standard RS 14/C/001

Testing standards

- EN ISO 29953 and amendments

Articles

Air Conditioning of St Mary's Archeological Church, Cairo

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Faculty of Engineering,
Cairo University
Cairo –EGYPT

Airflow characteristics in ventilated and air-conditioned spaces play an important role to attain comfort and hygiene conditions. This paper utilizes a 3D Computational Fluid Dynamics (CFD) model to assess the airflow characteristics in ventilated and air-conditioned archaeological Church of Christ (hanging Church) in Cairo, Egypt. It is found that the optimum airside design system can be attained, if the airflow is directed to pass all the enclosure areas before the extraction with careful selection of near wall velocities to avoid any wear or aberration of the wall paintings. Still all commonly known factors and evaluation indices have the shortage to describe the influence of the recirculation zones on the occupancy zone of the visitors and also on the fresh supplied air. The mode of evaluation should assess the airflow characteristics in any passage according to its position in the enclosure and the thermal pattern and air quality. The paper ends with brief discussion and concluding remarks.

Introduction

The present work raises several questions in the room airflow motion prediction techniques. This article presents the results of an ongoing evaluation of a CFD based on computer models for predicting room airflow distribution in the Hanging Church in Egypt. To design an optimal HVAC airside system that provides comfort and air quality in the conditioned spaces with good energy efficiency is a great challenge. For this project a numerical study is carried out to define the optimum airside design of the HVAC systems, providing optimal comfort and healthy conditions energy efficiency. A CFD program is used. Basically, various airside designs are considered including floor and or ceiling supply, different obstacle and alternative positioning to introduce the capability of each design to provide the optimum air flow characteristics. The optimum utilization of the air movement to condition and ventilate can be attained by properly locating the supply diffusers and extract grills to minimize the recirculation zone and prevent the air short circuits. Ideally, the optimum airside design system can be attained, if the airflow is directed to pass all the enclosure areas before the extraction, Berglund, L. G., and Cain, W. S. (1989). The primary objective of the project is to demonstrate the capabilities of the numerical tool to predict the airflow characteristics and thermal patterns in the different conditioned church configurations in view of basic known flow characteristics, Khalil (2008 and 2013). The numerical model is used to investigate the airflow pattern, temperature and relative humidity distributions inside the church main hall.

Figure 1 shows the church main hall while **Figure 2** depicts the hideaway location where baby Christ used to be hidden during the journey of the sacred family from Palestine to Upper Egypt. The church that was built over 1 500 ago suffered from adverse effects of excessive humidity and it was proposed to air condition this archaeological monument among the restoration plans that also included the nearby Coptic Museum.

The design of such facility didn't allow any alteration in the structure nor the bearing walls of the church that comprised a main hall and neighbouring rooms and facilities. There are students' chapel, First Floor Chapel as well as the main Nave. The main hall is of 17.2 m x 18.2 m length and width with a height which is variable with domes maximum of 9.3 m, and a total volume of 2 424 m^3. Full load estimation was carried out to obtain the maximum cooling capacity requirement at the worst prevailing climatic conditions in Cairo summer. Hourly air system simulation results were obtained for the months of June, July and August. The cooling capacity for the main Nave was 280 kW while for the other chapels

Figure 1. Church Main Hall.

Figure 2. Sleeping hideaway place of Baby Christ in basement.

these were of the order of 40 kW for the students' chapel, 40 kW for the ground floor and 36 kW for the first floor Chapel. The cooling plant was designed on the bases of five units each 90 kW to cover the whole complex.

Figure 3 depicts the roof top cooling units used for the main church and the adjoining chapels. The VRV units were used for the Coptic museum.

Computational technique

The present CFD computational procedure includes the numerical solution of the governing equations of mass, momentum, species concentration and energy in three dimensional configurations based on Launder (1972) and Spalding and Patankar (1974). A two equation k-ε turbulence model was used to represent the turbulence characteristics of the flow through the numerical solution of an equation of the kinetic energy of turbulence k and its dissipation rate ε. More than 1,000,000 tetrahedral control volumes were used and numerical convergence was better that 0.001%. Further details of the SIMPLEC numerical algorithm imbedded in FLUENT can be read in detail in references by Khalil (2013).

Figure 3. Cooling Equipment on Roof of adjoining building.

Model Architecture (Structure)

The church is located in Cairo; the main hall is modelled as shown here in **Figure 4a & b**.

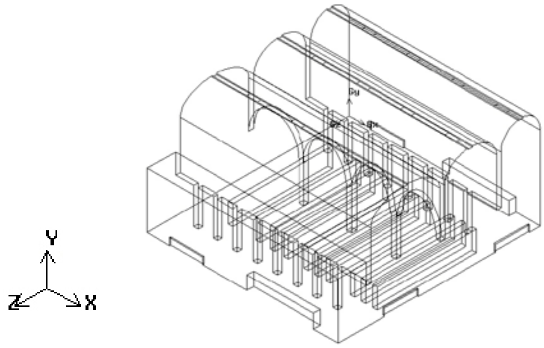

Figure 4a. Isometric View for the Church Main Hall.

Figure 4b. Arrows indicate location of air inlets through naturally openings in the roof.

Inlet air conditions

The inlet air conditions are based on the average day max of 40°C and 30% relative humidity, Egyptian Code, representing August climatic conditions. The main hall is of 17.2 m x 18.2 m x height which is variable with domes maximum of 9.3 m, with total volume of 2 424 m³.

Air inlets

The air inlets are set as velocity inlet boundary conditions where velocity was set to be 1.5625 m/s with a total of 12 air inlets, each of 0.4 m² of area (shown by arrows in **Figure 4b**). This resulted in a total flow of 7 m³/s. The inlet air temperature was set to 287 K, with an absolute humidity of 8 gr/kg. The ACH is chosen to be about 10.

Outlets

The air outlets are set as outflow conditions.

Walls

The walls are considered as a slab to have zero heat flux. The no slip condition is enabled for all walls, while using the standard wall function for near wall treatment.

Visitors Representation

The visitors' bodies are considered as isothermal walls with a temperature of 310 K. The visitors' faces are considered as isothermal walls kept at the human skin temperature of 310 K as well. Also it is assumed that there is a specified species mass fraction of 0.0411 $kg_w/kg_{d.a}$ in order to take into account the sweat effect in moisture gain, Olesen (2000). For carbon dioxide, a diffusive mass fraction of 0.0474 $kg_{co2}/kg_{d.a}$ is chosen.

Air circulation

The church hall model design included 12 air supply diffusers, each situated in between the ceiling arcs. The return grills were situated near the ground.

Number of Visitors

The model was used to simulate the situation during a prayer; consequently, the total number of visitors was set to 150 people. The total thermal load was 280 kW cooling, fresh air 1 350 l/s. Loads from solar gain were 3 kW, roof thermal transmitted loads were 69 kW while ventilation load was 79 kW.

Results and discussions

Velocity Predictions

Velocity contours indicated the penetration of the ceiling supply jet till almost above the occupancy zone. The jet flow towards the extract grilles locations as shown at Z=0 and Z=18 m. **Figure 5** shows the corresponding velocity contours at X=15 m which is near the other end of the church width as X varies between 0 and 17.2 m. **Figure 6** shows the velocity contours in a transverse section at Z=12.15 m and indicated the prayers standing locations. The velocities at these locations are well below 0.25 m/s which ensured the disappearance of any drafts for the comfort of prayers and visitors.

Thermal Patterns

Energy equation was solved to yield the temperature distribution at the various locations taking into account the heat dissipated from the humans, equipment and also the external heat sources in summer. **Figure 7** indicated the temperature contours at a Y-Z plane at X=4 m; temperatures are found to be homogeneously distributed and ensured comfort conditions. **Figure 8** represents thermal patters in transverse plane; one can easily see temperatures of 30°C at the seating and standing locations. The

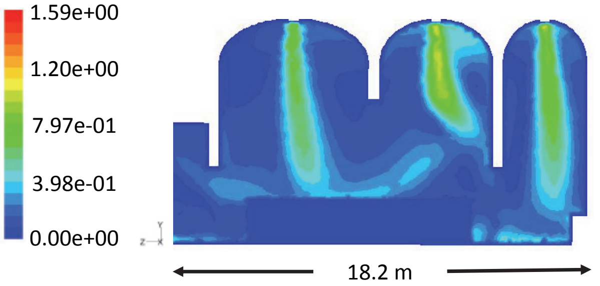

Figure 5. Contours of Mean Velocity In Y Direction, m/s at Y-Z Plane X=15 m.

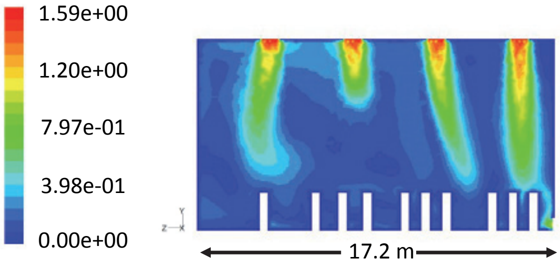

Figure 6. Contours of mean velocity in X-Y plane, m/s at Z=12.15 m.

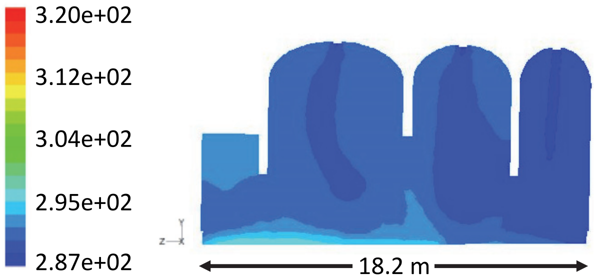

Figure 7. Temperature contours, K, in a Y-Z plane at X=4 m.

remaining zones are at lower temperatures that can be as low as 17°C, bearing in mind that the on coil temperature leaving the ceiling supply grilles are typically 13°C.

Relative humidity Predictions

The relative humidity contours at various locations in the church are shown here in **Figures 9 and 10** at Y-Z at X=4 and 15 m respectively. The local values of Rh% are around 50% at the occupancy level as clearly indicated in the figures above, the cooled supply air leaves the supply grilles at much higher values of 80% and more. Some disperse locations at near 1.8 m above floor indicated high Rh% due to the presence of candles and equipment. **Figure 11** indicates some high values of relative humidity at the vicinity of the occupants' faces.

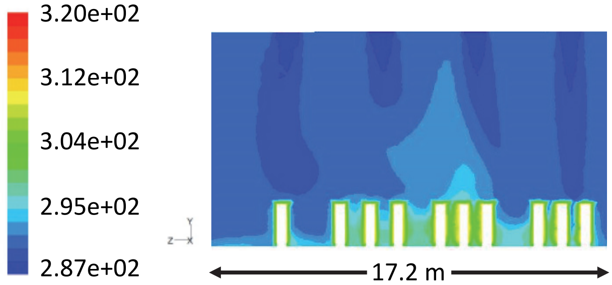

Figure 8. Temperature contours, K, at X-Y plane at Z=12.15 m.

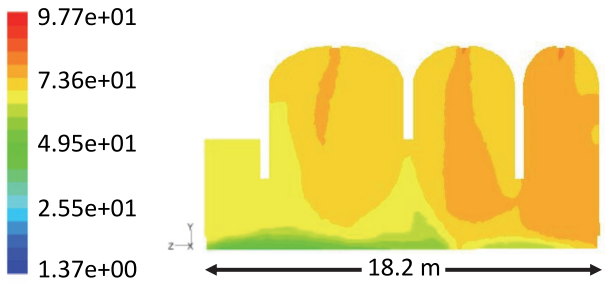

Figure 9. Contours of relative humidity, % at Y-Z plane at X=4 m.

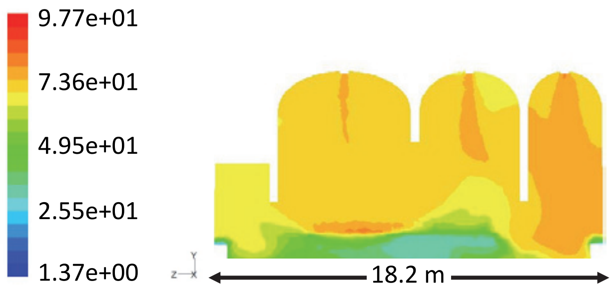

Figure 10. Contours of relative humidity, %, at Y-Z plane at X=15.

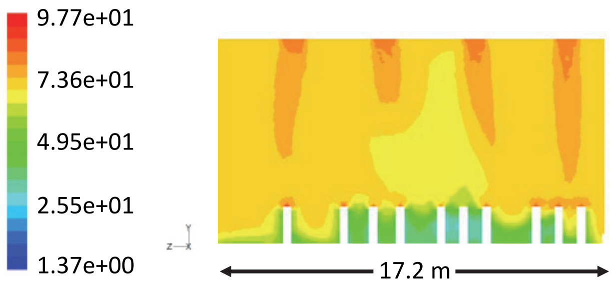

Figure 11. Contours of relative humidity, % at Y-X plane at Z=12.15 m.

Assessment and Validation

Measurements of mean air temperature and relative humidity percentage were obtained with the aid of a hotwire anemometer and electronic hygrometer with accuracy of ±5%. These were compared to the corresponding predictions in **Figures 12 and 13**. Qualitative agreements were demonstrated, with some discrepancies that are equally attributed to both experimentations accuracies and modelling assumptions.

Conclusions

From the previous results, one can conclude that the airside designs have a strong influence on the relative humidity distribution and consequently on the IAQ. The location of the supply outlets plays the major role in this distribution. The extract grills should be located in the right location to ensure comfort.Due to the architectural design restrictions of archaeological buildings such as in this church, designers should perform this calculation exercise to properly select the locations of supply and extract grilles in renovated systems in ancient buildings to yield better air flow, temperature, relative humidity behaviour. ■

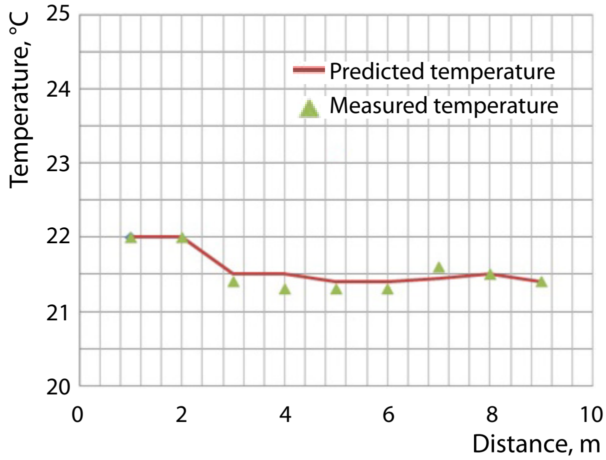

Figure 12. Measured and predicted air temperature at 1.0 m above floor in church.

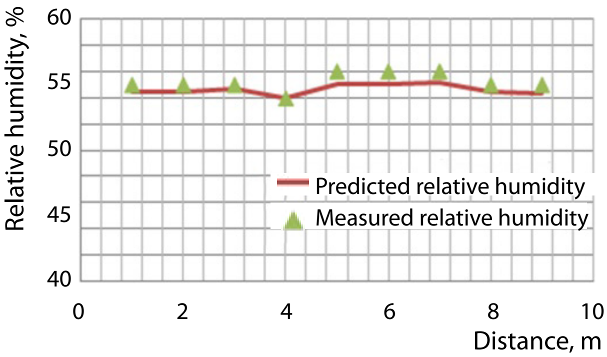

Figure 13. Measured and predicted RH % at 1.0 m above floor in the Church.

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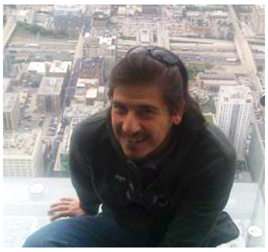
Indoor Environment Quality at Schools: A training project of the students and teachers in İzmir (Turkey)



SAIT CEMIL SOFUOGLU
Corresponding member of the working group. Prof.Dr., İzmir Institute of Technology – Turkey.
cemilsofuoglu@iyte.edu.tr

A group of researchers have teamed up with Chamber of Mechanical Engineers – Izmir Branch (CME-IB) to conduct a project to raise awareness on the importance of indoor environmental quality (IEQ) for children. School children and school IEQ were the targets, which lead to inclusion of teachers and school managements among the targets of the project. Primary and middle schools in the metropolitan Izmir were chosen as the main targets and the backing of Ministry of Education Izmir Directorate was obtained. There are 150 schools in the target area with roughly 30,000 students, 2,000 teachers and managers, therefore, only the 8th grades were selected for the first year.

Guidebooks for all six components of IEQ (indoor air quality, thermal comfort, acoustics, lighting, odour, and vibration) and guidebook for risks of school materials, cleaning and personal care products were written for teachers and management. An overall guidebook entitled "Indoor Environmental Quality" was prepared for students by putting together and simplifying the seven guidebooks and adding a part on health effects of IAQ using simple illustrations drawn by a renowned caricaturist. **Figure 1** shows the cover page of the guidebook.

Seminar lectures with slides were prepared that cover all aspects in the IEQ guidebook to be given at schools by volunteer professional mechanical engineers. The volunteers were scouted by CME-IB by issuing a call to member engineers who have school-aged children. Fifty-two volunteers were trained by the researcher's team. The volunteers visited the schools according to a schedule made by CME-IB. Twentysix schools were visited, 48 seminars were given to 5,066 students and 325 teachers by the end of 2015 spring semester.

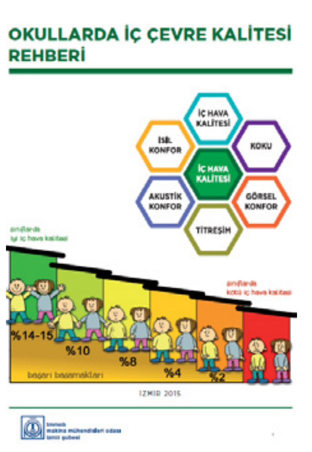


Figure 1. Front cover of the IEQ Guidebook.

A website was constructed to make all the prepared guidebooks and presentations available to the public. Homepage of the website (www.iccevrekalitesi.net) is shown as **Figure 2**. In addition to the documents, this website has a section for a computer program prepared as an illustrative calculation tool to show children and teachers how fast can IAQ in a classroom can worsen using CO_2 as an example (**Figure 3**).

Figure 2. Homepage of the information dissemination website.

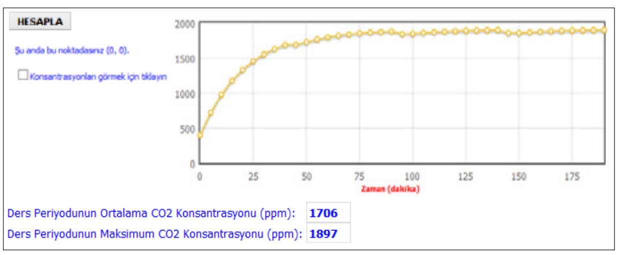


Figure 3. Output of the CO_2 modelling tool.

Figure 4. The fitted heat recovery ventilation unit in a classroom and the IAQ team made up of students and the teacher.

The tool may also be used by HVAC engineers to determine a ventilation rate that would keep CO_2 concentrations below a standard level.

The third leg of the project was installation of a mechanical ventilation system at an application school. The aim of this task was to show the school managers and the officials of the Ministry of Education that indoor air quality problems can be mitigated by fitting energy efficient mechanical ventilation units to existing naturally ventilated schools. A school in the metropolitan area was selected. It is located in a disadvantaged area where pollution from traffic and nearby industries and SMEs may be a problem. The existing conditions in the application school in terms of IEQ have been investigated in Fall-2014 semester; and was repeated after the installation in Spring-2015 semester. IAQ variables (particulate matter, volatile organic compounds, carbon dioxide) and comfort variables (temperature, relative humidity, illumination) have been measured. The ventilation system has been designed, manufactured, and installed a classroom of the school in the January semester break. Figure 4 shows the classroom and the IAQ team that actively involved during the measurements. It has been shown that CO_2 concentrations in this classroom of 30 students can be kept below the British Department of Education Building Bulletin 101 standard levels. ■

The HVAC&R market in the EMEA region – Eurovent Market Intelligence

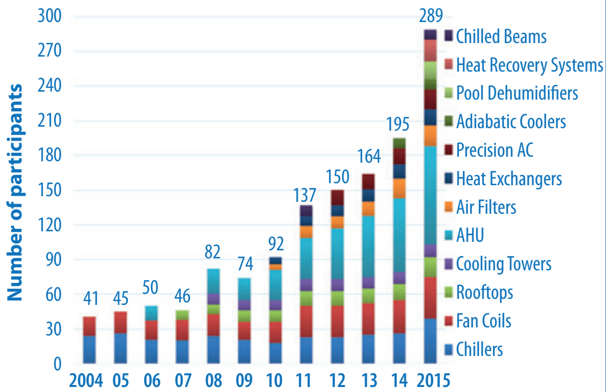
On 4 January, Eurovent Market Intelligence (EMI), the European statistics office for the HVAC&R market, launched its new annual data collections for 2016 (see info box below). The aim is to collect sales data from manufacturers in the sector so that we can provide them with a reliable and precise market map for HVAC&R in Europe, the Middle East and Africa (EMEA).

GHITA BOUDRIBILA
Analyst

YANNICK LU-COTRELLE
Market Intelligence, Manager

Last year, 289 manufacturers had joined EMI, a new participation record and a 48% increase on the previous year. This year, 350 participants are expected, which promises to provide the most comprehensive and reliable ever overview of the market, and thus become the largest collection of data on the HVAC&R market in terms of number of market players.

Eurovent Market intelligence Programmes (all products) : 12-year overview



One of the major changes last year was the significant improvement in quarterly reports (Market Evolution), which in just around 20 pages also includes qualitative, technical and macro-economic data in addition to the usual market data.

EMI is also aiming to go even further this year, offering customised reports as of March/April. These individual market reports, packed with between 100 and 200 pages, compare market characteristics for each country in the EMEA area (size, segmentation, main players, growth, etc.) and the position of the manufacturer in the market (market share, rank, progress, etc.). The aim is to offer each participant a full overview of his situation so that in a glance he can see his strong points and areas where he needs to improve.

All of the information will also be available – under private access only – on the Eurovent Market Intelligence website. A new marketing tool is currently being developed for this, which should be operational by April 2016 at the latest. This tool will allow users to carry out all possible market analyses in a single click, as simple as using a flight comparison tool, and export the results to an Excel file.

Also new for 2016 is that a new programme will be launched and an old one will be restored, relating to residential air handling units and chilled beams respectively, where representativeness already promises to exceed 80%. The programme for precision air conditioners has been expanded to include all solutions used for cooling IT devices (data centres, telecoms, etc.), in order to better take into account the development of less energy-intensive alternative in this sector.

From January to March 2016, Eurovent Market Intelligence is launching its thirteen annual data collections

- Liquid chilling packages
- Fan coil units
- Air-handling units
- Rooftop units
- Cooling towers
- Air filters
- IT cooling (formerly precision air conditioners)
- Heat exchangers
- Adiabatic coolers
- Heat recovery systems
- Pool dehumidifiers
- Cold beams
- Residential air handling units

Last but not least, EMI will launch the dissemination of bilingual English/Arabic market reports looking specifically into the Middle East this year. This expansion comes as a result of the ever-increasing role of EMI in this region, where the construction sector still remains relatively dynamic, where demand for air conditioning is very high. To this end, EMI attended the BIG5 exhibition in Dubai last November, where interest from local manufacturers was particularly high. As usual, EMI will also be attending the Mostra Convegno Expocomfort exhibition in Milan, Hall 22 P – Stand F 55, which will be held from 15 to 18 March 2016.

For additional information or to receive these reports:
https://www.eurovent-marketintelligence.eu /
statistics@eurovent-marketintelligence.eu

Natural air conditioning with Earth, Wind & Fire presents opportunities for vacant office spaces

The so-called Earth, Wind & Fire concept for the natural ventilation of buildings offers good opportunities for Dutch office buildings according to Peter Swier, who graduated on this topic at the Delft University of Technology on Thursday, 28 January 2016.

Architects and engineers

In his graduation research, Peter Swier focused on the Earth, Wind & Fire concept (EWF) http://bronconsult.org/onderzoek/het-earth-wind-fire-concept/, a technology that can help transform offices into an attractive, energy-efficient, healthy, pleasant and productive working environment. This can be achieved by realising air conditioning in buildings largely by means of natural methods, without mechanical ventilation.

Swier, an architecture student, looked specifically at the opportunities EWF presents for refurbishing vacant office buildings in the Netherlands. Among other things, Swier analysed around 100 projects conducted by master students on EWF. After this he came up with an extensive model for the practical application of Earth, Wind & Fire, with a description of the possibilities and limitations of this innovative concept. Swier then tested the results in a case study for the implementation of the Earth, Wind & Fire concept, in which a virtual renovation of Heerlen city hall was used as an entry for the International Building Exhibition (IBA).

'My graduation research can be seen as a practical EWF manual', Peter Swier explains. 'It shows the huge potential of EWF to become an architectural solution to bridge the gap between architects and engineers.' [1]

No mechanical ventilation

It is possible for buildings to have air conditioning using completely natural methods, without mechanical ventilation. Benjamin Bronsema already established this in 2013, when the 78-year-old obtained his doctorate in the subject at TU Delft[2]. Bronsema is the creator and main promotor of the Earth, Wind & Fire concept, and also one of Peter Swier's supervisors.

In short, EWF utilises cascading water, sun and wind. The system consists of three main parts: the Ventec Roof, the Climate Cascade[3] and the Solar Chimney[4]. The Ventec Roof draws in fresh air and expels stale air through the use of positive and negative wind pressures. Air is drawn in via the Climate Cascade and expelled via the Solar Chimney. The chimney heats ventilation air with heat captured from incoming sunlight. Initiation of the air flow takes place in the Climate Cascade. This is a structural shaft into which water drops are sprayed from above and with which the air can be cooled or heated.

Besides improving the energy and cost efficiency of buildings, Earth, Wind & Fire can also contribute to a more natural and healthier indoor climate, Bronsema explains. Circulating air through buildings contributes to the spreading of bacteria. Air filters are often a source of infection. According to Bronsema, his system ensures that nature can 'inhabit' the building by architectural means.

Hotel Breeze

The next important step for the EWF concept is also coming soon. Theoretically it has already been established in the laboratory that the concept works. But for real proof, a concrete practical application is needed - and that's coming soon in Amsterdam. There, Dutch Green Company, in collaboration with TU Delft and TU Eindhoven, is currently developing the first (nearly) energy neutral hotel in the world: Breeze[5]. The hotel will be largely energy self-sufficient, with Earth, Wind & Fire playing a crucial role. The Breeze Hotel with EWF concept, which should be ready in 2017, is expected to be the first energy neutral hotel in the world.

More information

Thesis: *EFW design manual: refurbishing structurally vacant office buildings into architectural attractive, low energy working environments.*

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1 http://repository.tudelft.nl/assets/uuid:58731072-677f-421b-872e-7c78d00009dd/PeterSwier_4020820_ResearchPaper.pdf
2 http://www.tudelft.nl/nl/actueel/laatste-nieuws/artikel/detail/promotie-energiepositief-met-natuurlijke-ventilatie/
3 http://www.tudelft.nl/nl/actueel/laatste-nieuws/artikel/detail/airconditioning-zonder-ventilatoren-eerste-resultaten-van-klimaatcascadec-positief/
4 http://www.tudelft.nl/no_cache/nl/actueel/laatste-nieuws/artikel/detail/tu-delft-test-zonneschoorsteen/
5 http://dutchgreencompany.nl/post_type_portfolio/zero-energy-hotel-breeze/

Attendance High for ASHRAE Winter Conference, AHR Expo

High attendance was reported for the recent ASHRAE Winter Conference and AHR Expo, in Orlando. The 2016 ASHRAE Winter Conference was held Jan. 23-27, with the AHR Expo held Jan. 25-27.

ASHRAE

The Winter Conference had more than 3,000 attendees. Attendance this year was higher than the past eight Winter Conferences, except Las Vegas 2011. Attendees came from 67 countries. The 2016 AHR Expo, co-sponsored by ASHRAE, set a record by being the first show outside of Chicago to break 400,000 square feet of exhibitor space. The Expo featured 2,063 exhibitors, including 561 deemed international. The total attendance for visitors was 42,672, with total attendance of visitors and exhibitors at 60,926.

The Conference's Technical Program ranked high in attendance, with new tracks focused on design-build practices and residential systems. Individual top-attended sessions in the technical program were related to Cooling with the Sun: Solar Thermal Cooling; Energy Submetering Fundamentals: Benchmarking, Baselining and Beyond!; The Impacts of Operable Windows on Building Performance; Highlights from the 24th IIR International Congress of Refrigeration; The Internet of Everything: How Smart and Connected Sensors Will Transform the HVAC Service Industry; HVAC Pumps: New ECM Motor and Control Technologies; Indoor Air Quality and Energy Efficiency: Measurement and Analysis of Multiple Approaches; Back to Basics: The Science, Application and Art of Load Calculations; Integrating Cutting-Edge Technology: Renewable Energy and Thermal Energy Storage; and Hydronic Systems: Doing More with Less.

Also offered were a combined 20 Professional Development Seminars and Short Courses from ASHRAE Learning Institute. The most popular Short Course offerings were Variable Refrigerant Flow Systems; Complying with Standard 90.1: HVAC/Mechanical; and Designing High-Performance Healthcare HVAC Systems. The Professional Development Seminars that drew the highest number of registrations were Energy Modeling Best Practices & Applications; Commercial Building Energy Audits; and Commissioning Process for New & Existing Buildings.

The 2016 ASHRAE Annual Conference takes place in St. Louis, Mo., June 25-June 29, 2016. The 2017 ASHRAE Winter Conference takes place Jan. 28-Feb. 1, Las Vegas, Nev., with the AHR Expo being held Jan. 30-Feb 1.

Jodi Scott
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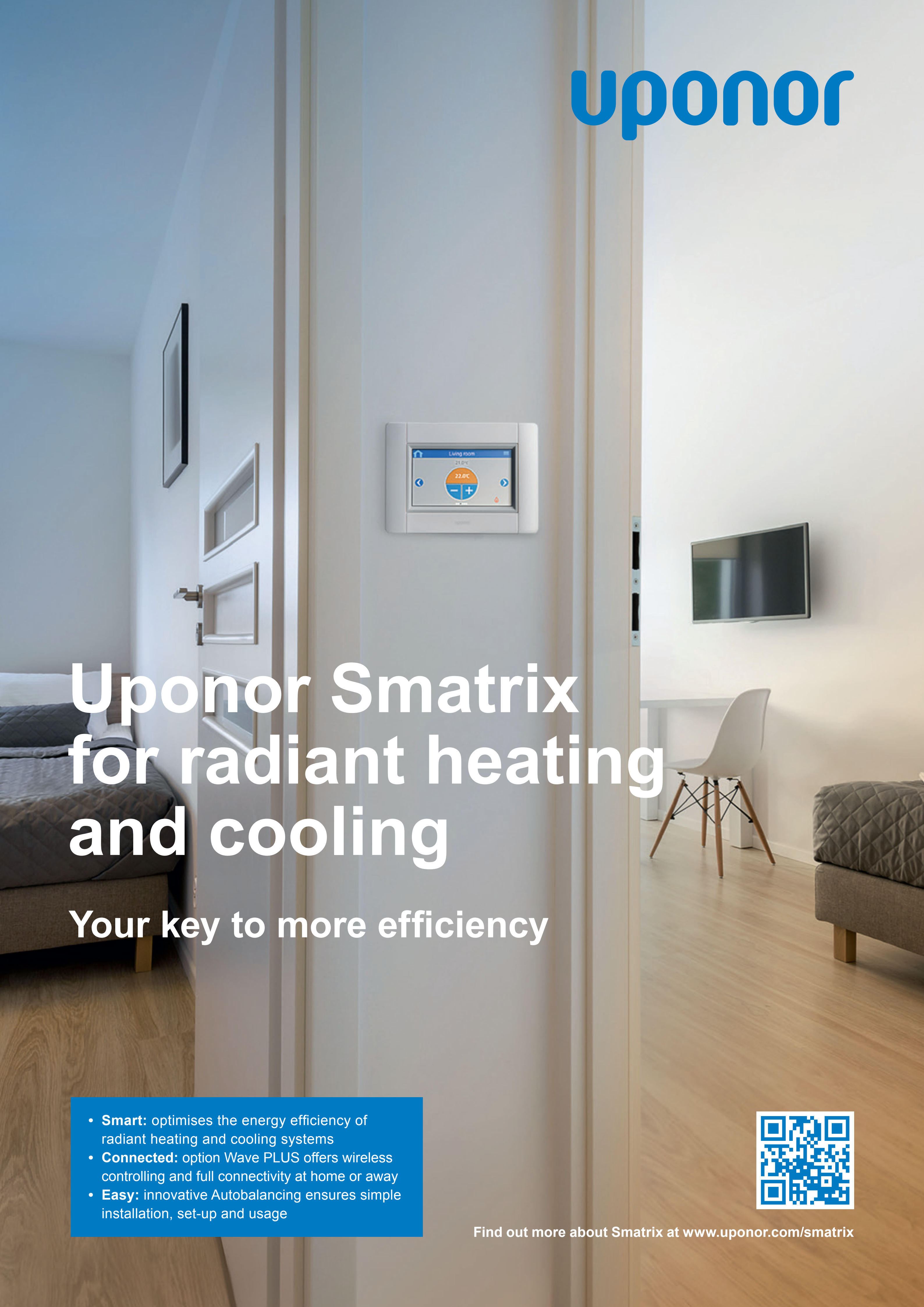
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Daikin ECH$_2$O domestic hot water heat pump

From February 2016 onwards, DAIKIN will launch its innovative domestic hot water heat pump, the Daikin ECH$_2$O. This new heat pump concept combines an inverter driven outdoor unit and a "Fresh Water Principle" based pressure less storage tank to provide the user with efficient and hygienic hot water.

The R410A based inverter driven heat pump efficiently heats up the water in the storage tank up to a temperature of 55°C, and can operate at ambient temperatures between −15°C and +35°C. If necessary, higher temperatures can be obtained by an electrical immersion heater inside the storage tank, which will also act as an emergency heater. The outdoor unit is very compact, silent and can be installed within 20m of the hot water storage tank.

The storage tank which is installed inside the house is based on the "Fresh Water Principle", providing some unique features not found at the traditional pressurised domestic hot water cylinders. The tank itself consists of 2 shells of polypropylene. The gap between the two shells is filled with 5 to 8 cm of high density polyurethane, providing in the same time high strength and excellent heat loss properties. The water contained in the tank only acts as heat storage and transfer medium. The tapping water itself is semi-instantaneously heated as flows through a spiral shaped heat exchanger immerged inside the storage tank. This water is continuously refreshed at each tapping, and has therefore excellent hygienic properties without the need of energy wasting thermal disinfection cycles. As this water is also not stagnating, scale and lime deposits are also avoided. An additional advantage is that the storage tank itself cannot corrode, and doesn't need protection from sacrificial anodes.

The storage tank comes in 2 different sizes, a 300 litre version and a 500 litre version. Both versions can easily be connected to a drain back solar thermal system, which allows maximizing the use of renewable energy. The 500 litre version can also be connected to a pressurised solar system or an external heat generator such as a gas boiler. Both versions also achieve an "A" energy label according to ErP requirements, the highest possible for this type of products. This label is achieved for a tapping pattern "L" for the 300 litre version and "XL" for the 500 litre version. For the French market, the heat pump is certified according to "NF Electricité".

The heat pump can operate in 4 different modes (ECO, AUTO, SILENT and BOOST), and is optimised for use with different peak/off peak tariffs or smart grids.

NF-Air Cleaners

Eurovent Certita Certification has developed a new NF mark certification for Air Cleaners under a mandate from AFNOR Certification. A dedicated working group gathered four times between May and November 2015 and the reference document is currently going through the approval process with an expected date of release in early January 2016.

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AIR CLEANERS
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This NF mark aims at certifying air cleaning devices for residential and tertiary applications as foreseen in the scope of the standards XP-B44-200:2011 and XP-B44-013:2009, chosen as product performance testing method references.

The Air Cleaners certification enables to verify the accuracy of the performance ratings claimed by manufacturers in terms of effectiveness with respect to several categories of pollutants: particulate matters (PM), Volatile Organic Compounds (VOC), micro-organisms (bacteria and fungi) and cat allergens, but also regarding the power consumption and the sound power level. The product testing also enables to verify that no dangerous products are emitted (ozone, VOC by-products…). The certification scheme comprises factory audits to check that the quality management system in place ensures the manufacturing process reliability. Besides, the reference document establishes a consistency principle between the air volume flow rate delivered by the device and the surface area of the room that can be cleaned.

In the near future, the NF-Air Cleaners mark will most certainly evolve to cover industrial applications and duct mounted installations.

For more information: please contact Gregory Kelijian g.kelijian@eurovent-certification.com.

REHVA organised a successful seminar at the ASHRAE winter meeting 2016 as part of the track: Cutting-Edge Technologies

Energy Performance Run By Data, Chaired by REHVA President Karel Kabele.

A consistent strategy for energy saving and sustainability should benefit from the all the opportunities opened by scientific and technological development. One of the biggest challenges in a building is to find the right equilibrium between the energy demand and the well-being provided to occupants. The evolution of information and communication technologies, together with the decrease of the cost of sensors and monitoring systems, opens new perspectives. Nowadays the decision making process is much better and based on performance indicators, which are widely used in energy and environmental rating systems for buildings.

Data Driven IEQ Control in Low Energy Buildings (Prof. Dr.Ing Karel Kabele, President of REHVA)

Reduction of the energy use in the buildings is the objective, which changed traditional approach to building construction and has impact to the architecture, materials and building technologies used in modern buildings. Energy performance of the buildings, given by the European laws, is defined as a set of parameters describing efficiency of the components as well as the whole building. Those requirements must be nowadays fulfilled by law in the new buildings and in future will lead to the status, that all new buildings will be nearly zero energy buildings. The current pressure to reduce energy consumption of buildings but leads also to actions that significantly adversely affect the quality of indoor environment and in many of such buildings we can meet unexpected decrease of indoor environment quality and complains of occupants. This approach has impact to the building industry mainly in the field of intelligent buildings, new high efficient building services system, new building materials. Results of two case studies, related to heating system and natural ventilation control evaluation were presented.

Occupant Behaviour Monitoring and Engagement: Low Investment Measures to Optimize IEQ and Save Energy in Buildings (Prof. Dr.Stefano Corgnati, President-elect of REHVA)

Actual energy performance of buildings shows a significant difference with respect to what measured and what is estimated by calculation: in general, most buildings do not perform as well as expected. Among the different influencing factors, the behaviour of building occupants has the most significant effect on building energy use, and this can result in a wide gap between real and predicted building energy consumption.

International research program promoted by the International Energy Agency, in particular EBC Annex 53 and Annex 66, started to deepen the knowledge on the effect of user behaviour on final energy uses in buildings. Statistical models describing the user actions in rooms of different building types, especially houses and offices, were developed and implemented in dynamic energy simulation tools, opening new scenario in energy forecasting for different occupant lifestyles.

At the same time, in field campaigns for occupants energy engagements, aimed at increasing the user consciousness on energy savings, were set-up and appreciable results were highlighted about the potentialities in reducing energy needs while keeping indoor comfort at the required level. Results shows that energy saving from 10% to 15% can be achieved by user education.

Indoor Environmental Quality Monitoring system developed to be installed in a medium-size building located in the city of Horst, in the Netherlands. (Prof.Dr. Manuel Carlos Gameiro da Silva Vice President of REHVA).

The system has been designed in a modular configuration to allow the connection of sensors or meters with an USB digital output to Mini PCs that communicate through the power line with the building manager computer. In the current configuration the system includes sensors to monitor indoor thermal comfort, indoor air quality (CO_2, VOCs and PM_1, $PM_{2,5}$ and PM_{10}), Interior noise level, indoor illuminance and outdoor weather conditions. Two software packages were developed, the first one to assure the data acquisition and saving process and the second to be used has a data viewer, including a dashboard display and graphical interfaces for the download, the processing and the analysis of data.

Translation of building performance into monetary performance (F. Hovorka vice president of REHVA)

Collecting and having access to good data is unquestionably an essential part of ensuring we understand effective quality and performance of real estate. The deployment of rating tools has created quality tags that could drive contemporary best practice outcomes. In addition, the market penetration of Building Information Modelling (BIM) could help organized the huge amount of data available for Life Cycle Assessment and performance evaluation. There is thus a new opportunity to look beyond and leverage rich data sets 'au naturel', organized around common baselines. The question is now how we incorporate the information collected into our investment decisions to pave the way for a more responsible real estate sector.

The translation into the valuation process and the assessment of the sensitivity to future changes is the bridge we should built to achieve this necessary transformation The translation into value will help foster the necessary trust and alignment of interests between stakeholders required to create a virtuous mechanism of joint value creation. The transparency on uncertainty (spread between theoretical data and reality) will also definitively be needed in order to aggregate (without huge mistakes) the projects into a portfolio. This is the demand from financial institutions in order to initiate the massification of energy efficiency retrofit.

The 12th REHVA World Congress – CLIMA 2016 will be held in Aalborg, Denmark on May 22-25, 2016

In order to successfully achieve the goals of the EU commission in reducing building energy use considerably, new innovative HVAC solutions are required, which both facilitate extensive energy savings, while maintaining a healthy and comfortable environment as well as the implementation and integration of building integrated renewable energy systems and interaction with the smart energy system.

The main themes of the congress include:

- Building and HVAC System Design
- Efficient HVAC systems
- Sustainable Energy for Buildings
- Smart Building Operation and Management

The 12th REHVA Congress will especially focus on energy efficient building and HVAC system performance in practice both in relation to fulfilment of the intended design, in relation to their ability to fulfil the needs of the occupants and interact with the users' daily practice as well as in relation to their role in the future smart energy system.

CLIMA 2016 is a truly multidisciplinary conference – Succeeding in achieving high living and indoor environmental qualities in nearly zero energy buildings is the result of the integrated effort of many different building professionals – each playing their role. CLIMA 2016 is a conference for all stakeholders in the building sector as it deals with the whole life cycle of buildings and their HVAC systems from design specification to demolition and reuse.

The CLIMA 2016 program will include:

Keynote sessions with eminent international recognized speakers from industry, international organisations, science and the HVAC community.

Scientific sessions with presentations on recent research findings. Almost 600 contributions are received from more than 60 countries worldwide.

Topical sessions where research achievements from international projects are presented, including 5 EU projects and a special session track with results from more than 10 different IEA research projects.

Technical sessions with short technical communication from industry on practical applications.

Workshops on concurrent and future challenges focusing on international possibilities for solving them. 24 workshops are organised by REHVA.

An exhibition for sponsors and industry in conjunction with the congress.

Technical Tours to sustainable buildings located in the area with examples of new innovative HVAC technical systems and solutions.

Training courses with leading experts from REHVA and ASHRAE before the congress.

Social Program to experience Aalborg and neighbourhoods.

Tomasz Sienicki

Tomasz Sienicki

It is expected that the CLIMA 2016 congress will attract approximately 800-1000 attendees from all continents and will offer researchers, industry, building owners, consultants, engineers, architects, policy-makers, etc. a platform for the exchange of scientific knowledge and experiences on innovative technical solutions and on practical applications and technical solutions. CLIMA 2016 is organized and hosted by The Danish HVAC Society, Danvak, in cooperation with Aalborg University.

For more information: www.clima2016.org

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Professor Olli Seppänen, President of FINVAC, gave his opening address to the seminar audience (picture by Tiina Strand).

FINVAC Seminar on "The Impact of CE Marking and EU Regulation on HVAC Industry and Profession"

On 27 January 2016, the Finnish member association FINVAC arranged in Helsinki a half-day seminar on the impact of CE marking and EU regulation on HVAC industry and profession. The seminar was attended by 100 participants: product manufacturers, system suppliers, HVAC designers and consultants, HVAC inspectors, contractors and construction clients. The topics presented by the speakers included introduction to the legislation process in EU, Ecodesign Directive and Regulations, Construction Products Regulation, market surveillance, and points of view of national legislator, test house and product/system supplier.

A very lively discussion followed all presentations, indicating a huge confusion among the practitioners and need for reliable, practical and well-structured information. FINVAC had just established their own "EU Regulations" webpages, similar to those of REHVA but in Finnish. The seminar brought some new information within the field and revealed needs to update the webpages – actually this information will be useful also in updating REHVA's EU Regulations pages.

It is obvious that HVAC people will need a strong "wake-up" about the Construction Product Regulation (CPR), and we also have to take into account more facts about Ecodesign and Labelling. Different pieces of EU legislation bring different requirements to the same product, maybe also contradictory requirements although no such cases have yet been revealed. Even if such contradictions were not yet known, the field of regulations is confusing - the number of new regulations is huge, new ones will appear all the time.

We all have to learn new terminology and new rules in a very short time, and even though the preparatory process of individual regulations is long and transparent – at least in principle – we feel overloaded and "lost in a big jungle".

The picture of EU legislation is fragmented in many ways, and will remain fragmented and also confusing in near future. For example, an Ecodesign regulation gives exactly the same minimum requirements for a product throughout the EU, while CPR gives the Member States national freedom in setting the minimum requirements but requires the same Declaration of Performance everywhere. Furthermore, CE marking of a construction product is possible only if a harmonized European product standard (or alternatively European Technical Assessment scheme) exists for the product and its relevant characteristics. Otherwise the conformity to essential requirements has to be verified using national procedures, which may be totally different in different countries. For multifunctional products, subject to requirements from several regulations, and for products exposed to very different weather conditions in different installations, the complete evaluation of conformity may become very complicated and confusing.

The seminar focused on product level, so there was no detailed discussion about the energy performance of systems or buildings, the EPBD key issues. However, we learned that some of the Ecodesign regulations already take into account system or installation aspects, and give some rules how to evaluate assemblies or subsystems like certain heat pump / water heater combinations or ventilation units.

So, little by little, HVAC designers and their clients will have better tools to compare and specify products in a harmonized and thus in a more reliable way, manufacturers and suppliers will have a solid basis to compete with lifetime quality instead of just the investment cost. REHVA and the Member Associations have a big challenge: how to forward all the new information to HVAC practitioners and their clients about European regulations and what the regulations will mean in real practice.

JORMA RAILIO, FINVAC

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REHVA Workshops at CLIMA 2016 conference in Aalborg May 22-25, 2016

The REHVA workshops will take place parallel to other sessions at CLIMA 2016 conference. Each workshop will focus on a specific question (or questions). The result of the workshop will be an international action plan, a list of research needs, outline for a guideline, a policy statement, etc. The results will be presented to the congress participants in a summary report that will be sent to all participants after the conference and published on the website. To have more information on the workshops, please read the short descriptions online.

	Meeting Room 8	Meeting Room 9	Meeting Room 10
MONDAY – 23 May			
11.00 - 12.30	WS 1 Understanding HVAC Operational Performance SWEGON	WS 2 NZEB design and construction: skill gaps and interdisciplinary training of professionals PROF/TRAC	WS 3 Realizing (nearly) Zero Energy Hospital Buildings together REHVA Task Force
13.00 - 14.30	WS 4 Beat Low DeltaT Syndrome by use of the latest pump generation GRUNDFOS	WS 5 Nearly zero energy buildings nZEB REHVA Task Force	WS 6 Building Commissioning, -what's in it for me? REHVA Task Force
15.00 - 16.30	WS 7 Energy efficient heat pumps, from "Standard" performances to "Seasonal performance" Eurovent Certita Certification	WS 8 Inspections of ventilation and air conditioning systems REHVA Task Force	WS 9 Greenhouse gas reduction in buildings & healthy building SAREK
TUESDAY – 24 May			
11.00 - 12.30	WS 10 BELIMO Water Solutions Energy Efficiency in modern buildings Belimo	WS 11 CCHVAC-REHVA	WS 12 Building and ductwork airtightness: what has changed in the past 5 years, what is likely to change in the next 5 years? TightVent, AIVC, QUALICHeCK
13.00 - 14.30	WS 13 Dynamic solar shading in HVAC and daylight design ES-SO/EQUA/SWEGON	WS 14 Zero Internal Heating/Cooling Load Air-Conditioning system SHASE	WS 15 Perspectives for assessing ventilative cooling potential in Energy Performance regulations venticool, IEA Annex 62, AIVC, QUALICHeCK
15.00 - 16.30	WS 16 How to make cheaper GSHPs in Europe/How to diffuse GSHP in Europe Cheap-GSHPs/EU project	WS 17 Eurovent Innovation Hub - Adding value to your buildings: Efficient air curtain technologies made in Europe Eurovent Association	WS 18 European voluntary certification scheme: a tool linking environment and energy to market value Sustainable Business Alliance
WEDNESDAY- 25 MAY			
11.00 - 12.30	WS 19 Building Automation and Control Systems: continuous operational energy use optimization REHVA & eu.bac Task Force	WS 20 How to improve the quality of the works and compliance of Energy Performance Certificates? QUALICHeCK	WS 23 Quality management for building performance: Closing the gap between design and operation QUANTUM
13.00 - 14.30	WS 21 Coupling HVAC + Refrigeration + Lighting systems in shopping centres: technology solutions and modelling approach IIF-IIR and EURAC	WS 22 Agenda for Ventilation and Air Infiltration 2020 and beyond: knowledge gaps, research priorities and the need for innovation AIVC	WS 24 Energy Refurbishments REHVA Task Force

Short descriptions of the REHVA Workshops at CLIMA 2016

WS 1: Understanding HVAC Operational Performance

Monday, May 23, 11.00-12.30 (Meeting room 8)

Organiser: SWEGON

Presenters: Petra Vladykova, Swegon, John Woollett, Swegon, Ian Knight, Cardiff University

Short description: The impending requirement for near zero Energy Buildings (nZEB) needs the efficient consumption of energy by services. This presents requirements for data to support understanding of how to achieve this in practice. This participatory workshop explores the potential for informative and practical guidelines for facility managers, REHVA Guidebook and input for building regulations. The aim is to discuss what information and data are needed, how it should be done and provided, and how it might be used in the light of the updating of a number of Standards in this area, including ISO 52000-1, prEN 16798-17 and prCEN/TR 16798-18.

WS 2: NZEB design and construction: skill gaps and interdisciplinary training of professionals. The PROF-TRAC Training and Qualification Platform

Monday, May 23, 11.00-12.30 (Meeting room 9)

Organiser: PROF/TRAC

WS Leaders: Peter Op't Veld, HIA, Karel Kabele, REHVA

Presenters: Philippe Moseley, EASME, Peter Op't Veld, HIA, Anita Derjanecz, REHVA

Panel discussion: Jos Bijman, TVVL, Juan Travesi, ATECYR, Branimir Pavkovic, HKIS, Michael Mast, DANVAC

Short description: Nearly Zero Energy Building construction and renovation require a huge contribution from the building sector and is a challenge for the construction industry. A successful design and construction process towards nZEB requires innovative design processes and technologies based on an integrated design approach and multi-disciplinary work teams. This approach is not yet common as the building sector works in a fragmented process. Especially the collaboration between architects, technical experts and managers is necessary to develop mutual understanding of each other's disciplines and combine skills to achieve optimal nZEB construction and retrofitting in terms of quality, energy efficiency and cost effectiveness. The workshop will present the PROF/TRAC project that develops an Open Training Platform and Qualification scheme for Continuing Professional Development for engineers, architects and managers involved in nZEB design and construction. PROF/TRAC identifies skills gaps and professional profiles needed for nZEB construction and refurbishment, and develops a voluntary training and qualifications scheme involving REHVA Member Associations and training providers from the Architects' Council of Europe (ACE), Housing Europe. Several REHVA Member Associations have joined the platform or expressed interest in being involved in the scheme and in attending the Train the trainer sessions. The workshop will be also an opportunity to present the first achievements, to exchange about the experiences of the 4 project partner REHVA Members (ATECYR, DANVAC, HKIS, TVVL) and to discuss about the involvement of other REHVA Members in the PROF/TRAC Training and Qualification Platform.

WS 3: Realizing (nearly) Zero Energy Hospital Buildings together

Monday, May 23, 11.00-12.30 (Meeting room 10)

Organisers: TVVL/Rehva and Royal HaskoningDHV

Presenters: H. Besselink, Royal HaskoningDHV, W.H. Maassen

Short description: Legislation from the EU in 2020 will set much stricter requirements on the energy consumption of buildings and the way the energy is generated. This workshop will identify which performance requirements are facing us and how we can fulfill to these requirements.
Ultimately, the (nearly) Zero Energy Buildings (nZEB) legislation will be mandatory. The most sustainable performances will be achieved if the different stakeholders have an interest in the sustainable project. Therefore the different possibilities to achieve these performances and how they can be translated into costs and revenues for each stakeholder are important.
In an interactive workshop different groups will work on making 2 example cases energy neutral areas: an innercity district in the Rotterdam Port Area energy (Merwevierhavengebied) and an academic hospital in Amsterdam (VU-VUmc campus). In the first part of the workshop the technical possibilities on different scales will be explored. Then in the second part the group will determine how to realize this goal together from the perspective of the different stakeholders. The differences between the cases will give insight in the specific challenges of each project and especially nZEB Hospitals!

WS 4: Beat Low DeltaT Syndrome by use of the latest pump generation

Monday, May 23, 13.00-14.30 (Meeting room 8)

Sponsor: GRUNDFOS

Organiser: Jens Nørgaard, Grundfos

Presenters: Carsten Østergaard Pedersen, Grundfos, Anders Nielsen, Grundfos, Karin S. Nielsen, Grundfos**,** Jens Nørgaard, Grundfos

Short description: Chilled water systems are often suffering from low return water temperatures and hence low deltaT syndrome. The undesired effects of this condition are numerous and it leads to reduced system performance and efficieny. It is explained how the latest Grundfos pump generation can discover low deltaT syndrome and adapt the pressure in the system until the right flow and the correct ΔT is restored. Grundfos pump generation may be controlled by fluid temperature difference and how this can be utilized in HVAC systems. The advantage of this procedure is described. Constant temperature mode is utilized in domestic hot water applications, installation and the benefits of this. The latest pump generation may be utilized in large boiler shunt installations and how risk is reduced by this procedure.

WS 5: Nearly zero energy buildings nZEB

Monday, May 23, 13.00-14.30 (Meeting room 9)

Presenters: Jarek Kurnitski, REHVA Vice President, Prof. Tallinn University of Technology, Ryozo Ooka, Tokyo University, Jonas Gräslund, Skanska

Short description: This REHVA nZEB Task Force workshop will discuss nZEB technical, regulatory and policy progress with the aim to provide input to REHVA nZEB technical definition (2013) revision. nZEB WS will focus on recent developments in national applications in EU, Japan and US by rising an open issues in nZEB definitions and requirements. The essential question of nZEB buildings, how well buildings with on-site production fit to central energy system, is discussed based on recent results from Sweden. This study is developing a method of how to quantify the consequences of carbon dioxide emissions for energy efficiency and renewable energy solutions and investigate how the relevant time steps shall be chosen in order to be able to calculate which solutions provide the best addition of renewable energy at the same primary energy performance level when considering load match and grid interaction issues which is not obvious.

WS 6: Building Commissioning in Europe

Monday, May 23, 13.00-14.30 (Meeting room 10)

Presenters: Ole Teisen, Sweco Danmark A/S, Frank Hovorka, UNEP Financial Initiative, Sustainable Building Alliance, Ian Knight, Welsh School of Architecture, Cardiff University, Thomas Toftgaard Jarløv, Copenhagen Airports

Short description: REHVA is planning to produce handbooks and other material that support the use of Building Commissioning in Europe. Attending this workshop will provide new insights into how Building Commissioning is performed, how it interacts with sustainability measures and how it influences the value of buildings. It will also allow you to bring your own ideas to the table, and influence future work into Building Commissioning in Europe! The Workshop will start with 4 different angles on Commissioning from the moderators. This includes introductions to The Commissioning Process, the way it is described by IEA, the International Energy Agency, and the way it is performed in various countries. Also, an overview of benefits from Building Commissioning as it is done today and expected benefits from tomorrows Building Commissioning Process. After the introductory presentations, the workshop then starts. The moderators will facilitate the participants in finding topics to work with in the REHVA Commissioning Task Force, and to include in future publications. We intend to map market needs, elements we can foresee will be included in the future Commissioning processes, as well as demands for information about the Commissioning Process. Participants are invited to bring their anecdotes and experiences with gnarly Building systems to the plenum. We will have a good time discussing probable solutions and processes that can prevent the repetition of previous nightmares, and add more value to the Commissioning process.

WS 7: Energy efficient heat pumps, from "Standard" performances to "Seasonal performance"

Monday, May 23, 15.00-16.30 (Meeting room 8)

Organiser: Eurovent Certita Certification

Speakers: Sandrine Marinhas, Eurovent Certita Certification

Short description: Since first application to our products in 2013, residential and higher capacity air-conditioners, chillers and heat pumps are progressively moving from nominal (COP) to seasonal performance (SCOP and ηs) in heating mode and (EER, SEER, SEPR and ηs,c) in cooling mode, and associated minimum requirements and labelling schemes are set up. Calendar and details of the corresponding regulations and associated standards and certification documents will be presented, focused on the consequences for the end-users, the manufacturers, the laboratories and the organisation of certification.

WS 8: Inspections of ventilation and air conditioning systems

Monday, May 23, 15.00-16.30 (Meeting room 9)

Presenters: Jorma Railio, REHVA, Ian Knight, Cardiff University

Short description: Activities supporting the practical implementation of inspections required by the EPBD will be discussed in a participatory workshop format. From experiences in Member States, only a fragment of the mandatory inspections have been done, but there are encouraging experiences of alternative approaches. Now that the European standards for ventilation and air conditioning inspections have been revised and merged into the new prEN 16798-17 and prCEN/TR 16798-18, it is time for REHVA to collect the experiences and existing knowledge into a practical Guidebook.

WS 10: BELIMO Water Solutions - Energy Efficiency in modern buildings

Tuesday, May 24, 11.00-12.30 (Meeting room 8)

Organiser: BELIMO Automation AG

Presenters: Dr. Marc Thuillard, Dipl. Ing. Forest Reider, Dipl. Ing. Reto Hobi, Dipl. Ing. Christian Luchsinger

Short description: The proper balancing of hydraulics flows is an important factor contributing to the stability of HVAC in a building. Balancing can be achieved through different approaches using an electronic or a mechanic pressure-independent valve. Besides balancing an electronic solution can be expanded to a performance device, known as Energy Valve, capable of monitoring and optimizing energy consumption. This concludes the introduction. This talk will focus on electronic balancing methods and discuss two approaches for achieving this goal. The first method uses an electronic pressure-independent valve (ePIV). In state of the art office buildings the main comfort demand is more and more on cooling with a general low heating demand. Therefore a 4-pipe system with one heat exchanger like heating/cooling ceiling is likely and very common. To run such a system in an efficient way it is important that the pump runs efficient, independent on the load. For reaching this, different flows for heating and cooling are required combined with the lowest possible pressure loss. The advantages and disadvantages of mechanic and electronic pressure-independent solutions are highlighted with three different examples in relation with the established Belimo 6-Way Zone-Valve. During the discussion, we will show how the ePIV can be expanded into an even more intelligent HVAC device by adding two temperature sensors, resulting into an Energy Valve. Experimental results obtained during field tests at Massachusetts Institute of Technology (MIT), Boston and University of Colorado, Boulder: Saving energy and primary costs by preventing DeltaT degradation. Test at Nanjang Technical University (NTU), Singapore. We will show how the measurement of air enthalpy can enhance very significantly the function of the Energy Valve. Case study Hospital – Ludmillenstift / Germany: through a case study demonstrating how hydraulic problems can be discovered, monitored, analyzed and finally solved with the Belimo Energy Valve. A too low and/or too high flow results in wrong Energy transmission and will have a huge impact on patient comfort, energy bill and maintenance cost.

WS 12: Building and ductwork airtightness: what has changed in the past 5 years, what is likely to change in the next 5 years?

Tuesday, May 24, 11.00-12.30 (Meeting room 10)

Organisers: TightVent, AIVC, QUALICHeCK

Chairs: François Rémi Carrié and Benjamin Jones

Presenters: Dr. Marc Thuillard, Dipl. Ing. Forest Reider, Dipl. Ing. Reto Hobi, Dipl. Ing. Christian Luchsinger

Short description: The objective of this workshop is to discuss the major developments regarding building and ductwork airtightness in the past five years and the expected changes in the near future.

WS 13: Dynamic solar shading in HVAC and daylight design

Tuesday 24 May, 13.00-14.30 (Meeting room 8)

Organisers: ES-SO, European Solar-Shading Organization in collaboration with EQUA and Swegon

Presenters: Ann Van Eycken, ES-SO, Anders Hall, ES-SO, Per Sahlin, EQUA

Short description: The impact of solar radiation on the heat and light balance of a room is profound and, consequently, shading devices, glass, and control strategy are the first things to consider in HVAC and daylight design. Unfortunately, doing this is easier said than done. Not only do you need models that capture the correct physics of modern glazing and shading, but these models must also interact with a room model that accounts for all the physical processes that come together in the final room heat and light balance. Naturally, one must have correct product data for all involved components and be able to describe control action that reflects real systems. Today, these systems may well couple artificial and natural daylight with the thermal state of the room. The workshop starts with a presentation of a new quality assured database for shading products under the auspices of ES-SO and continues with the introduction and demonstration of a new tool chain for the complex design task.

WS 14: Zero Internal Heating/Cooling Load Air-Conditioning system

Tuesday, May 24, 13.00-14.30 (Meeting room 9)

Chair: Dr. Kato

Co-Chairs: Dr. Zhang, Dr. Hiyama

Short description: Dealing with the whole indoor air to maintain a comfortable thermal environment has been the main solution of the building air-conditioning system for many years. Recently, owing to the development of radiant heating/cooling systems and personal ventilation, a new trend has arisen where heat is dissipated to several independent areas, providing custom heat loads; this even provides us with the possibility of creating a zero heating/cooling load environment. In other words, it allows us to deal with the heat load from each heat source before the heat diffuses into the space. This solution enables us to utilize lower level heat sources, for instance chilled water at high temperatures. It also ensures more uniform temperature distribution and a more comfortable indoor thermal environment with improved energy efficiency. The attempt to realize zero internal heating/cooling load was first carried out for data centers and recently, in Japan, a liquid cooling air-conditioning system for office buildings was developed and will soon be used in real buildings. In this workshop, we will report the progress we have made in this field, followed by a discussion. Because the success of the zero internal heating/cooling load system is based on many different experiments and attempts, any presentation related to this topic is welcome. The aim of the workshop is to come up with a list of research gaps and questions and identify additional concerns regarding this topic.

WS 15: Perspectives for assessing ventilative cooling potential in Energy Performance regulations

Tuesday, May 24, 13.00-14.30 (Meeting room 10)

Organisers: venticool, IEA Annex 62, AIVC, QUALICHeCK

Chairs: Peter Holzer and François Rémi Carrié

Short description: The principal objective of this workshop series is to discuss the status, needs, and perspectives on developments to consider ventilative cooling in energy performance assessment methods.

WS 16: CHP Workshop How to make cheaper GSHP in Europe/How to diffuse GSHP in Europe

Tuesday, May 24, 15.00-16.30 (Meeting room 8)

Chairs: Michele De Carli, University of Padova, Robert Gavriliuc, Faculty of Building Services Engineering Bucharest

Presenters: Javier F. Urchueguía, David Bertermann, Luc Pockele

Short description: The market of heat pumps in Europe is increasing. Even though the most efficient solution is represented by GSHP, air to water heat pumps are mostly used in residential and commercial buildings, due to the lower investment costs. Based on the experience of the speakers and based on the recent work began in the Horizon 2020 European Project "Cheap-GSHPs" the workshop intent is to show the recent advances in the frame of the drilling and in the heat pump solutions to improve the market of the GSHPs. Discussion will be driven on current limits and potentialities of the GSHPs. In particular the discussion will be on the possible introduction of a CEN standard committee or working group on the GSHP systems.

WS 17: Eurovent Innovation Hub - Adding value to your buildings: Efficient air curtain technologies made in Europe

Tuesday, May 24, 15.00-16.30 (Meeting room 9)

Organiser: Eurovent Association

Presenters: Francesco Scuderi, Morten Schmelzer

Short description: By attending this Eurovent workshop, participants of CLIMA 2016 will learn how to save energy by applying the best performing air curtains for their construction projects. Which ISO standards should be applied for measuring air curtain performance? How state-of-the-art air curtains can contribute to a healthier indoor environmental quality? We will the upcoming Eurovent rating standard for air curtains. It makes sound economic sense to create an efficient and invisible door that keeps the cold and hot inside. Air curtains can be even more effective when used in air conditioned or cold storage buildings. Thermozone technology with its precisely adjusted air velocity gives even protection throughout the opening and contributes to a better indoor air quality. Effective air curtains provide an efficient separation with the lowest possible energy consumption, regardless of whether it is the heat or the cold that project engineers want to keep out. This Eurovent workshop provides for a hands-on introduction to state-of-the-art air curtain technology, allowing you to make valid choices concerning your building projects.

WS 18: European voluntary certification scheme: a tool linking environment and energy to market value

Tuesday, May 24, 15.00-16.30 (Meeting room 10)

Chair: Frank Hovorka

Co-chair: Johann Zirngibl

Presenters: Frank Hovorka, Carolina Mateo Cecilia, Johann Zirngibl, Jana Bendžalová

Short description: Multinational property owners and developers, financial institutions (including UNEP-FI) and building professionals are demanding international standardisation and uniform conditions in energy performance certification in order to enhance the comparability, transparency, coherence, reliability and accuracy in the Union. The EPBD requires adopting a voluntary common European certification scheme (VCS) for the energy performance of non-residential buildings. This workshop will describe how to create this common tool, able to be used Europe wide, and how it can be integrated in existing environmental certification schemes.

WS 19: Building Automation and Control Systems: continuous operational energy use optimization

Wednesday, May 25, 11.00-12.30 (Meeting room 8)

Workshop leaders: Peter Hug, eu.bac, Andrei Litiu, eu.bac

Presenters: Bonnie Brook, eu.bac, Stefano Corgnati, REHVA, Simona D'Oca (REHVA), Valentina Fabi (REHVA), Andrei Litiu, eu.bac, Roland Ullmann, eu.bac

Short description: The aim of the workshop is to interactively discuss about the crucial role of building automation and control systems in continuously optimizing energy use during the operation phase of buildings while at the same time ensuring adequate indoor environment quality and enabling occupants' behaviour change. The participants will learn about existing tools that help assess how well a building (new or existing) is equipped for energy use optimization and will be granted the opportunity to provide feedback on the ongoing work of REHVA & eu.bac`s Task Force on Building Automation, Controls and Building Management.

WS 20: How to improve the quality of the works and compliance of Energy Performance Certificates?

Wednesday, May 25, 11.00-12.30 (Meeting room 9)

Organisers: QUALICHeCK

Chair: Peter Wouters

Presenters: Peter Wouters, Jarek Kurnitski, Francois Durier, Heike Erhon-Kluttig, Susanne Geissler

Short description: To address these quality and compliance challenges, the objectives of this workshop are to discuss the following questions: What is the status on the ground in terms of quality and compliance? What steps could be taken to improve the situation? What are key aspects to consider for effective compliance frameworks? The discussions will be preceded by presentations summarising key findings of the QUALICHeCK project on these issues.

WS 21: Coupling HVAC + Refrigeration + Lighting systems in shopping centres: technology solutions and modelling approach

Wednesday, May 25, 13.00-14.30 (Meeting room 8)

Organisers: Eurac Research, Institute for Renewable energy, IIF-IIR, International Institute of Refrigeration

Short description: This workshop is intended to present and discuss tools and solutions for an effective energy-retrofit of shopping malls. It will take advantage of the participation of experts from the CommONEnergy project, who will bring their expertise and open a fruitful debate on the outcomes of the project. The result of the workshop can be an outline for a guideline on the energy-refurbishment of shopping malls.

WS 22: Agenda for Ventilation and Air Infiltration 2020 and beyond: knowledge gaps, research priorities and the need for innovation

Wednesday, May 25, 13.00-14.30 (Meeting room 9)

Organisers: AIVC

Short description: Taking into account the challenges we have in energy saving, there is a clear need for innovative and smart ventilation systems both in terms of comfort and health addressing challenges associated with renovation and new buildings. This session will discuss the need for advancing knowledge on ventilation in future buildings, it will discuss research priorities and the list the areas where the innovation is necessary. The broad areas that need to be addressed in the context of advancing ventilation in the future will be identified prior to the workshop together with the short list of priorities and innovations. This will be done by contacting relevant stakeholders in research and industry. The list will be discussed and supplemented by the workshop participants. The voting will be completed to identify the priorities that need to be quickly addressed and methods for their implementations.

WS 23: Quality management for building performance: Closing the gap between design and operation

Wednesday, May 25, 11.00-12.30 (Meeting room 10)

Chair: Stefan Plesser, Head of the Energy and Quality Management Group, IGS - TU Braunschweig

Co-chair: Karel Kabele

Presenters: Stefan Plesser, IGS - TU Braunschweig, Jan Mehnert, synavision GmbH, Niels Delaere, Factor4, Michele Liziero, EnergyTeam SPA

Short description: QUANTUM develops and demonstrates pragmatic services and appropriate tools supporting quality management for building performance in the design, construction, commissioning and operation phase as a means to close the gap between predicted and actual energy performance in European buildings. The workshop will present the current stage of quality management for building performance and discuss its role as key action within the life cycle of buildings. It addresses especially building owners, engineers, facility management and contracting companies with their individual perspective on quality. REHVA will set up a Task Force around this topic exchanging related knowledge and using the project outcomes to elaborate a REHVA Guidebook. The workshop aims also to launch the Task Force.

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

Events in 2016

Conferences and seminars 2016

March 8-11	Sustainable Built Environment - SBE 2016	Hamburg, Germany	www.sbe16hamburg.org
March 16-18	9th International Conference Improving Energy Efficiency in Commercial Buildings and Smart Communities (IEECB&SC'16)	Frankfurt, Germany	http://iet.jrc.ec.europa.eu/energyefficiency/node/9096
March 31-April 2	12th International HVAC+R Technology Symposium	Istanbul, Turkey	www.ttmd.org.tr/sempozyum2016/eng/
May 10	3rd QUALICHeCK Conference	Brussels, Belgium	http://qualicheck-platform.eu/2015/12/3rd-qualicheck-conference/
May 22-25	12th REHVA World Conference - CLIMA 2016	Aalborg, Denmark	www.clima2016.org
May 30-June 3	CIB World Building Congress 2016 Intelligent built environment for life	Tampere, Finland	http://wbc16.com
June 22-24	Central Europe towards Sustainable Building Prague 2016	Prague, Czech Republic	www.cesb.cz
July 3-8	Indoor Air 2016	Ghent, Belgium	www.indoorair2016.org
August 21-24	12th IIR Natural Working Fluids Conference	Edinburgh, United Kingdom	www.ior.org.uk
September 21-23	International Conference on Solar Technologies & Hybrid Mini Grids to improve energy access	Frankfurt, Germany	www.energy-access.eu
October 23-26	IAQVEC 2016: international conference on indoor air quality, ventilation & energy conservation in buildings	Seoul, South Korea	www.iaqvec2016.org

Exhibitions 2016

March 1-4	AQUATHERM Prague	Prague, Czech Republic	www.aquatherm-praha.com/en/
March 13-18	Light and Building	Frankfurt, Germany	http://ish.messefrankfurt.com
March 15-18	Mostra Convegno Expocomfort	Milan, Italy	www.mcexpocomfort.it/
April 5-8	Nordbygg	Stockholm, Sweden	www.nordbygg.se
April 20-22	Aqua-Therm St-Petersburg	St-Petersburg, Russia	www.aquatherm-spb.com/en
May 4-7	ISK-SODEX 2016	Istanbul, Turkey	www.sodex.com.tr/
May 30 – June 1	ISH China & CIHE	Beijing, China	www.ishc-cihe.hk.messefrankfurt.com
August 31 - September 2	ISH Shanghai & CIHE	Shanghai, China	www.ishs-cihe.hk.messfrankfurt.com
October 12-14	FinnBuild	Helsinki, Finland	www.messukeskus.com/Sites1/FinnBuild/

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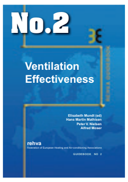
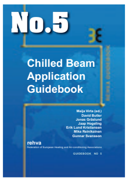
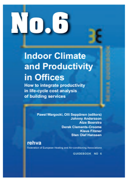


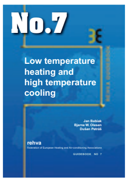
Ventilation Effectiveness. Improving the ventilation effectiveness allows the indoor air quality to be significantly enhanced without the need for higher air changes in the building, thereby avoiding the higher costs and energy consumption associated with increasing the ventilation rates. This Guidebook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



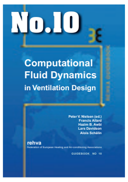
Chilled Beam Cooling. Chilled beam systems are primarily used for cooling and ventilation in spaces, which appreciate good indoor environmental quality and individual space control. Active chilled beams are connected to the ventilation ductwork, high temperature cold water, and when desired, low temperature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



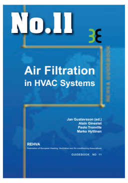
Indoor Climate and Productivity in Offices. This Guidebook shows how to quantify the effects of indoor environment on office work and also how to include these effects in the calculation of building costs. Such calculations have not been performed previously, because very little data has been available.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



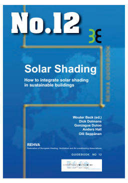
Low Temperature Heating And High Temperature Cooling. This Guidebook describes the systems that use water as heat-carrier and when the heat exchange within the conditioned space is more than 50% radiant. Embedded systems insulated from the main building structure (floor, wall and ceiling) are used in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



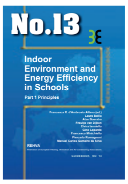
Computational Fluid Dynamics in Ventilation Design. CFD-calculations have been rapidly developed to a powerful tool for the analysis of air pollution distribution in various spaces. However, the user of CFD-calculation should be aware of the basic principles of calculations and specifically the boundary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



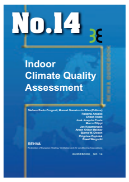
Air Filtration in HVAC Systems. This Guidebook will help the designer and user to understand the background and criteria for air filtration, how to select air filters and avoid problems associated with hygienic and other conditions at operation of air filters. The selection of air filters is based on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



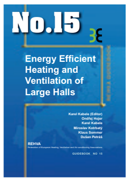
Solar Shading – ***How to integrate solar shading in sustainable buildings.*** Solar Shading Guidebook gives a solid background on the physics of solar radiation and its behaviour in window with solar shading systems. Major focus of the Guidebook is on the effect of solar shading in the use of energy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



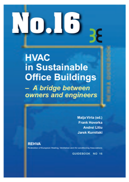
Indoor Environment and Energy Efficiency in Schools – *Part 1 Principles.* School buildings represent a significant part of the building stock and also a noteworthy part of the total energy use. Indoor and Energy Efficiency in Schools Guidebook describes the optimal design and operation of schools with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



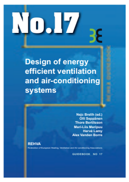
Indoor Climate Quality Assessment. This Guidebook gives building professionals a useful support in the practical measurements and monitoring of the indoor climate in buildings. Wireless technologies for measurement and monitoring have allowed enlarging significantly number of possible applications, especially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



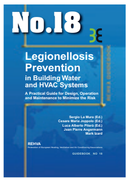
Energy Efficient Heating and Ventilation of Large Halls. This Guidebook is focused on modern methods for design, control and operation of energy efficient heating systems in large spaces and industrial halls. The book deals with thermal comfort, light and dark gas radiant heaters, panel radiant heating,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



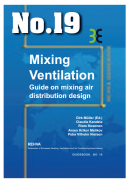
HVAC in Sustainable Office Buildings – ***A bridge between owners and engineers.*** This Guidebook discusses the interaction of sustainability and heating, ventilation and air–conditioning. HVAC technologies used in sustainable buildings are described. This book also provides a list of questions to be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



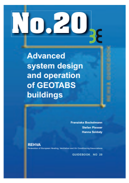
Design of energy efficient ventilation and air-conditioning systems. This Guidebook covers numerous system components of ventilation and air-conditioning systems and shows how they can be improved by applying the latest technology products. Special attention is paid to details, which are often overlooked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



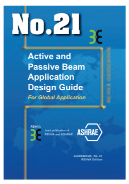
Legionellosis Prevention in Building Water and HVAC Systems. This Guidebook is a practical guide for design, operation and maintenance to minimize the risk of legionellosis in building water and HVAC systems. It is divided into several themes such as: Air conditioning of the air (by water – humidification),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



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



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



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

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