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Compliance and quality of the works:
critical factors for successful EPBD implementation

The Energy Performance of Buildings Directive recast introduced in 2010 two important articles requiring member states to implement independent control systems for the Energy Performance Certificates (article 18) and penalties in case of non-compliance (article 27). Why?

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One significant hurdle on the route towards NZEB concerns the compliance of buildings to NZEB requirements, in particular, how to ensure they actually comply with applicable regulations or programme specifications. Overlooking this problem can lead to competition distortion and discourage building professionals to deliver compliant buildings. To avoid this pitfall, member states should have a good understanding of the situation on the ground. This includes an evaluation and analysis of the gaps observed between declared and "determined as-per-the-rules" building characteristics in Energy Performance Certificates (EPC). In addition, member states should also set up boundary conditions forcing people to do what they declare, consistently with the implied objectives of articles 18 and 27 of the EPBD.

Another high hurdle lies in upgrading the quality of the works to meet NZEB standards at commissioning but also in a longer term. The approaches to address this problem should build on sufficient knowledge of field practice and boundary conditions urging building professionals to execute works in line with specifications consistent with NZEB levels.

Experience shows that the remedies to overcome both problems aforementioned must be adapted to the local context to be effective. In particular, societal support is a major key to success but it largely depends on the market acceptance of the penalties, control systems, incentives as well as their cost effectiveness.

The QUALICHeCK project (2014-2017, http://qualicheck-platform.eu) funded under the Intelligent Energy Europe programme focuses on EPC compliance and quality of the works, and finding ways to overcome these problems based on the analysis of existing approaches and interaction with stakeholders. We have also foreseen a series of activities (conferences, workshops, webinars, national roadshows and consultation platforms in 9 countries represented in the consortium) to raise awareness among stakeholders by sharing the analysis of the status on the ground and examples of possible approaches.

In this special issue of the journal, you will find syntheses of several outputs of QUALICHeCK, including results from field studies and analysis of interesting schemes. The hurdles are high and the status on the ground can sometimes be worrying, but there are also promising signals from the evaluation of several recent or old schemes. Disseminating this information is essential to trigger new initiatives and generalize NZEB in practice without market competition distortion. ■

QUALICHeCK responds to the challenges related to compliance of Energy Performance Certificate (EPC) declarations and the quality of the building works. Find out more at http://qualicheck-platform.eu.

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Compliant input data for building energy performance certificates

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In order to establish the Energy Performance Certificates of buildings required by national transpositions of the EPBD, input data for energy performance calculation are needed that describe the building and its systems. This article from the QUALICHeCK project identifies existing approaches that contribute to compliant and/or easily accessible input data.

Keywords: EPBD, building, certification, energy performance, certificate, EPC data, EPBD compliance.

The European Directive on the Energy Performance of Buildings (EPBD) [1] requires that Member States set up a calculation of the energy performance (article 3) and a certification (article 11), with an Energy Performance Certificate (EPC) (article 12) showing to the owner or tenant the energy performance of his or her building compared to reference values. Member States must also establish an independent control system for the energy performance certificates (article 18), including a check of the results stated and of the input data used. According to article 27, non-compliance must be sanctioned.

These energy performance calculations resulting in EPCs need input data describing the building (location, climate, orientation, area, construction products used and their implementation) and its systems (HVAC, lighting, solar shading, local production of electricity…). In order to get a correct assessment of the energy performance, it is necessary that:

- the input data for the energy performance calculation are compliant and an evidence of this compliance exists;
- these input data are easily accessible to experts in charge of the calculations.

This article describes examples of existing approaches in European countries that help for compliant and/or easily accessible EPC input data for HVAC systems. These examples are taken from a report [2] of the European project QUALICHeCK, co-funded by the Intelligent Energy Europe Programme of the European Union.

Definitions

In QUALICHeCK, the following definitions are applied:

1. A quantity used as an input data for the calculation or the assessment of the energy performance of a building, and/or the declaration of its energy performance in the Energy Performance Certificate

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(EPC), is compliant if this data has been established in line with the procedures in force in the context of the applicable legislation.

2. It is easily accessible if it is able to be found, seen and used by taking reasonable time, effort or money.

The procedures to obtain compliant data should be publicly available and may be integrated into regulations, codes, standards, professional rules,...

The evidence that the data have been obtained according to these procedures may rely on:

- the control by an independent third-party;
- the declaration by the manufacturer;
- the proven competence of the expert in charge of assessing the data;

Note that compliant does not necessarily mean accurate. The procedure to get a data may introduce an error, but if this procedure is recognised, the data will be compliant. Therefore, compliant data may be far from real values. For example, a default value used as an input data according to the procedures may be too pessimistic or too optimistic compared to the real value. Nevertheless, it will meet the definition of compliant data.

Considering that an information can be found and used by taking reasonable time, effort and money is subjective. It has to be appreciated in the context of the best available information technologies. In Europe, a data will be considered as easily accessible if it can be found with quite the same time, effort and money as an information that would be available for free on an Internet page.

Easy access to EPC input data

One of the identified examples described in report of the European project QUALICHeCK [2] contributes to easily accessible data.

A voluntary scheme has been implemented in France by the ventilation system manufacturers under the umbrella of their national association, Uniclima, with the technical support of CETIAT, in order to publish harmonized data.

Requirements have been defined about the characteristics to be published in the manufacturer documentations (technical sheet, website, catalogue, and packaging) for 19 different ventilation and air handling products, together with the conditions for obtaining and displaying them (standards to be used, quantities and units to be published).

Data published according to this scheme are identified by a specific logo. Joining the scheme is free. The development and update is operated by manufacturers within Uniclima.

AFFICHAGE DES PERFORMANCES
Les produits repérés par ce logo respectent les recommandations d'affichage des performances définies par Uniclima.

Logo to identify data published according to the scheme.

The scheme allows professionals to easily find data that are published in a harmonised way, compatible with their use for the EPC calculation.

This approach is described in more details in a dedicated QUALICHeCK factsheet [3].

Compliant EPC input data

One of the identified examples contributes to compliant data.

In order to reduce the variability in the values of building airtightness between testers and to improve the consistency between test results and EPC input data, several countries (the Czech Republic, Denmark, France, Germany, Ireland, Sweden, the United Kingdom) have implemented schemes to qualify testers.

Such schemes reduce the risk of wrong values due to unintentional mistakes (caused by lack of competence) and lead to more reliable test results, that are used as input data for the EPC calculation.

This approach is described in details in a dedicated article of the same issue of REHVA Journal ([4]).

Compliant and easily accessible EPC input data

Some of the identified examples provide interesting approaches to achieve compliant and easily accessible data.

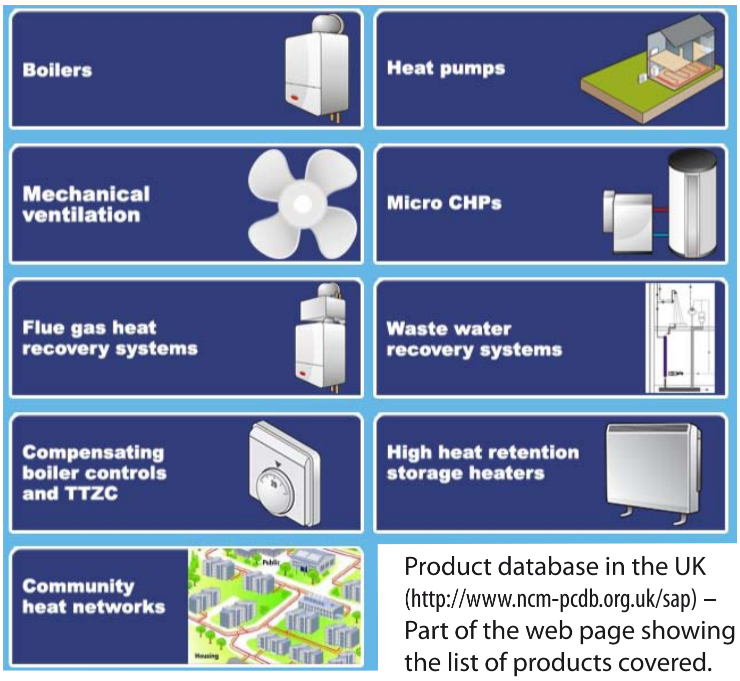
Product characteristics databases have been implemented in Belgium, the United Kingdom and France.

Belgian EPBD product database (http://www.epbd.be) - Web page (in French) showing the list of products covered: insulation products, opaque construction products, sunscreens, ventilation components/systems.

They provide data related to products that are useful for the EPC calculation, with an easy access, through an online public website.

In addition, the data are compliant together with an evidence of their compliance as they are controlled by a third-party (Belgium, France), or because the manufacturer must provide the data with validated evidence of their performance (UK).

The Belgian EPBD product database gives the characteristics of hundreds of ventilation and thermal insulation products, as well as sunscreens. It is managed by BBRI on behalf of the three Regions of Belgium.



Product database in the UK (http://www.ncm-pcdb.org.uk/sap) – Part of the web page showing the list of products covered.

The database implemented in the United Kingdom covers heating systems, ventilation systems and heat recovery systems. It is managed by BRE on behalf of the Department of Energy & Climate Change.

The French database is focused on heating systems (boilers, heat pumps, solar thermal systems, domestic hot water systems, hot water radiators, independent gas-fired space heaters). It has been launched by Uniclima (French association of heating system manufacturers) and is managed by the French association ATITA.

The use of these databases by product manufacturers is voluntary. The cost of their operation is paid by manufacturers who decide to join. The success of such databases is rather high, with possible or actual connections to the software used to calculate the building energy performance.

How to deal with innovative products

A possible way to generate compliant and accessible EPC input data for innovative products is illustrated by one of the identified examples. A scheme implemented in Belgium allows assessing the performance of innovative products thanks to specific procedures, defined by a collective of relevant industrial associations, assisted by experts and with representatives of the Regions. To a certain extent, similar schemes (but with some substantial differences) exist in France and The Netherlands.

The Belgian example is implemented in the framework of the Belgian technical body for the approval of construction products. The manufacturers may use this scheme on a voluntary basis and pay for the corresponding costs.

French product database (http://www.rt2012-chauffage.com) - Web page showing the list of products covered.

The scheme has so far mainly been used for innovative ventilation products, and especially for demand-controlled residential ventilation systems, for which the procedure consists in the calculation of a performance coefficient from the characteristics of the product. This performance coefficient is then used as an input data into the building energy performance calculation.

The scheme provides compliant input data with an evidence of compliance, as the product characteristics are checked by a third-party and the correct implementation of the assessment procedure is checked by the approval body.

The data to be used for the EPC calculation are easily accessible as they are published on the regional public authorities' websites.

Conclusions regarding replication in European Member States

In order to make the access to the EPC input data easier, the approach may be to set up rules for a harmonized publication of product performance (example in France).

In order to improve the compliance and evidence of compliance of EPC input data, the approach may be to implement a qualification scheme, as e.g. for building airtightness testers in the Czech Republic, Denmark, France, Germany, Ireland, Sweden and the United Kingdom, thus securing the test result used as an input data for the EPC calculation.

In order to improve the compliance and evidence of compliance of the EPC input data and the easy access to them, the approach may be:

- to establish a database of product characteristics (examples in Belgium, France and the United Kingdom), combined with either a control by a third party, or a validated performance of the published values;
- to set up a procedure for generating compliant EPC input data for innovative products (example in Belgium).

These approaches often have a high potential for replication in other countries. Their potential of extension to other products is also often high.

All the approaches that provide compliant data contribute to a more accurate calculation of the energy performance and thus reduce the risk for non-compliance of the actual building energy performance with the minimum requirements of the regulations. ■

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Quality of works Existing situations, reasons for problems and first best practice solutions

Keywords: quality of works, QUALICHeCK, construction site.

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Compared to today's practice, the trend towards Nearly Zero-Energy Buildings (NZEB) implies the correct execution of classical building works, e.g., airtightness and the correct execution of building nodes, and the use of advanced technologies requiring specific skills of the workforce such as handling renewable energy sources in combined HVAC systems or advanced ventilation systems. The IEE project QUALICHeCK is here focusing on establishing good technical boundary conditions to ensure adequate quality of the works. In this context it is important to understand that technical requirements are a prerequisite for having a framework that encourages compliance and allows imposing effective penalties related to the quality of the works. The ultimate goal is to stimulate the development of schemes to improve the quality of the works, taking into account the pros and cons of previous experience, with specific attention given to boundary conditions and to allowing effective compliance. The work in QUALICHeCK documents and builds on successful initiatives to overcome critical site implementation issues that undermine the confidence in actual building energy performance.

Matrix on critical situations regarding the work vs. focus areas

As starting point of the work, QUALICHeCK has compiled a matrix with more than 60 critical situations that can arise on the construction site starting with general issues like poor specifications of product performances, time pressure, language barriers, and insufficient knowledge of new technologies and ending with rather specific mistakes that can be made when installing certain technologies, e.g. no accessibility for cleaning the ventilation ducts or wrong control settings. These critical situations have been allocated to the project's technical focus areas transmission, ventilation, sustainable summer comfort technologies, and renewables in multi-energy systems. The matrix has then been filled with experiences and studies from various EU countries and with first best practice solutions.

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Reasons for problems with quality of works

Based on the matrix there can be a wide range of reasons for poor quality on the construction site from poor specifications at the level of projects, standards or regulations to lack of competence, critical economic conditions and lack of control, see **Figure** below. Poor specifications can concern the material to be used (material characteristics such as thermal conductivity, or the construction details for joints), the definitions of the required performances (air-/water-tightness, wind resistance for PV panels fixtures, acoustical performance of the ventilation system, etc.) or the execution principle (e.g. under which conditions roofing may be installed). Lack of competence can occur at the designer level (see QUALICHeCK work on compliant and easily accessible input data), at the construction workers level and can generally be caused by language barriers. Critical economic conditions may be caused by financial limits and by deadlines too short for the work. Last but not least, lack of control (in combination with the other reasons) may lead to a lower quality of work, but can be overcome by checks from either parties involved in the project (building owner or architect) or by third parties, which can be governmental or come from independent control organisations.

Four main reasons for problems associated with the quality of works.

National experiences and studies

A collection of national experiences and studies of critical situations regarding the quality of works is ongoing, but the first report of the “quality if works” area [1] within QUALICHeCK contains a summary of 17 national reports. They have been analysed with regard to the technological areas covered, their transferability to other countries and the resulting consequences. Examples include results of field tests of heat pumps, solar thermal systems and ventilation systems, the impact of storm on the fixtures of PV systems, surveillance activities on construction sites, studies on reasons for moisture and mould damages, costs of defects in construction, factors affecting the building’s airtightness and the general analysis of a country’s national status quo regarding the quality of works within BUILD UP Skills [2].

One example for the collected analyses is a study on ventilation systems in classrooms conducted in Austria in 2008 [3]. The researchers performed a technical evaluation of the ventilation systems and found many shortcomings due to mistakes made during planning and installation, including poor specifications of execution performances in the tender, reduced ventilation rates due to noise problems, filter change problems and partly incorrectly installed filters. As a result of the study, a planning guideline proposing 61 detailed quality criteria for classroom ventilation systems was developed. Additionally, the training material for the ventilation installer course was revised.

Good practice examples to solve critical situations

Some first successful national examples that help to guarantee a higher quality of construction and installation works have also been gathered and included in the project report [1]. Fifteen national solutions are presented that can be grouped into education and training of construction workers, qualification schemes and certification of workers or companies, guidelines and checklists, quality assessments by third parties and guarantees for building owners. One example is the voluntary UK quality framework CIGA for the insulation of cavity walls that is a guarantee scheme available since 1995 providing home owners with the comfort of knowing that work carried out by registered contractors complies with the requirements of the UK building regulations. The CIGA guarantee covers defects in materials or workmanship. Another good practice example is presented in the QUALICHeCK fact sheet “the German contractor’s declaration” [5]. The German contractor’s declaration is a new obligatory scheme that requires contractors to confirm in writing after having completed the works, that the specific minimum energy performance requirements for building envelope components, space heating and hot water generation and distribution systems and newly installed cooling and ventilation systems are met during the realisation of a renovation measure. Infringements lead to fines.

Conclusions and future work

QUALICHeCK has collected and analysed critical situations on the construction site regarding the quality of work, has summarised relevant national experiences and studies and found good practice solutions that help to solve the critical situations. The collections will be extended by further studies and approaches and will be discussed with stakeholder organisations during workshops and bilaterally. This will enable for the experiences an assessment by the stakeholders concerning how they rate the experiences and whether they are aware of similar experiences in other countries, a collection of additional published studies and other knowledge and a discussion about the reasons for the critical points. For the best practice examples the stakeholder feedback shall contain an assessment of the solution examples already included, their view regarding the transferability to other countries or even other critical situations and additional best practice examples.

Thus reviewed and extended, the national and international experiences with critical points at the construction site and approaches to a better quality of work will be presented in the final report. The most interesting experiences and solution approaches will be described in more detail in fact sheets. ■

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Compliance of U-values in new residential buildings in Cyprus

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This study examines whether the minimum requirements regarding the U-values of the new residential buildings in Cyprus comply with the decrees issued by the MCIT, both as they were declared in the buildings' EPCs, and as they were built on site.

Keywords: energy, performance, certificate, EPC, U-values, compliance.

Introduction

Buildings have a significant contribution in the overall energy consumption in the European Union ("EU") by about 40%. For this reason, the EU has issued specific directives to member states related to the Energy Performance of Buildings and the use of renewable energy in buildings. Cyprus has embedded into national law the aforementioned directives, by taking various measures, such as issuing relevant decrees. The latest decrees by the Cypriot Ministry of Energy, Commerce, Industry and Tourism ("MCIT"), came into effect on 11 December 2013, according to which the new maximum specified heat transmission coefficients ("U-values") for the building envelope are as follows: Umax external walls/ columns/ beams = 0.72 W/m²K, Umax external exposed floors/ roofs = 0.63 W/m²K, Umax floors above spaces without air-conditioning = 2.00 W/m²K, Umax external openings = 3.23 W/m²K, Umean max. = 1.30 W/m²K.

Compliance with the decrees issued by MCIT is both essential and crucial. That is why this study examines whether the minimum requirements regarding the U-values for the building envelope, as well as the average U-value, of the new residential buildings in Cyprus are according to the decrees issued by the MCIT, both as they were declared in the buildings' Energy Performance Certificates ("EPCs"), and as they were built on site.

Type of information collected and analyses conducted

The present study focuses on the U-values of 22 new residential buildings, located in the southern part of Cyprus (see **Figure 1**). During the study, photographs of the examined buildings during construction phase and documents from suppliers regarding the U-values of specific elements were collected, site visits and inspections took place in order to gather information regarding their real construction, and communications with architects, constructors, and tenants, where possible, were conducted in order to verify the as built situation of the examined construction elements that were declared in the EPCs. Moreover, a calculation of their U-values was conducted taking account of the as built situation in order to check whether the buildings were built as designed, specified and declared regarding those specific elements.

EPCs input data compliance

Non-compliance with the input data in the EPC of a building leads to wrong reporting, which in most cases means that the reported performance is better than the actual performance. Reported U-values may vary from actual U-values due to various reasons. For example

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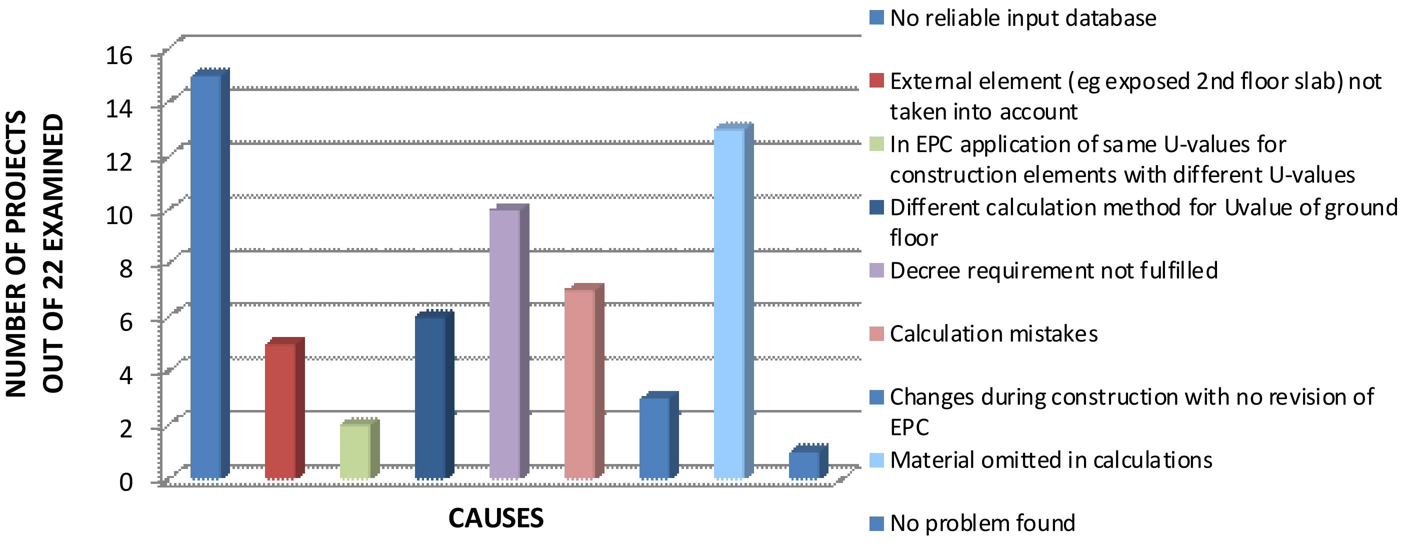

Figure 2. Causes for deviations between calculated in EPC U-values and in actual U-values.

during EPC calculation the qualified building energy assessors (QE) may be applying same U-values for construction elements with different U-values, or during construction there may be use of different products with worse U-values than the ones specified during the EPC calculation, or there may be mistakes or omissions of building elements during construction which lead to a different U-value than the one stated, or there may be missing or unclear definition regarding input data (e.g. windows, doors). Also, in Cyprus, although there is a control framework regarding the calculations in the EPCs in order to submit to authorities for building permit, there is no control framework on site, which means that there is no procedure to control energy performance issues related to the quality of the works.

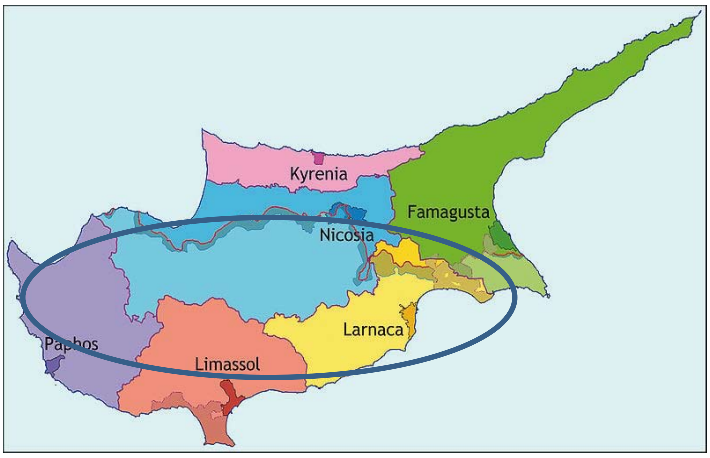

Figure 1. Study conducted in the southern part of Cyprus.

Conclusions of Cyprus new data collection study

In the 22 new residential buildings, which were examined in the present study, there are deviations between reported and actual U-values, which sometimes are not so important, for example during calculation a construction element like the coat cement being omitted, but which sometimes are very important, for example there may be no reliable input data, or a construction element like part of an exposed slab or a single glazed window may not be taken into account, or there may be changes during construction without the required EPC revision (see **Figure 2**).[1]

The study also showed that only 54.5% of the examined new residential buildings fully comply with the new requirements regarding maximum U-values and maximum average U-Value, whereas in the cases that they do not comply, there are specific construction elements that do not comply, which are the exposed floor slabs and the external openings. As for the pattern of causes for non-compliance, the study revealed that in most cases the causes ■

[1] Important note: Requested information was not provided by some QE and the main reason, as was reported by them, was that the reported in EPCs U-values vary from actual U-values due to either lack of a supervising engineer on site, or alterations made during construction without the required revision of the EPC due to time/budget reasons, or engineers giving wrong and/or deficient information to QE due to lack of knowledge or appreciation of the value of EPC.

Competent tester schemes for building airtightness

Several hundreds of thousands of building airtightness tests are performed every year in the EU. Competent tester schemes have been developed in eight countries to increase confidence in the results and values reported in Energy Performance Certificates. About 2000 testers are now qualified through those schemes.

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Building airtightness is a key issue to reach low- and very low-energy targets. Therefore, an increasing number of tests are performed in European countries for various reasons, including:

- compliance to the energy performance regulation;
- compliance to a specific energy programme; or
- wish of the building owner.

To illustrate this trend, to our knowledge, measuring the airtightness of all new buildings or at least part of them is required by the energy performance regulation in UK, France, Ireland and Denmark. Other countries give a significant reward in the energy performance assessment for better-than-default airtightness values. In addition, specific energy programmes (such as Passivhaus or Minergie) that require or encourage building airtightness testing are increasingly popular in many other countries. Consequently, likely within a few years, over a million tests will be performed every year in Europe.

Reasons behind the development of competent tester schemes

Performing and reporting correctly an airtightness test requires knowledge and know-how as well as pre-requisite on the tools used by the tester. Because of related legal and financial issues, having confidence in the test results as well as the consistency between the measurement results and values used in the energy performance assessment have become crucial issues. In fact, the building's compliance to the regulation may be affected in particular because:

- the test is not performed although required;
- the test is wrongly performed and/or reported;
- the test results are such that the EPC does not meet the regulatory requirements.

Therefore, competent tester schemes have been developed in several countries to prevent errors. The following objectives were implicitly or explicitly sought:

- Ensure testers are competent to perform a test;
- Give a quality seal to airtightness testing;
- Bring trust to the market;
- Avoid the pitfalls experienced with EPC experts;
- Follow-up the testers' service.

Key components of testers' schemes

The key components we identified in 8 competent tester schemes from various countries (BE, FR, IE, DE, DK, SE, UK, CZ) are:

- To set a minimum standard for the knowledge of

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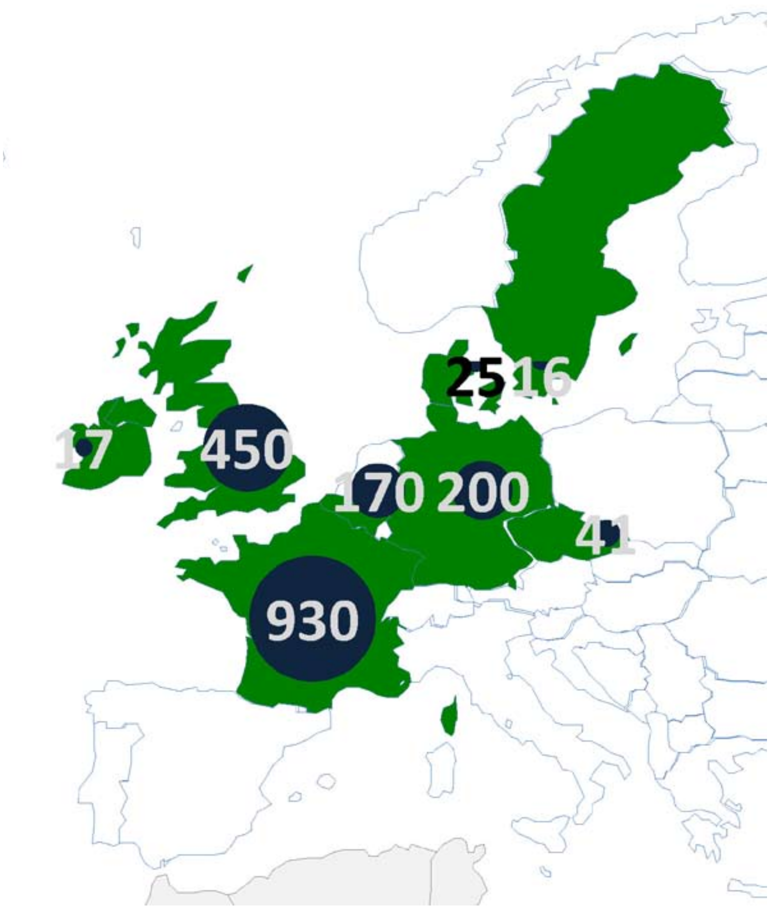
the tester (in particular on the regulatory or the programme context, the fundamentals of ventilation and infiltration, and the fundamentals of airtightness measurement);

- To set pre-requisites on the tools used (equipment, analysis and reporting tools);
- To set a minimum standard for the know-how of the tester (including the building preparation, the steps of the test, the proper use the equipment on site, the data analysis and calculation of derived quantities, the writing and filing of the report);
- To follow-up the testers' service, for instance, through periodic checks of reports, on-site checks, or test data lodgement.

These components are supported by technical documents, training programmes and evaluation procedures.

About 2000 qualified testers with competent tester schemes

Thanks to members of the TightVent Airtightness Associations Committee (TAAC), we have counted about 2000 qualified testers distributed in 8 countries



Number of qualified testers in 8 European countries in February 2015.

as shown in **Figure** below.

Database developments

Six schemes (BE, DK, DE, CZ, FR, UK) require reporting in a database specific to each scheme. This has several advantages, provided that the database is well-structured:

- It becomes easy to analyse large samples and extract meaningful trends, e.g. per building type or construction methods. The French database expects to grow by over 100 000 tests per year;
- The database can be used as a means to secure the data and check the consistency between the test results and the values used in the Energy Performance assessment;
- The database can be used to ease and initiate on-site checks by the scheme holder. To our knowledge, on-site checks are operational at this time only in Belgian and, to a lesser extent, in France although such procedures are considered or under development in other countries;
- It is possible to track suspicious results. To our knowledge, this is not operational in any scheme now but simple checks (and maybe cross-checks with energy performance certificates) could be performed to check the consistency of the results. It can be one step to check the testers' honesty (e.g. by cross-checking the number of tests performed in a single day and the distance travelled).

Conclusions

Several competent tester schemes are now operational. Because they require specific knowledge and know-how as well as pre-requisites for the tools used, they can only improve the quality of measurements. It is now difficult to quantify this improvement although there are positive signs from the market. Future developments, in particular with databases and on-site checks, should help better evaluate those schemes and further secure the data produced and reported by the testers. ■

Acknowledgements

The authors wish to thank the following participants to the TightVent Airtightness Associations Committee (TAAC) who have kindly accepted to answer our questions: Clarisse Mees (Belgium); Jiri Novak (Czech Republic); Walter Sebastian (Denmark); Targo Kalamees (Estonia); Valérie Leprince (France); Oliver Solcher (Germany); Mark A. Shirley (Ireland); Andrejs Nitijevskis (Latvia); Andrzej Gorka (Poland); Owe Svensson (Sweden); Paul Carling and Barry Cope (United Kingdom).

Quality management and building airtightness: the French approach

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A quality management scheme allowing builders to justify for a given building airtightness without systematic testing has been introduced in the French regulation since 2005. At the end of 2014, 81 such quality management approaches have been approved representing a production of about 15 500 buildings per year.

The Quality Management (QM) scheme was introduced in the 2005 regulation considering the difficulties building professionals had to achieve good airtightness and the hope that cost abatements due to allowance for non-systematic testing could encourage building professionals to engage in a QM approach (QMA) for building airtightness.

This scheme has become increasingly popular with the increased requirements in the regulation. In fact, the regulation now requires the justification of a given airtightness level for all residential buildings. This requirement was first experimented within the Effinergie label which was firmly based on the regulation. A similar approach is adopted for the Effinergie+ label with the aim to experiment possible changes for the next regulation update (see **Figure 1**).

Justification of a given airtightness level can be provided either with a measurement by a certified tester or with a certified quality management approach.

The underlying idea of the QMA is to push professionals to get organized to properly design airtightness, to implement adequate solutions, to trace critical steps, and to monitor their performance. The QMA requirements detailed in the energy regulation are summarized in **Figure 2**. Applicants must propose a scheme to address each step listed in Figure 2 and to ensure that the approach will remain effective with time, based on measurements on a sample, by independent certified measurers. They also must have their system audited according to ISO 19011 (Guidelines for quality and/or environmental management systems auditing) by an independent ISO 9001 certified organisation.

After approval of their application by a committee of experts, successful applicants are not required to perform tests systematically but only on samples (typi-

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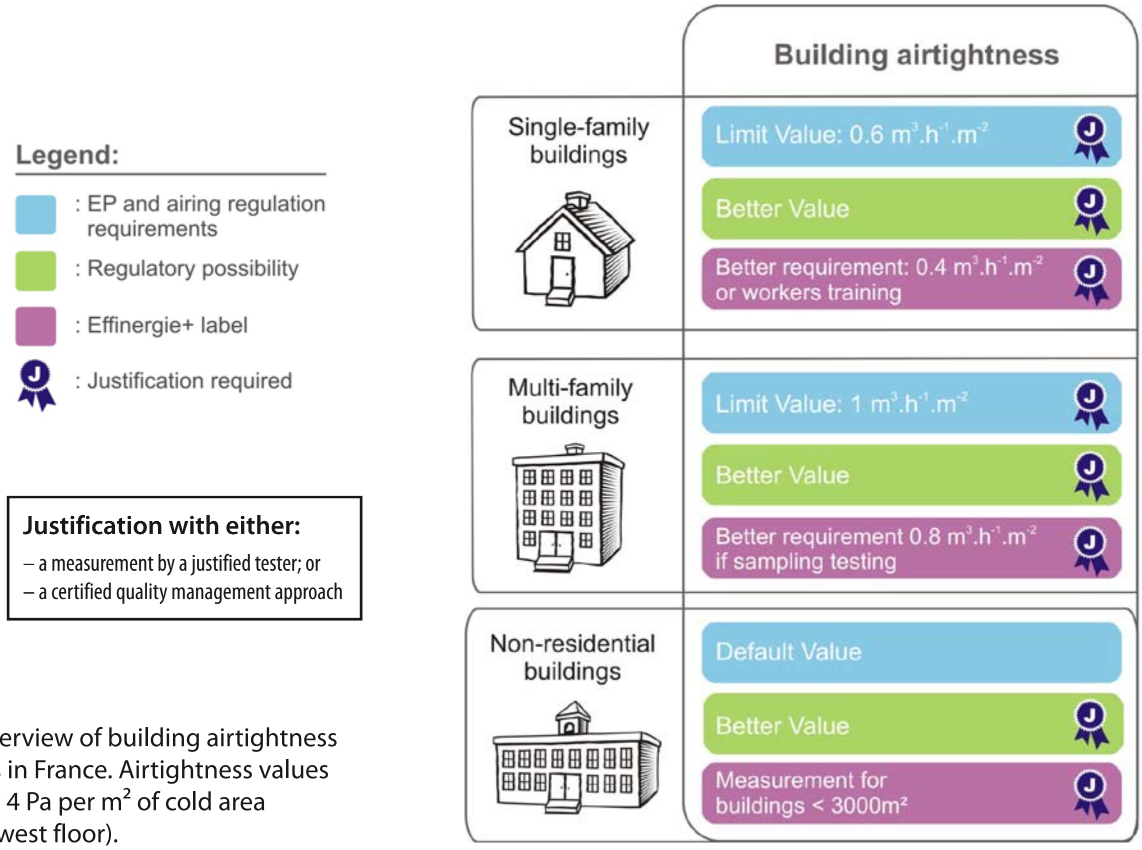

Figure 1. Overview of building airtightness requirements in France. Airtightness values are in m^3/h at 4 Pa per m^2 of cold area (excluding lowest floor).

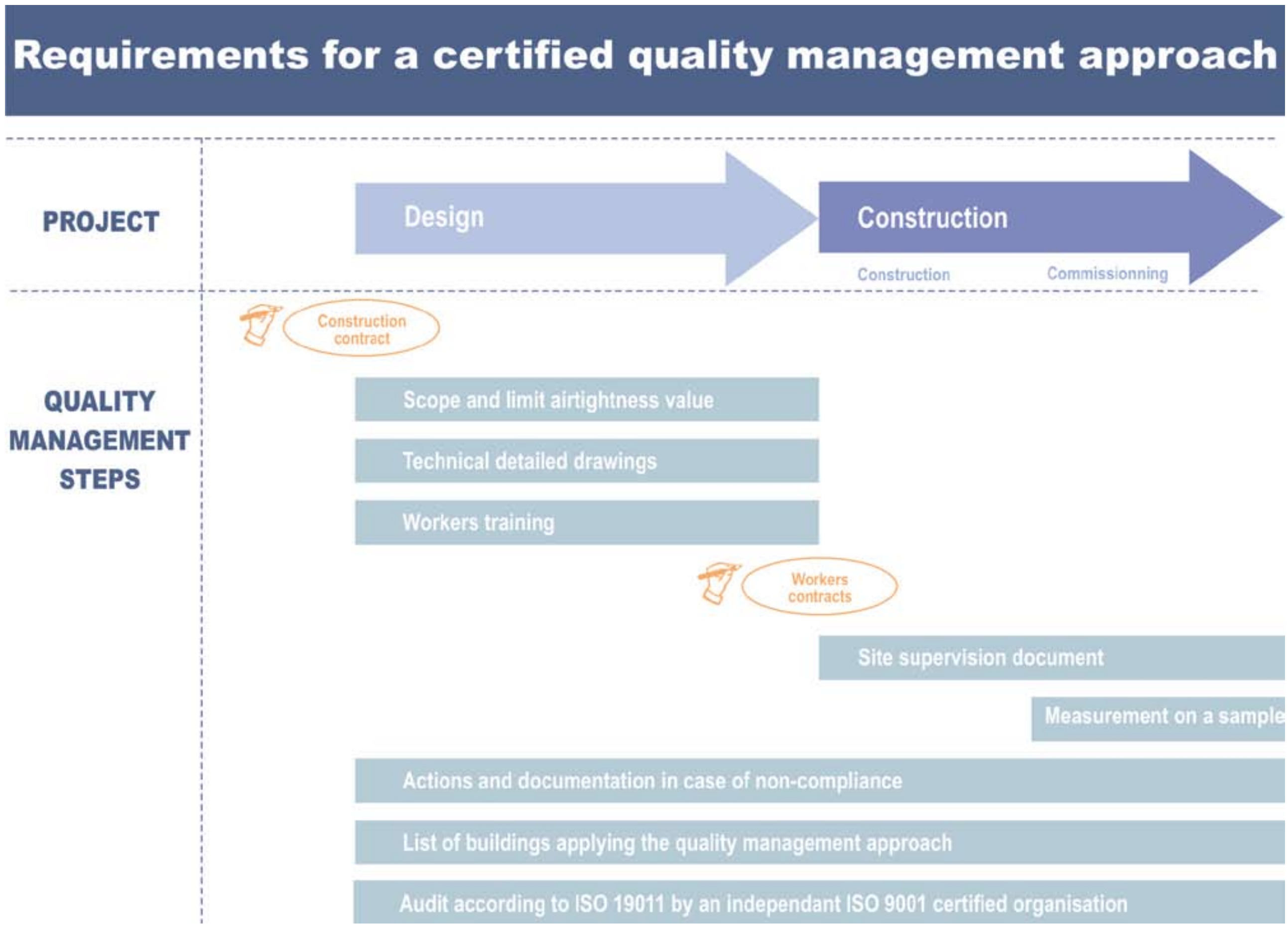

Figure 2. Overview of requirements for a certified quality management approach.

cally 5% to 10% of their production for single-family dwellings with a third-party certified tester) to comply with the justification for the airtightness level used in energy performance calculation.

Despite legitimate concerns about its market penetration, its effectiveness, and its potential biases to competition, the current approach has proved to be successful among builders, to positively question applicants about their methods to reach good or at least required airtightness levels, and to be consistent with the achievement of better airtightness levels (**Figure 3**). The evaluation of the process conducted by the state authority has confirmed the effectiveness of the approach; it has also shown weaknesses that should be dealt with and strongly suggests reinforcing in situ controls to avoid deviations which may in turn question the relevance of the approach. ■

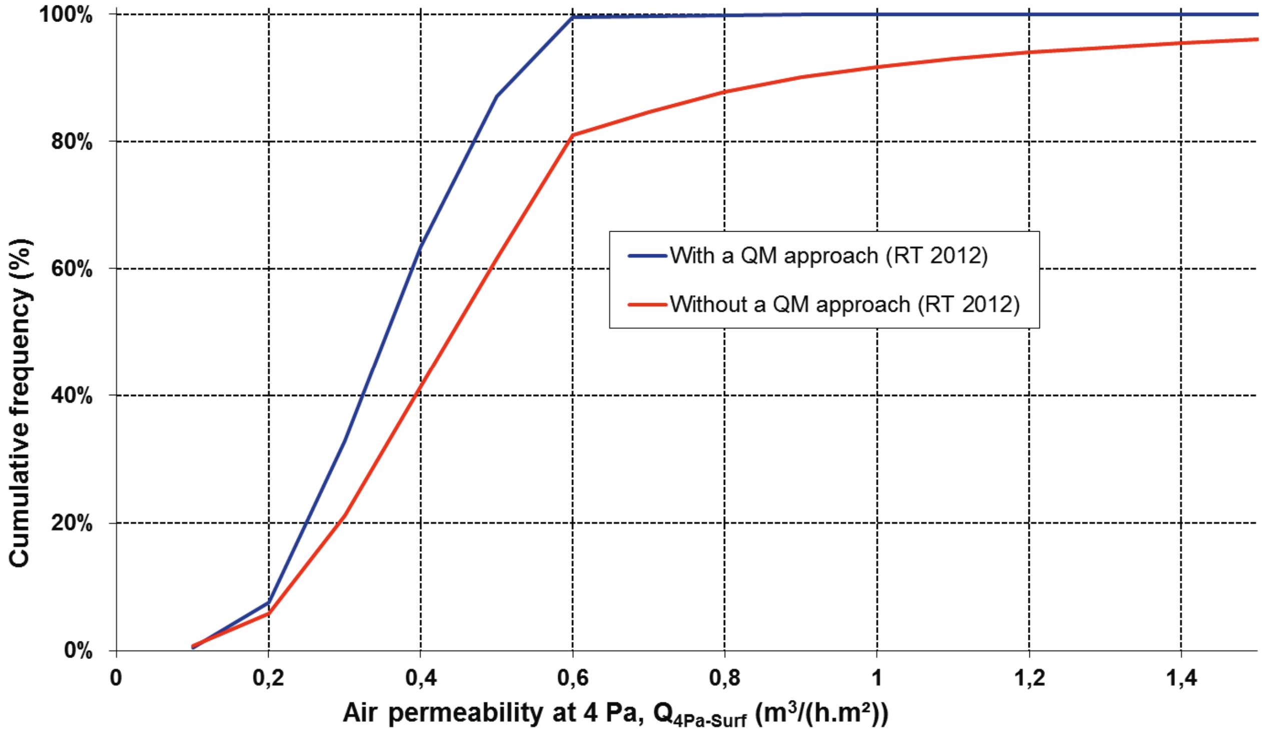

Figure 3. Distribution of measured airtightness of houses with and without implementation of a certified Quality Management Approach (QMA).

Additional information can be found in QUALICHeCK fact sheet #01:
http://qualicheck-platform.eu/wp-content/uploads/2015/02/QUALICHeCK-Factsheet-01.pdf

Belgium quality framework for building airtightness tests

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As a result of the reinforcement of the energy requirements in the 3 Belgian regions, the number of pressurization tests in new buildings is strongly increasing. This increasing market is attractive but experience shows that some testers don't have the needed competences. In order to deal with this lack of reliability, a quality framework imposing a competent tester scheme has been introduced.

Keywords: airtightness of buildings, fan pressurization test, quality, Belgium, qualified tester

Background

In Belgium, the measured airtightness of buildings can be used in the regional Energy Performance (EP) regulations in order to improve the theoretical performance of these buildings. With the progressive strengthening of the regulations, the airtightness performance has become more crucial. Possible not-reliable tests are a great threat in this area.

Description of the framework

The reference documents are the standard EN 13829[1] (ISO 9972) and additional specifications published by the Regions. Updated rules and technical criteria for pressurization tests have been defined in the Technical Specifications STS-P 71-3 published by the federal ministry of economy[2]. The schematic content and specific items are shown below.

STS-P 71-3 contains an informative annex describing in general terms the requirements for a quality framework for the realization of pressurization tests. Certification bodies may organize a system allowing to show the compliance with the STS and this particular annex.

This system is based on two main points described in the informative annex.

The first point is a qualification examination showing the competency of the testers. Examination includes a theoretical part (50 multiple choice questions) and a practical part. The practical examination consists of testing a dedicated building with a controller. Minimum experience in the field is also required (supply of at least 5 test reports).

In order to be recognized, companies must fulfil the following requirements:

- to have civil liability insurance;
- to have all necessary measuring instruments and software;
- to employ at least one qualified tester.

1 Thermal performance of buildings - Determination of air permeability of buildings - Fan pressurization method (ISO 9972:1996, modified)

2 The legislator wants to make measurement possible for nearly all buildings. So, criteria related to the zero-flow pressure difference have been loosened for large buildings. Highest pressure difference has also been adapted.

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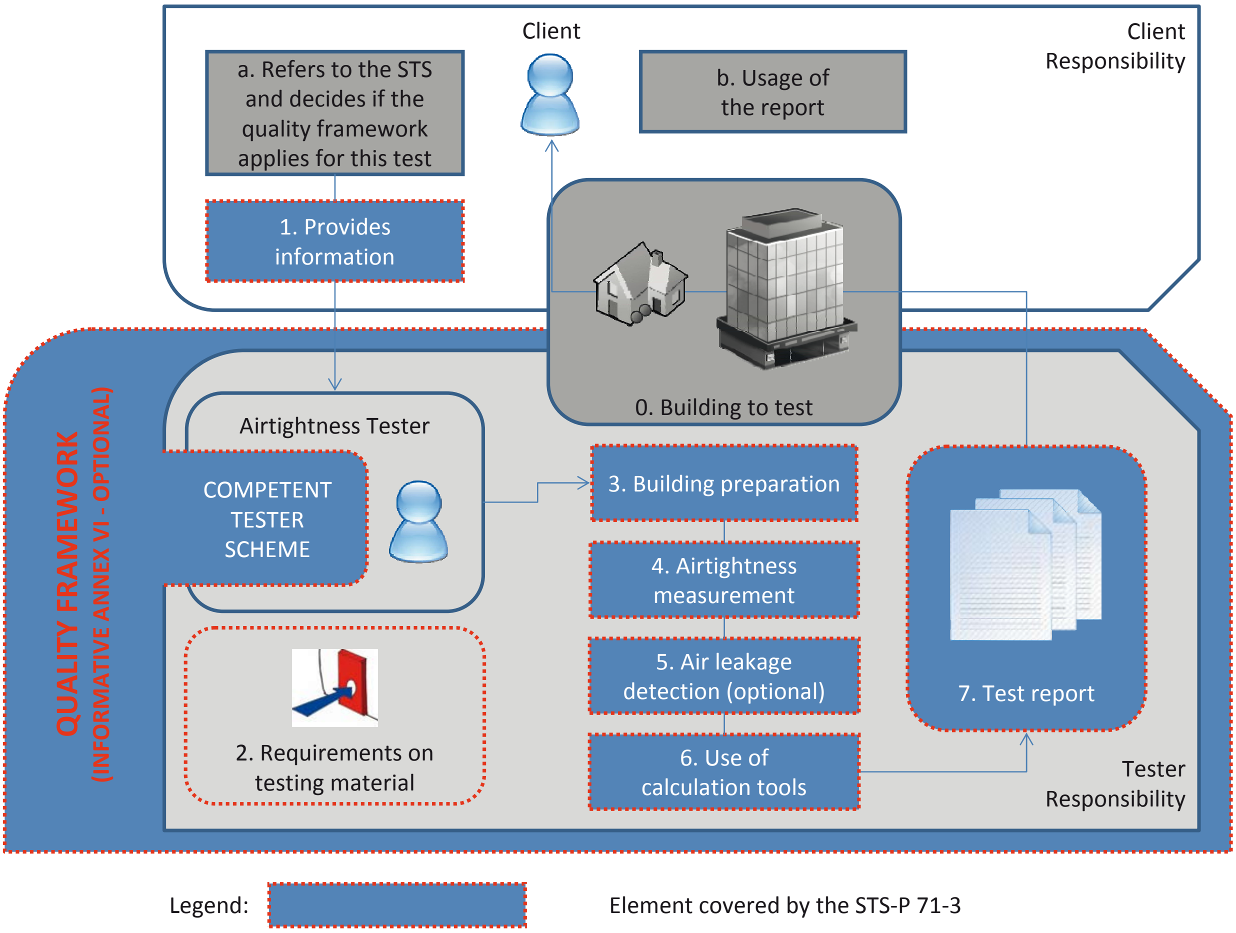

Steps for the report delivery.

It is worth noting that accredited companies can be automatically recognised without further requirements.

The second point of the quality system is a continuous control. Two types of controls are scheduled: control of the reports and on-site controls.

Respecting all requirements and the whole procedure permits the certified testers to deliver a **declaration of conformity for each airtightness test**.

Regional ministries in charge of the EPB-regulation in the building sector may refer to STS-P 71-3. Since January 2015, the Flemish region imposes the respect of the STS including the annex related to the quality framework for every new pressurization test in the context of the EP regulation. In other words, the introduction of the airtightness test result in the EP calculation is allowed only if a declaration of conformity is available.

At the time of writing this paper (June 2015), about 170 Belgian companies are already recognized.

Advantages of the system

The advantages for the clients and the final users are the availability of a list of recognised competent professional and mainly the assurance of good quality results. It allows the authorities to hold reliable input data. In addition, less control is needed at the moment of EP declarations. Finally, the airtightness testers are also satisfied because they have better opportunities to value higher quality. ■

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AMA and Certification of Ventilation Installers

Two Swedish ways of improving the quality of HVAC-systems

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To reduce the problem with inferior HVAC-systems Sweden is using several quite unique quality assurance systems: AMA (that has been in use for more than sixty years), OVK (compulsory ventilation system inspection that started 1991) and a new system for certification of ventilation installers.

Keywords: AMA, HVAC, Certification, Installer, Third-party, Incert, Quality, Tightness.

AMA (short for Allmän Material och Arbetsbeskrivning) meaning "General Material and Workmanship Specifications" has been in use in Sweden since 1950, i.e. for sixty-five years! The AMA family covers today demands on all types of building and infrastructure projects, such as Buildings, HVAC, Refrigeration, Electrical installations, Roads, Bridges and Tunnels to mention some.

AMA is a tool for the employer (developer/future proprietor) and the designers to specify the demands on the new building and its installations in the building specification.

The AMA Family.

The AMA requirements are based on accepted demands – these are regularly updated in accordance with technology development and (LCC)-costs. Experience from the more than 60 year old use of AMA has shown that it has led to substantially raised quality levels. The demands in AMA are specified in measurable units and in such a way that the tenderers and contractors understand them and are able to calculate a price for their commitments. The demands are – whenever possible – combined with prescribed systems for measuring and reporting the results.

Practically all buildings and their installations in Sweden are performed according to the quality requirements in the AMA specification guidelines. These requirements are made valid when they are referred to in the contract between the owner and the contractor.

AMA vs. Authority regulations

The AMA requirements cannot change but are complementary to statutory rules, regulations and specified building standards laid down by the authorities. There is a difference between the two: Authorities are mostly focused on reducing the risk of injuries to people while AMA (not having to deal with that) is instead focusing on reducing property damages and LCC-costs. Common interest areas for both are to achieve sustainability and low energy use.

Statutory demands, that have to be followed by the building proprietor and the contractor, are based on EU requirements, laws, statutes and directions. The observance of these is normally controlled by the central or local authorities.

In addition to these compulsory demands both parties also have to follow the requirements in the contract once it is signed. The contract documents include a building specification referring, by codes and headings, to specified AMA demands. The fulfilling of the contract conditions is controlled by tests and measurements during the contract works and finally by a specialized surveyors.

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Commissioning

Before a new ventilation installation is taken into operation it is controlled in two separate ways:

By the OVK inspection (compulsory ventilation control) which has to be done before start-up and then at prescribed intervals in the future. These are done by certified inspectors on behalf of the authorities to control that the system is working according to statutory requirements.

The additional AMA-requirements are controlled at the commissioning to establish that the installation is performed according to the contract requirements and that the two contract partners, the contractor and the owner, have lived up to the contract conditions. The commissioning includes e.g. control of measured airflows, testing of ductwork tightness and measuring of noise levels as well as checking that the system and component quality fulfils AMA requirements and that the installation operates as prescribed. Another book in the AMA family, AF AMA, covers administrative requirements covering e.g. guarantee periods and commissioning.

Tight ductwork – an example of AMA requirements and practical results

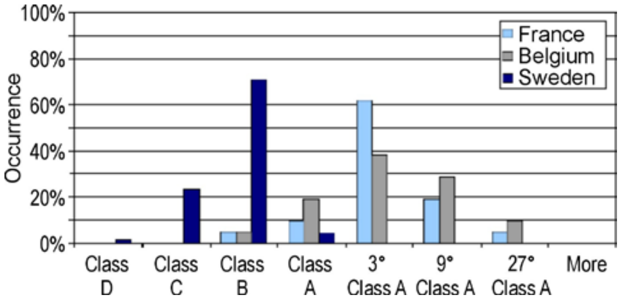
Tightness of ductwork can serve as an example of how AMA has raised the quality of HVAC-systems and components during the years. The first demand on this came already in the 1966 HVAC AMA and was the followed by raised demands along with technology improvements (to a great extent influenced by raised AMA requirements) and increased energy costs.

The duct system leakage has to be verified; normally by the contractor as part of the contract (i.e. the cost for this first test is normally included in the contract lump sum). This test is undertaken as a spot check where the parts to be checked are chosen by the owner's consultant. For round duct systems 10% and for rectangular ducts 20% of the total duct surface normally is tested.

In case the system is then found to be leakier than required, that part of the tested system shall be tightened and tested. Additionally, another equally sized part of the system shall be verified in the same manner. Should this part also be found to leak more than accepted the complete duct installation has to be leak tested and tightened until the requirements are fulfilled. The costs for the contractor can be quite considerable if the tests have to be repeated due to bad test results.

Proven quality

The EU-project SAVE-DUCT found that duct systems in Belgium and in France were typically 3 times leakier than EUROVENT Class A, see Figure below. Typical duct systems in Sweden fulfilled the requirements for EUROVENT Class B and C and were thus between 25 – 50 times tighter than those in Belgium and France.



Ductwork Leakage.

Why this large difference?

Most probably because Sweden has required tight ducts since the early sixties whereas in the two other countries tightness of ductwork was normally neither required nor tested.

Certification of Ventilation Installers

The quality of ventilation systems is vital for a well-functioning building. They must correspond to demands on air quality, thermal climate, low noise levels, low energy use and sustainability. The awareness of the importance of this has increased due to information from authorities, trade organizations and companies.

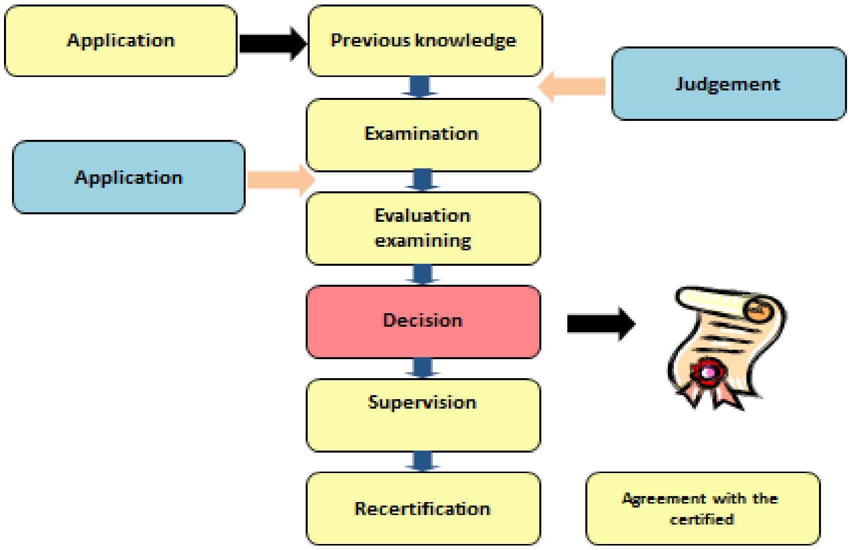
Well-functioning ventilation is required e.g. by OVK, AMA and environment classification systems. Several studies have shown that inferior systems can cause discomfort, irritation and even result in SBS (Sick Building Syndrome) while high quality systems can increase productivity, comfort and well-being and reduce sick-leave. The conclusion of the latter (REHVA and others) is that the additional investment and running costs for a system with good air quality, providing an acceptable thermal climate at low noise levels and low energy use are low when compared to the benefits achieved by higher productivity and well-being and reduced sick-leave.

The Swedish Association of Contracting Companies (The Employers' Association of Swedish Plate Works) have found that:

- An increasing number of the customers are aware of the risks attached to inferior ventilation systems and the benefits of good ones.
- They often want to have systems that fulfill high

requirements in environment classification systems (Miljöbyggnad, BREEAM, LEED, etc.)

- Customers and authorities are going to require more competence by ventilation installers.
- The confidence of the customers when engaging companies with certified installers is increased and he will be surer of the result of the installation work.
- Certification of their ventilation installers is one way for a company to guarantee the quality of deliveries, workmanship and installations.
- It could be used as a natural and long-term development scheme for the employees.
- For the installer himself it means that he has proven to have a good knowledge of his job, both in theory and practice and has got a proof to show this.

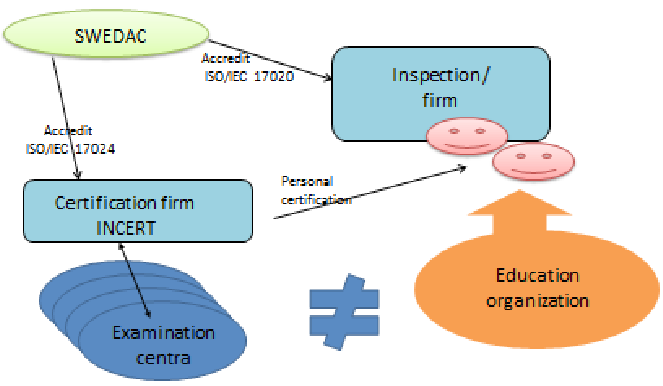


The Certification Process for Individuals.

The Association has therefore commissioned INCERT (The Certification Organization for Installations) to certify their Ventilation Installers.

This means that the certification is done as a Third party certification which means that it is an independent judgment and assurance that specified demands related to a product, person, process or management process has complied with requirements.

INCERT is accredited by SWEDAC (Swedish Board for Accreditation and Conformity Assessment, a government authority for quality and safety) as one of totally 13 Certification firms in Sweden approved to issue personal certificates according to ISO/IEC 17024.



The Certification Process.

INCERT is the only one of these companies certifying ventilation installers. The upper right hand part of the figure referring to ISO/IEC 17020 has not been used and will be replaced by company certificates issued by INCERT or other companies accredited for personal certification.

INCERT controls the examination centers and provides them with examination documents and issues the personal certification certificates for those who have passed. The not equal sign shows that an education organization providing courses for the applicants must not be affiliated with the examination centers.

The examination requirements cover a wide area, e.g. manufacturing installation methods, measuring and adjusting airflows, noise attenuation, reducing energy use, contract conditions and AMA, etc. as well as proof from his employer of experience as installer of different types of ventilation systems.

As preparation for the exam the applicant can study an extensive data-based education material produced by an expert group and financed by the association. This study is not compulsory but could be helpful.

The certification procedure starts with an application stating previous knowledge and experience. After examination and evaluation INCERT decides whether the requirements for certification are fulfilled. If accepted, the certification proof valid for a period of five years, is issued. This process follows the same data-based procedure used by INCERT for certifying other occupational groups. ■

QUALICHeCK

Solar and daylight management for energy performance buildings

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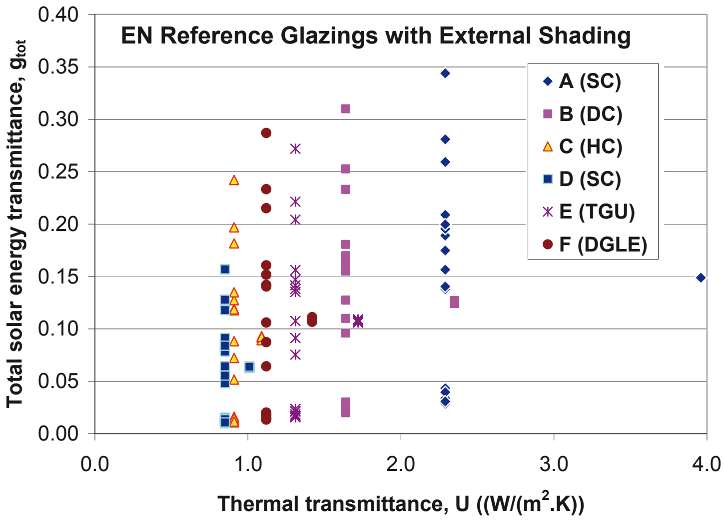
EUROPEAN SOLAR-SHADING ORGANIZATION
Energy Savings & Comfort

The need for energy efficient solar shading solutions is shown in a recent scientific study commissioned by ES-SO, the European Solar-Shading Organization. Results of this study are summarised in "A New Vision on Solar Shading: Solar and daylight management as an essential concept in the energy performance of buildings", the ES-SO position paper 2015; www.es-so.com/publications.



See the accompanying two illustrations of the ES-SO study 2014: Dynamic shading solutions for energy efficient buildings, impact of shading on cooling and heating.

Designing for solar and daylight management objectives needs an understanding of the shading performance properties and - most importantly- the use of accurate data.

In a preliminary enquiry among its members, ES-SO identified that in all European countries shading properties are used in the EPB calculation methodology and software.

Two thirds of the countries use the g-tot value, i.e. the solar energy transmittance of the glazing and the solar shading or in some countries the Fc-shading factor, which is the ratio of the solar factor of the combined glazing and solar shading (g-tot) to that of the glazing (both values are defined in EN-14501 Blinds and shutters - Thermal and visual comfort - Performance characteristics and classification) in order to *combat overheating*. This is in accordance with the EPBD recast (recital 25) where solar shading has been determined as strategy to avoid or reduce overheating in energy performance buildings. In addition, one third of the European countries consider solar shading as an *additional thermal resistance* to the window and one third recognise the impact on the *visual comfort*. In one third of the EU countries default values for shading properties are only used; however in most of the countries detailed value properties are used as an alternative to default values.

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Objectives of ESSDA- the European Solar Shading Database

Compliant and Easily Accessible EPC (Energy Performance Certificate) input data is one of the objectives of the European QUALICHeCK Project. The database of shading properties at European level which is currently being developed by ES-SO will meet those requirements. The importance of considering shading in the early stages of design is highlighted as it enables a comparison of glazing with and without shading. Moreover, with the revision of the product standards EN 13659 (shutters) and EN 13561(external blinds and awnings) to be published in the second half of 2015, the g-tot value (solar energy transmittance) on the shading products will become soon mandatory.

The database intended use and audience

Solar shading within the Energy Performance of Buildings Directive (EPBD) has ensured that it is now a requirement in National Building Codes. The ESSDA database will provide energy performance data for shading combined with standard (reference) glazing types in EN14501(Blinds and shutters - Thermal and visual comfort - Performance characteristics and classification) and EN13363/1, the Standards for initial design concepts and product comparison.

It also provides the data for shading that can be used for more advanced calculations in EN13363/2 (Solar protection devices combined with glazing - Calculation of solar and light transmittance - Part 2: Detailed method) which is used for more detailed building modelling.

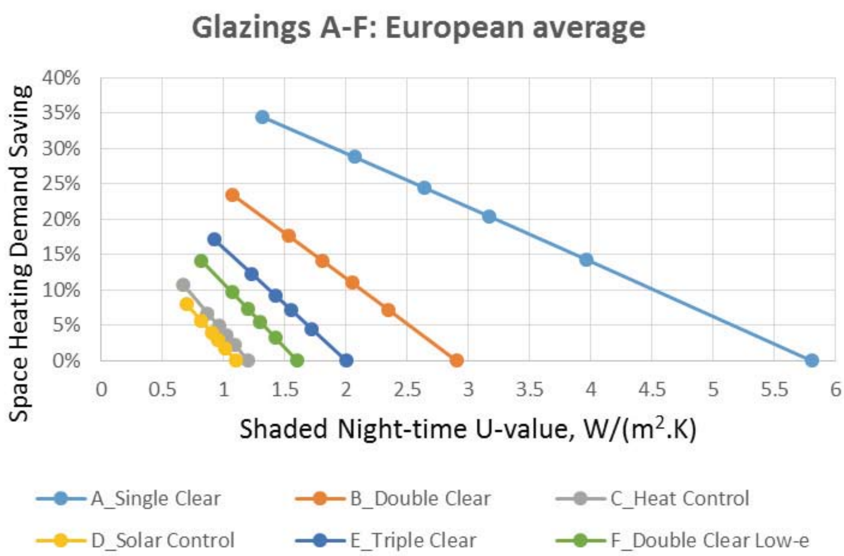
In general, this database will be useful for any simulation scientific based tool considering the impact of shading in the building design. In the longer term, the input data can also be used for a possible energy label based on the energy balance of the complex window, that is the glazing combined with the shading. The database will permit the different users of the solar shading industry, architects, specifiers and building services engineers to use reliable validated data.

The Database procedure

All data submitted is generated by laboratory testing to EN standards. The data will be validated by a peer review team of shading manufacturers, to the same procedures as the requirements WIS-WINDAT(WIS 3.0: free European Software tool for the calculation of the thermal and solar properties of windows) which is similar to the requirements of WINDOW in America.

The database output will be able to demonstrate the control of solar energy transmittance (g-tot) and the heat retention (U-values) of solar shading products. Moreover, control of daylight figures of shading products will be available for glare control and openness factor of the product for outward vision. It has a knowledge base that explains the properties of shading and how to use the data.

The data file format for the data submitter is designed to be compatible with the existing European Window Information Systems (WIS) software database for shading and solar protection devices. Also the output values will be calculated following the WIS software.



The ESSDA, European Solar Shading database approach is based on the necessity and willingness of the industry to present and update shading manufacturers' declarations based on **reliable uniform data**. ESSDA will become the unique reference solar shading database from which comparable output will be possible for different uses and calculations for the benefit of specifiers' buildings owners and users.

Procedures testing phase

At this stage, ES-SO is developing the procedure methodology to be followed by a testing phase. The QUALICHeCK project will be the ideal platform to present more information soon. ■

Certified Performance Database: tool for quality and compliance

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Due to a challenging regulatory and normative background it is often hard for end-users to have a clear view of the quality of HVAC products. The Eurovent Certified Performance (ECP) certification has been used for more than 20 years to provide guidance on the real performance in the European market.

Keywords: Certification, database, compliance, quality, regulation, energy efficiency, standardization.

Third party certification of HVAC&R products and systems

The Eurovent Certified Performance (ECP) certification is a voluntary, third party certification managed and accredited according to the ISO/IEC 17065:2012 – "Conformity assessment -- Requirements for bodies certifying products, processes and services" requirements (COFRAC accreditation n°5-0517, international recognition EA/IAF). Accreditation is a proof for independence and competence. It also ensures that all manufacturers are allowed to have their product certified without any restriction provided that the products fulfil the requirements given in the certification reference documents which are freely and publicly available.

The certification process is based on continuous (yearly) verifications relying on tests by independent accredited laboratories, factory audits and check of selection software.

As of today the ECP mark covers 19 certification programmes in all fields of HVAC&R. It applies to residential, commercial and industrial products from the residential air conditioners to the industrial chillers. More than 1 300 tests, 160 factory audits and 100 checks of selection software are carried out every year.

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 products.

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: analysing performance and the impact of certification

The availability of such database allows 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 **Figure 1**.

A Eurovent energy efficiency classification was created in 2011 for these products based on their average energy consumption at three different fan speeds1. It can be

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

QUALICHeCK responds to the challenges related to compliance of Energy Performance Certificate (EPC) declarations and the quality of the building works. Find out more at http://qualicheck-platform.eu.

The QUALICHeCK project is co-funded by the Intelligent Energy Europe Programme of the European Union. The sole responsibility for the content of this article lies with the author(s). It does not necessarily reflect the opinion of the European Union. Neither the EASME nor the European Commission are responsible for any use that may be made of the information contained therein.

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.

Another example is the energy efficiency of air filters. For these products a Eurovent energy classification has been implemented in 2012. This classification is based on the estimated annual energy consumption derived from the average pressure drop of the filter2. A more classical way to assess the energy consumption of an air filter is to look at its initial pressure drop. **Figure 2** 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 increase to reach a maximum in 2013 and then decrease until 2015. This behaviour can be explained knowing the standardization context behind. A revised version of the European testing standard was published 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: reference for voluntary or regulatory requirements

Database of certified data can be used for many purposes: criteria for tax incentives, input data for the energy performance calculation of buildings in the framework of national implementations of EPBD, requirements or input data for building energy labels and green public procurements, input data for assessing the energy consumption reduction for 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 given to certified products over non certified products in regulatory schemes (e.g. national implementation of EPBD).

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

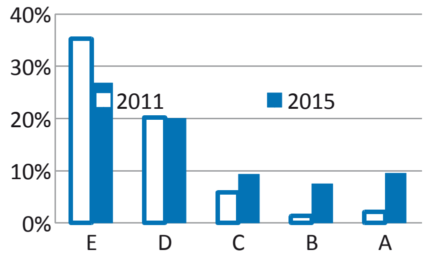

Figure 1. Evolution of the distribution of the energy efficiency class for fan coil units between 2011 and 2015.

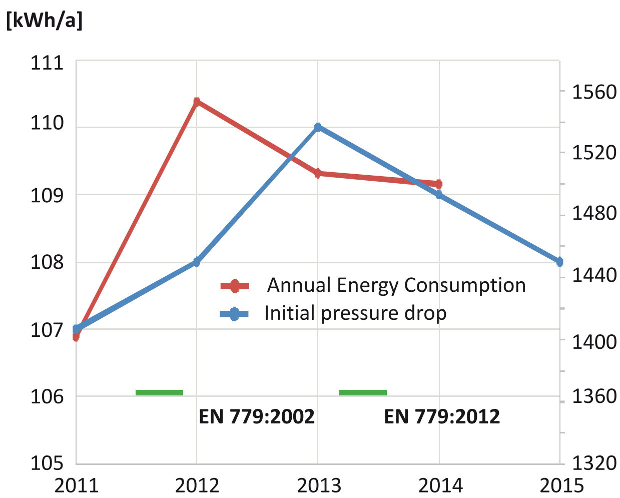

Figure 2. Evolution of the energy efficiency for F7 bag filters between 2011 and 2015.

An example of such use can be found in the French building energy performance calculation method (RT 2012) which applies among others a penalty for non-certified heat pumps and air-to-air heat exchangers. Approved software for the energy performance calculation according to this French regulation are 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 for all stakeholders. Assessing the quality and compliance of product performance 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 updated, trustful and exhaustive data. Such information can be (and is already) used in various voluntary and regulatory compliance schemes. ■

Air conditioning environmental challenges

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Air conditioning is part of our comfort in our buildings. It is however also necessary in many various uses and the technology is basically the same as the refrigeration technologies. These technologies face two important challenges, reduction of energy consumption and reduction of refrigerant emissions. The International Institute of Refrigeration aims to reduce these environmental impacts.

Keywords: air conditioning, energy consumption, refrigerants, hydrofluorocarbons, global warming.

Air conditioning is necessary for life

Air conditioning is largely used in buildings, in houses as well as in commercial buildings. It is also largely used for industry purposes, since the temperature is a magnitude and a key variable in physics, chemistry and biology. It characterizes the state of matter and liquid, solid and gaseous phases. It thus drives to applications for which the size of the materials shall be particularly stable such as information technologies and nanotechnologies or datacenters. It is also vital to all living beings (biotechnologies industry …).

It is similar to other refrigeration uses, in:

- Cryogenics (petrochemical refining, steel industry, space industry, nuclear fusion…)
- Medicine and health products (cryosurgery, anesthesia, scanners, vaccines…)
- Food industry and the cold chain
- Energy sector (including heat pumps, LNG, hydrogen…)
- Environment (including carbon capture and storage), public works, leisure activities…

Everybody can understand the need of refrigeration for the preservation of food and its vital necessity. Less people know that air conditioning is also useful for health. For instance:

- a recent MIT study showed mortality during hot days (temperatures higher than 32°C) decreased by 80% between 1900–1959 and 1960–2004 in the US: "The adoption of residential air-conditioning explains essentially the entire decline in the temperature-mortality relationship" (1).
- Air conditioning is expected to play an increasing role in the context of climate change and increase of ambient temperatures. IPCC estimates that energy demand for residential air conditioning in summer is projected to increase over 13-fold between 2000 and 2050 and over 30-fold by 2100, under its reference climate change scenario (2).
- According to another study, in the United Kingdom, 15.7 billion Euros are lost every year because of inadequate temperatures (3).

Refrigeration and air conditioning are a major energy consumer

Refrigeration, including air conditioning, represents more than 17% of global electricity consumption (4). And this figure increases. Refrigeration issues are clearly linked with electricity issues, which are:

- Global warming because of CO_2 emissions (electricity production depending on fossil fuels): we need to take into account the TEWI (Total Equivalent Warming Impact), and the LCCP (Life Cycle Climate Performance) of the refrigerating equipment.
- The price of electricity will increase in a long term perspective (new sources of energy have higher costs).
- There is a lack of power infrastructures, particularly in developing countries.

Overall system solutions (district cooling, trigeneration…) should certainly be developed and we need to review the coefficients of performance of the systems as we did for heat pumps. There are new regulations on energy and on buildings in Europe, the USA or Japan with new constraints on energy and thus new constraints on refrigeration systems, and probably everywhere in the future.

New sources of energy can be used, such as solar energy. Even if the coefficient of performance of solar equipment is still relatively low and if investment costs can be high, some systems are already in place and many experiments and research programmes are ongoing.

In any case, changing a system because of refrigerant issues must take into account potential reductions in energy consumption: both issues are linked.

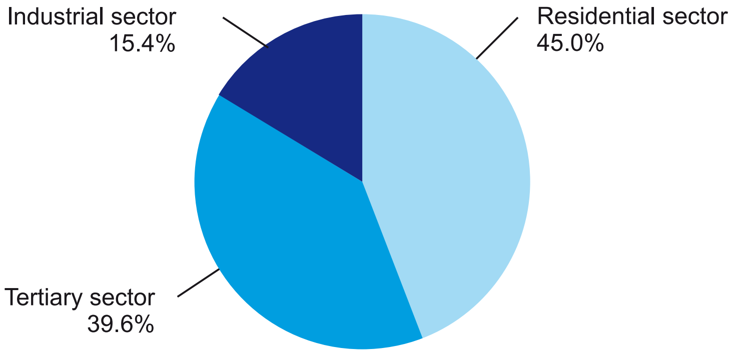

Chart 1 shows IIR estimations of the global distribution of the refrigeration sector's electricity consumption between the residential, tertiary and industrial uses.

Chart 1: Global distribution of the refrigeration sector electricity consumption.

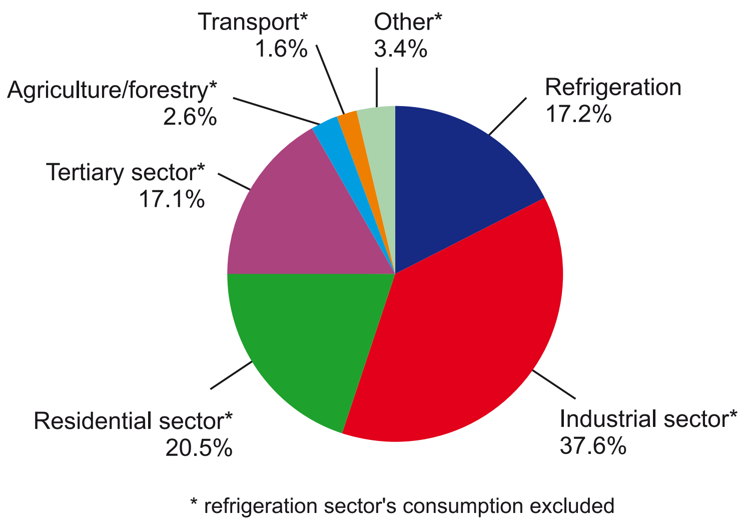

Chart 2 compares this refrigeration sector related electricity consumption ratio of 17% with electricity-consumption ratios in other sectors: industrial, residential and tertiary (refrigeration-sector consumption excluded), agriculture/forestry, transport and other non-specified sectors, based on IEA data (15) and IIR estimations.

Chart 2: Comparison of the refrigeration sector electricity consumption with that of other sectors.

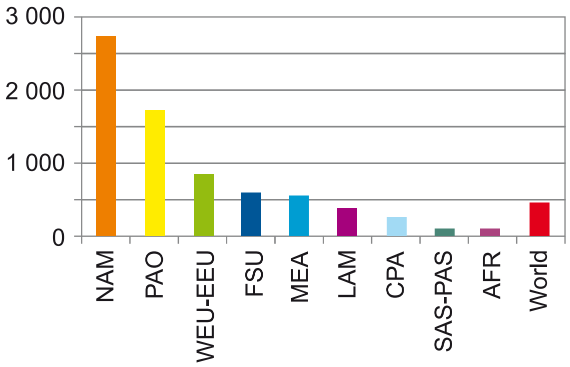

Chart 3 demonstrates regional differences in refrigeration sector electricity consumption, depending especially on development levels and climatic conditions.

NAM: North America
PAO: Pacific OECD
WEU-EEU: Western, Central and Eastern Europe
FSU: Independent states of the former Soviet Union
MEA: Middle East and North Africa
LAM: Latin America and the Caribbean
CPA: Centrally planned Asia and China
SAS-PAS: South Asia – Other Pacific Asia
AFR: Sub-Saharan Africa

Chart 3: Distribution of electricity consumption for refrigeration (kWh/year/capita) between the world regions (According to IPCC definition of SRES World Regions)

Air-conditioning penetration is expanding quickly. As a whole, it is responsible for around 5% of global electricity consumption, according to IIR estimations. This ratio varies widely from one country to another, depending on the local climate and the development level. While air conditioning is almost absent in the least developed countries, it accounts for about 14% of the total electricity consumption in the US (5) and 40% in the Indian city of Mumbai (6).

Air-conditioning is dramatically growing in the world's emerging economies. For example, less than 1% of urban Chinese households owned an air conditioner in 1990, while this number rose to almost 100% by 2009 (7,8).

The value of the world market of air conditioners was 72.3 billion Euros in 2012, corresponding to 128.5 million air-conditioning units sold. This value is predicted to reach about 82 billion Euros by 2017 (+13.4%) (9).

Furthermore, air conditioning is expected to play an increasing role in the context of climate change and the associated increase of ambient temperatures. IPCC estimates that energy demand for residential air conditioning in the summer is projected to increase over 13-fold between 2000 and 2050 and over 30-fold by 2100, under its reference climate change scenario (10).

Mobile air conditioning is expanding at an even higher pace since most new vehicles currently sold are air-conditioned. There are currently about 700 million mobile air-conditioning units in vehicles and buses worldwide (11).

The impact of refrigerants on the environment

Vapour-compression systems will remain predominant in the short and medium term and thus we will require more refrigerants in the future.

Because of their impact on the stratospheric ozone layer, Chlorofluorocarbons (CFCs) and Hydrochlorofluorocarbons (HCFCs) are included in the Montreal Protocol and each country (whether developed or developing) had to build phase-out plans. Hopefully this issue will soon be behind us, apart from the bank issue (refrigerants in existing equipment to be destroyed in the future). However, the main issue of phase-out plans is the kind of refrigerating equipment which is used to replace old equipment.

There are alternative refrigerants:

- Hydrofluorocarbons (HFCs), including Hydrofluoroolefins (HFOs) have no impact on the ozone layer but they have an impact on global warming (they are included in the Rio Convention and the Kyoto Protocol)
- Natural refrigerants (ammonia, CO_2, hydrocarbons, water, air) have a very low impact on global warming.
- Mixtures, combinations (cascades, secondary fluids) are being developed in order to meet the various requirements.

HFCs currently represent less than 1% of CO_2 eq emissions. In 2050, they will represent 7-45% (more likely 7%) of CO_2 equivalent emissions.

HFCs emissions in 2050 could offset the achievements of the Montreal Protocol related to the phase-out of CFCs.

Two international discussions are underway simultaneously and the challenge is to link them.

The Montreal Protocol

The Montreal Protocol is clearly a success, since CFCs were phased out and HCFCs are gradually being phased out. Its tools were efficient: gradual phase-out within about 20 years for developed countries, 30 years for developing countries, which gives the industry time to adapt and maintain existing equipment which has an average lifespan of about 20 years; replacement refrigerants which are well identified and allowing drop-in solutions in general; UNEP correspondents (ozone officers) in each country, who are in contact with ministries and the industry in the country and have to report to UNEP each year; funding via a dedicated fund for developing countries in order to help them to finance refrigerant projects replacement. Soon these tools will no longer be necessary because of the success of the Protocol.

HFCs have the same applications as CFCs and HCFCs and the above-mentioned tools could also be efficient for phasing out or phasing down HFCs. HFCs only concern particular sectors and their impact on lifestyles is invisible, compared to CO_2 emissions which directly concern housing and transport. Constraints on them would only directly concern a few industrial associations.

Moreover, the lifespan of HFCs is much lower than that of CO_2. A phase-down of HFC emissions would therefore have rapid positive consequences, even if such consequences would exert a more limited impact on the climate than a reduction in CO_2 emissions, and would not address the climate change issue in the long term.

The Rio Convention and the Kyoto Protocol

The Rio Convention established the need to reduce emissions of greenhouse gases in order to mitigate climate change. HFCs are included, as well as CO_2, CH4… The Kyoto Protocol, signed in 1997, obliged developed countries to reduce CO_2 equivalent emissions with objectives, country by country, and to financially help projects in developing countries. The Kyoto Protocol ended in 2012. It was decided in 2012 to continue the same kind of commitments until 2020; however, only Europe and Australia agreed to sign a commitment this time, representing less than 15% of global greenhouse gas emissions.

The aim is to reduce emissions by 50% in 2050 compared to 1990 on average and to reduce emissions by 80% for developed countries in order to stay within a limit of +2°C (temperature rise) in 2050. In Copenhagen (2010), the European Union confirmed its commitment to reduce emissions by 20% in 2020; the USA to reduce emissions by 4% in 2020 (compared with 1990); China, India and Brazil only agreed to reductions compared with their GDPs (e.g. China: –40%/GDP).

Since 2010, new negotiations have started. The aim is to obtain new commitments for the year 2030 in Paris, during the United Nations Conference on climate change, in December 2015. Countries will have to present their commitment proposals before November 2015, before the final negotiations in Paris.

The current negotiations on HFCs

The European Union (EU) adopted a Mobile Air Conditioning (MAC) Directive and a Fluorinated Gas regulation (F-gas) in 2006. According to the MAC Directive, new cars are progressively being equipped with systems using refrigerants with a GWP under 150 for air-conditioning. According to the 2006 F-gas regulation, staff shall be trained and certified, companies shall be certified in order to use fluorinated gases in all fixed equipment, in order to reduce leakage. In addition, various EU member countries implemented taxes on HFCs.

In 2014, the EU adopted a new F-gas regulation, completing the first one. As of January 2015, quotas are given to companies selling HFCs; these quotas will be reduced by up to 21% of the initial level. And HFCs with the highest GWPs will be progressively forbidden in various applications (12).

This new regulation is in line with the North American and Micronesia amendment proposals to the Montreal Protocol. Since 2009, these countries try to impose a phase down of HFCs: 15% of an initial level in 2033 for developed countries and 15% of that level in 2043 for developing countries.

The key negotiation is the Paris 2015 United Nations Conference on climate change: an amendment to the Montreal Protocol on HFCs needs to be previously adopted by the UN Convention on climate change and the next one is now that one. Because of that agenda and the new position of the European Union, negotiations accelerate in 2015. The EU, North America, Islands states and India proposed in April 2015 new amendments to the Montreal Protocol which are more flexible for developing countries. Negotiations will continue until the next UN Conferences on the Montreal Protocol which will take place in Paris in July 2015 and then in Dubai, United Arab Emirates, in November 2015, just before the UN Conference in Paris.

A phase down of high global warming refrigerants will very probably take place in the near future with or without an international agreement in climate change in 2015. HCFs must not be replaced by high GWP HFCs which will progressively disappear, region by region, for most applications. Alternative solutions are needed. IIR works with UNEP on these solutions, including for hot climate countries, thanks to the PRAHA project and various conferences and meetings.

Solutions exist

Many solutions have already been developed in order to face these challenges: eco-design, ecolabelling in order to reduce the energy consumption; reducing leakage, reducing the refrigerant charge, choosing a lower GWP refrigerant, particularly natural refrigerants in order to reduce refrigerant emissions; developing not-in-kind technologies (solar refrigeration, evaporative cooling …). The International Institute of Refrigeration proposes these solutions, thanks to its publications and conferences (see www.iifiir.org).

Changes will rapidly occur since the goals are clear: 2030 is the deadline for the current commitments of the European Union, both for its general reduction of greenhouse gases emissions and for its phase down of HFCs. 2030 is tomorrow for industrial investments as well as domestic investments. Training and information are needed. The IIR is a REHVA partner and is at your service. ■

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2015 REHVA Student competition summary

Under the leadership of **Manuel Gameiro da Silva**, REHVA Vice-President from Portugal, the REHVA 2015 Student competition took place on Friday 8 May in Riga, Latvia during the Annual Meeting. Ten candidates representing nine countries were in competition this year, The Netherlands being represented by a team of two students. **Jelle Loogman** and **Ivo de Visser** presented their work on *An alternative ventilation system for operating theatres: an experimental and numerical parameter study and a full-scale experimental study on the performance of a local ventilation system*; **Magdalena Zwiehoff** (Germany.) on *Passive cooling measures for single-family houses*; **Joaquim Fernandes Monteiro** (Portugal.) on *Experimental and numerical study of ventilation efficiency as indicator of air diffusion quality*; **Szilveszter Zoltan Geyer Ehrenberg** (Romania) on *Heat recovery as source of energy optimization in industrial plants*; **Raimo Simson** (Estonia.) on *Performance of room-based ventilation units in renovated apartment buildings*; **Aleksejs Prozuments** (Latvia) on *The use of a chilled beam technology in a hospital ward*; **András Balázs** (Hungary.) described the *Winter set point correction*; **Vukašin Kendrisić** (Serbia) presented the *Photovoltaic solar systems and solar building's distributed power generation* and **Stine Pedersen** (Denmark.) presented a *Desktop polling station for real-time building occupant feedback*.

Competitors with their certificate of participation in REHVA 2015 student competition.

Karel Kabele, Stine Pedersen and Manuel Gameiro da Silva.

Award winner proudly showing her diploma.

The Jury was composed of Manuel Gameiro da Silva (Portugal), **Michael Schmidt** (Germany), **Marija Todorovic** (Serbia), **Hans Besselink** (the Netherlands) and **Hywel Davis** (United Kingdom). It was very difficult and hard to come to the winner. After a tight deliberation, the jury declared winner Stine Pedersen from Aarhus University (Denmark) for her work on "Desktop polling station for real-time building occupant feedback ".

The second was awarded to the Dutch team of Jelle Loogman and Ivo de Visser. The third prize was awarded to Magdalena Zwiehoff of Germany.

The next day, during the Conference, REHVA President, **Karel Kabele**, offered a check of 500 € to the winner, a certificate and the Trophy Cup for her university. Stine Pedersen gave an oral presentation of her work.

Manuel Gameiro da Silva also thanked all contributors emphasizing the high quality of the works presented and the members of the jury for their excellent task. ■

Desktop polling station for real-time building occupant feedback

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In general people spend up to 90% of their daily life indoor and therefore a good indoor climate is important. Building designers therefore use quantitative models to foresee the expected quality of the indoor climate when designing buildings. These models are established based on relations between measured (quantitative) data and subjective (qualitative) data. A newly developed Desktop Polling Station (DPS) for fast collection of vast amounts of subjective and objective data in real building environments helps developing more accurate indoor climate prediction models.

Motivation and theory

The concept of a Predicted Mean Vote (PMV) as a design criterion for thermal comfort (Fanger 1970) is carefully developed and validated in a scientific manner under controlled conditions in laboratories. These criteria are widely accepted and used for design goals in building design projects. However, a number of experiments (de Dear *et al.* 1998, Humphreys and Nicol 2002, Olesen and Parsons 2002) show that there seems to be a deviation between the "theoretical" thermal comfort and the "actual" thermal comfort in real buildings.

Reasons for this deviation are by some ascribed to be the occupant *expectations* to the indoor climate and the possibilities of occupants to adapt themselves or their environment to maintain thermal comfort. The so-called adaptive comfort models (de Dear *et al.* 1998, Humphreys and Nicol 2007) rely on the recognition of these behavioural and psychological factors. Even the heat balance-based PMV has been suggested to be expanded with an *expectation factor* so the index becomes PMV_e (Fanger and Toftum 2002).

The prevailing adaptive models and the PMV_e model result in different temperature ranges of thermal comfort. This is because the data for the models are obtained in different climates. This goes to show that *expectations* to the indoor climate can be different in different climates and cultures. More studies are needed to understand the expectation factor in relation to thermal comfort in real buildings. The challenge of research in this area is the scale and frequency of the data needed. Typically web-based indoor environment surveys only sample each participant once (Konis 2012). This can be problematic because the indoor environment is not homogeneous but dynamic: the indoor conditions change throughout the day. Furthermore, the participants are likely to forget to answer the survey due to their work tasks (Konis 2012). Therefore new efficient methods to collect vast amounts subjective and objective data simultaneously in a fast and reliable manner are desired.

Desktop polling station

A desktop polling station (DPS) for fast and reliable collection of vast amounts of data has been developed. The DPS is a small box with an interface where building occupants can be asked for their subjective assessment of the indoor climate while sensors continuously are logging objective measures like air temperature, relative humidity, CO_2 concentration, and illuminance level. The subjective assessment is based on a questionnaire containing questions about clothing level, thermal sensation, thermal preference, air quality, air velocity and lighting level. The questionnaire takes 1-2 minutes to answer. The questionnaire uses the 7-point ASHRAE-scale (ISO 7730 2005) to assess the subjective thermal sensation. The other questions were adopted into this form but only with a 5-point scale to shorten the survey time. The DPS can be seen in **Figure 1** (top).

The desktop polling station was designed and built to be located at each participant's workstation making the interaction easier. This allows the occupants to participate in studies without them having to change location, time schedule or environment. Interactions with the DPS are encouraged trough prompts for regular subjective feedback by blinking diodes in the buttons. The conceptual design of how the DPS collects fast data can be seen in the **Figure 1** (bottom).

Pilot field study

A pilot field study was conducted on the lower floor (2nd) of a 5-story open plan air-conditioned office in Aarhus, Denmark. The purpose was 1) to test the robustness of the DPS for data collection, 2) testing the rate of user interaction and experience, and 3) to gather data for the development of a conceptual analysis method to identify the expectation factor based on DPS data. Data was collected at the workspaces of 10 participants with a distribution of gender at 40% female and 60% male. All participants had similar work task that involved computer work for the majority of their work hours.

The potential for data collection

Despite of some minor technical issues, a total of 371 subjective assessments of the indoor environment were collected from 9 participants on the course of 10 workdays. This is a relatively vast amount of assessments within the few days considering that 4 655 observations were collected in a time period of three years in the research project SCATs (Nicol *et al.* 2007) which is the basis for the adaptive comfort criteria in the European

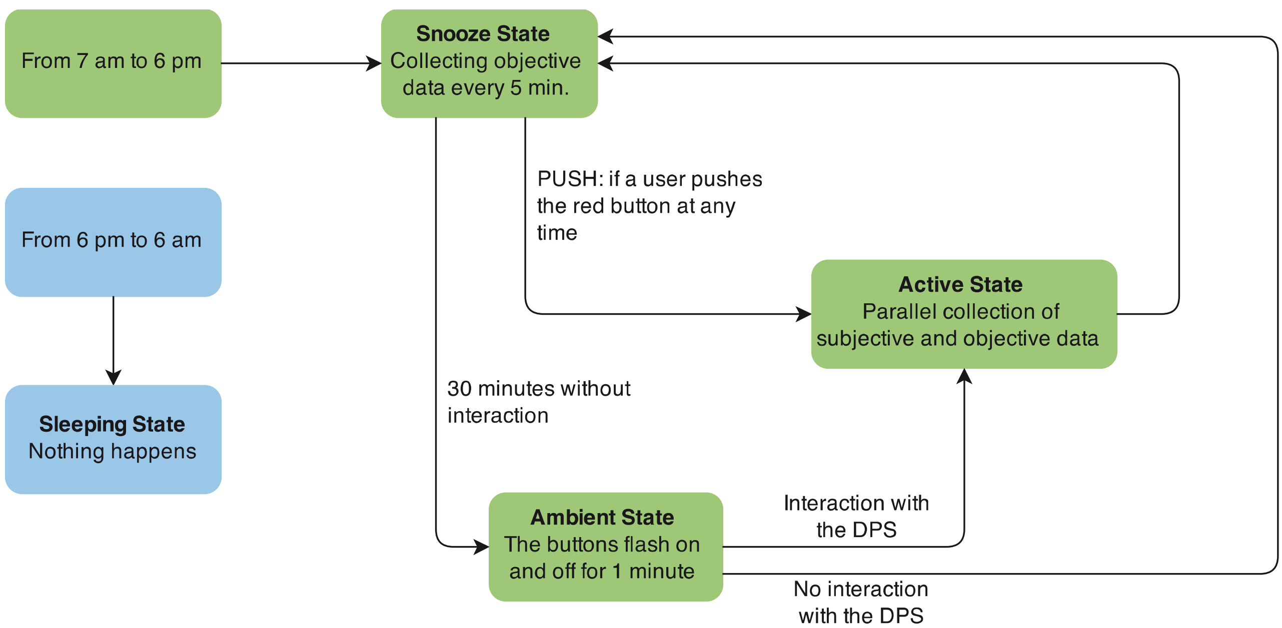

Figure 1. Top: The Desktop Polling Station. Bottom: Flow diagram of the user interactions.

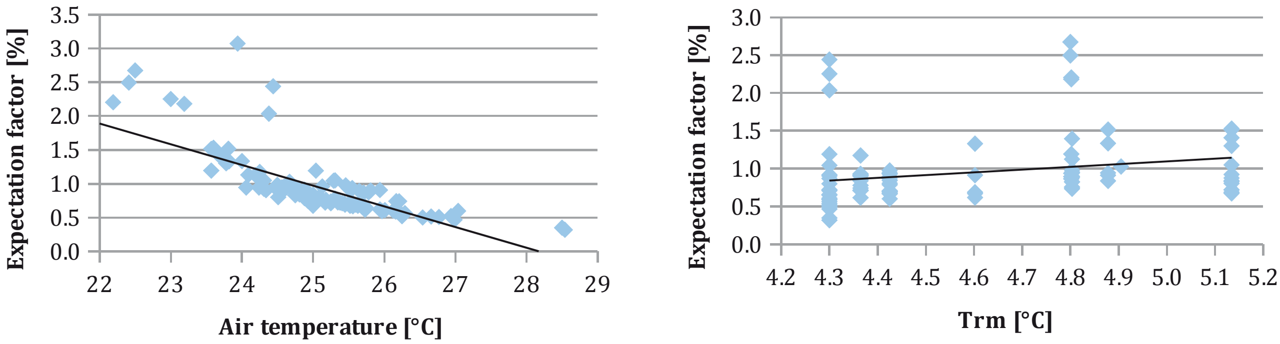

Figure 2. The expectation factor in relation to the air temperature and the running mean outdoor temperature.

standard EN 15251. In average each DPS collected 4.7 participant responses per day but the most active participants had 8–12 assessments per day. The DPS technology therefore has a high potential for gathering large amounts of subjective votes and objective data.

The expectation factor

A difference between PMV and Actual Mean Vote (AMV) was observed. A theory is that difference between PMV and AMV is due to an expectation factor since no other adaptive behaviour was observed in the pilot field study case. The preliminary findings showed a tendency for a relationship between the derived expectation factor and air indoor temperature (**Figure 2**, left) and a relatively weaker relation between the expectation factor and running mean outdoor temperature (**Figure 2**, right). It is important to note that the pilot study was very small in number of participants and limited to a very short period to make any sound conclusions for development of indoor climate models. However, the pilot study has illustrated that the DPS technology has the potential to collect vast amount of data – data which is valuable for various purposes in indoor climate research and development of more user-driven control of indoor climate systems. We welcome any ideas for future collaborations in this field. ■

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A local ventilation system for the operating theatre

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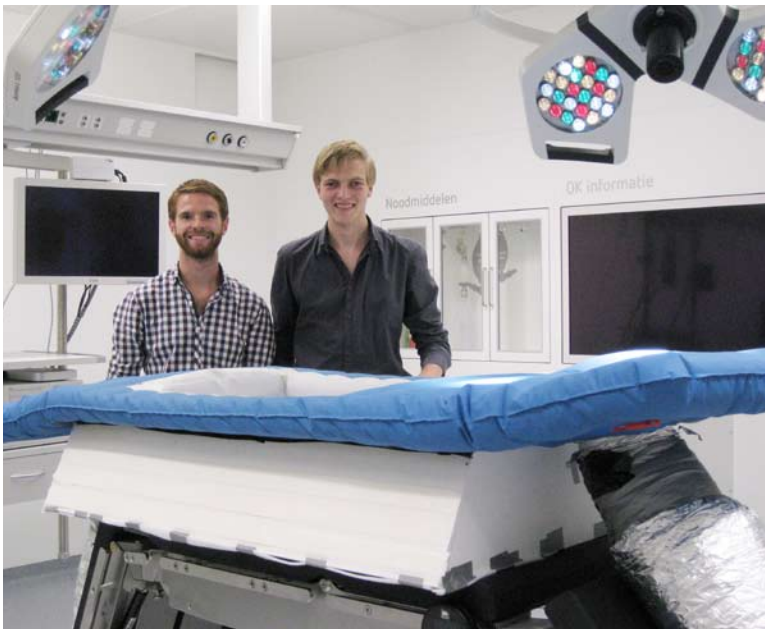
[3] Interflow, Wieringerwerf, The Netherlands

Clean air in operating theatres is of major importance to reduce infection risk. This article describes the performance of a new solution for ventilation in operating theatres based on full-scale measurements. The main advantages are an optimized airflow pattern, from urgent to less urgent areas, higher comfort for the surgeons and lower energy consumption.

Keywords: Surgical site infection, air quality, relative particle concentration, operating theatre, hospital environment, personal ventilation, experiment, CFD.

Introduction

A surgical site infection (SSI) occurred in 2.9% of all surgical operations in conventionally ventilated operating theatres (OT) in The Netherlands (PREZIES, 2012). A SSI is associated with a serious health risk of the patient and increased healthcare costs. Lidwell et al. (1982) found a significant positive correlation between the contamination of the air and the number of SSIs in OT. As a result, the effectiveness of unidirectional flow (UDF) ventilation systems have been studied increasingly and such a system was prescribed in Dutch guidelines. Although the system performs properly in an at rest situation, several studies showed concerns related to the position of the surgical light, limited space available for the operating team and instrument tables. Furthermore, clean air first passes the surgeon before reaching the wound, while research has shown that persons are the main source of bacteria in the OT.



Authors Ivo de Visser (left) and Jelle Loogman (right).

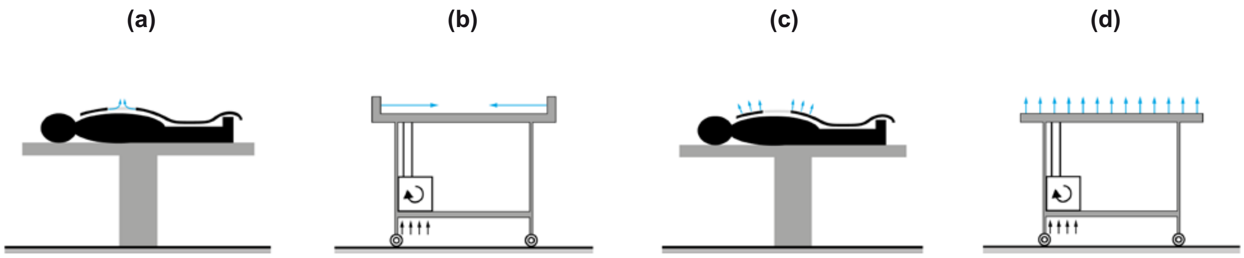


Figure 1. Impression of the local ventilation system; (a, b) configuration 1 with clean air supply around and parallel to the wound area and instruments, (c, d) configuration 2 with clean air supply from the top surface of the blanket and instrument table.

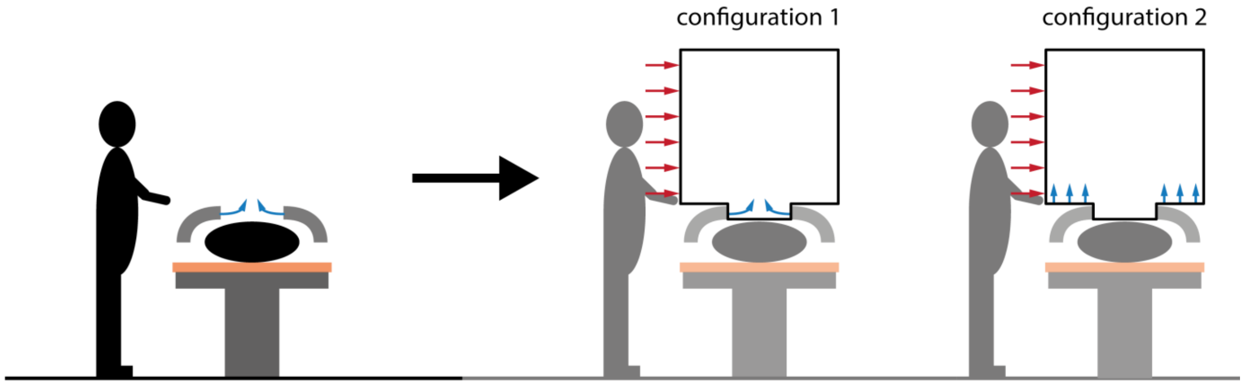


Figure 2. Origin of the geometry for the parameter study. The geometry represents the wound area with a contaminated airflow (red arrows) coming from the side of the surgeon and HEPA-filtered airflow (blue arrows) supplied at the wound area (configuration 1) or from the top surface of the blanket (configuration 2). The outlet was located at the right side, opposite to the contaminant supply.

Contrary to the previous Dutch guideline, in 2014 a performance based guideline was introduced which offered the opportunity to develop alternative ventilation systems for the OT (WIP, 2014). Therefore, a new ventilation system is researched in this study which makes use of a reversed airflow direction, from critical to less critical areas. The clean air supply is released around the wound area from a blanket which is spread out over the patient's body during the operation. Two configurations were designed: configuration 1 concerns a blanket where HEPA-filtered air is supplied around and parallel to the wound area (**Figure 1a**); configuration 2 makes use of HEPA-filtered air which is supplied from the top surface of the blanket, perpendicular to the wound area (**Figure 1c**). Similar approaches were applied to the instrument tables as well (**Figure 1b and d**). The performance of the local ventilation systems was studied in a full-scale experimental set-up. However, first a parameter study was applied in order to evaluate a wide range of situations.

Parameter study

A parameter study was performed on a simplified model, which represents the wound area of the patient and its immediate surrounding (**Figure 2**). Both particle measurements and computational fluid dynamics (CFD) simulations were performed to investigate the performance. Particles of size 0.5-0.7µm were measured in the center of the wound at 0.12m height (**Figure 3**). Next to this, Steady-state

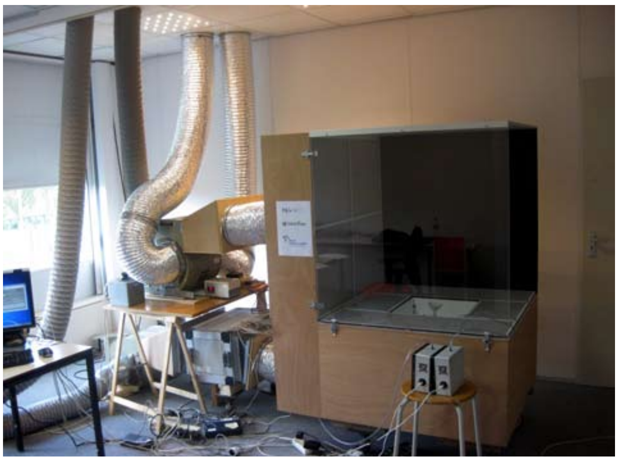


Figure 3. Impression of the measurement model at the TU/e, which was used for the parameter study.

RANS CFD simulations using a RSM model were performed on a replica of the experimental model. Contamination was modeled as a scalar.

The supply velocity and supply temperature of the clean airflow were the two most critical parameters. For the non-isothermal situation the supply temperature of the clean airflow was 22°C higher than the contaminated air in order to prevent for hypothermia of the patient. For configuration 2 a supply temperature of 5°C lower than the contaminated airflow was considered to increase comfort for the surgeons.

Measurement results of configuration 1 showed that a higher supply velocity of the filtered airflow significantly reduced the particle concentrations, while a higher supply temperature significantly increased the particle concentration. No significant differences were observed for different velocities and temperatures of the filtered airflow regarding configuration 2. Furthermore, under isothermal conditions, comparison of configuration 1 and 2 showed no significant difference in the measured relative particle concentration at a supply velocity of 0.40m/s and 0.30m/s respectively. The smoke visualization and CFD simulations demonstrated that for both configurations a layer of clean air is created around

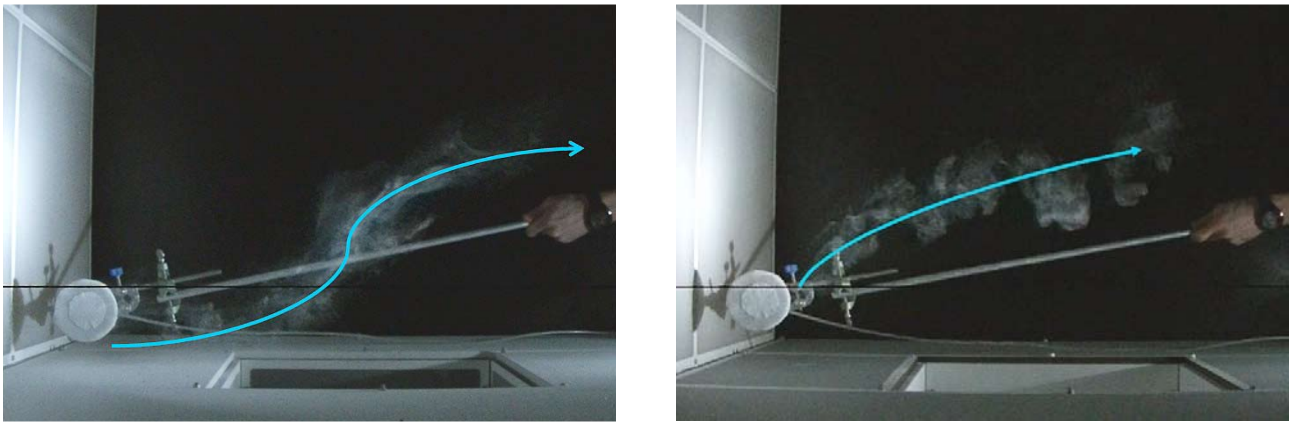


Figure 4. Smoke visualization of the contaminated airflow in the measurement model under isothermal condition of configuration 1 (left) and configuration 2 (right). In both situations it is clear that the contaminated air is lifted over the wound area.

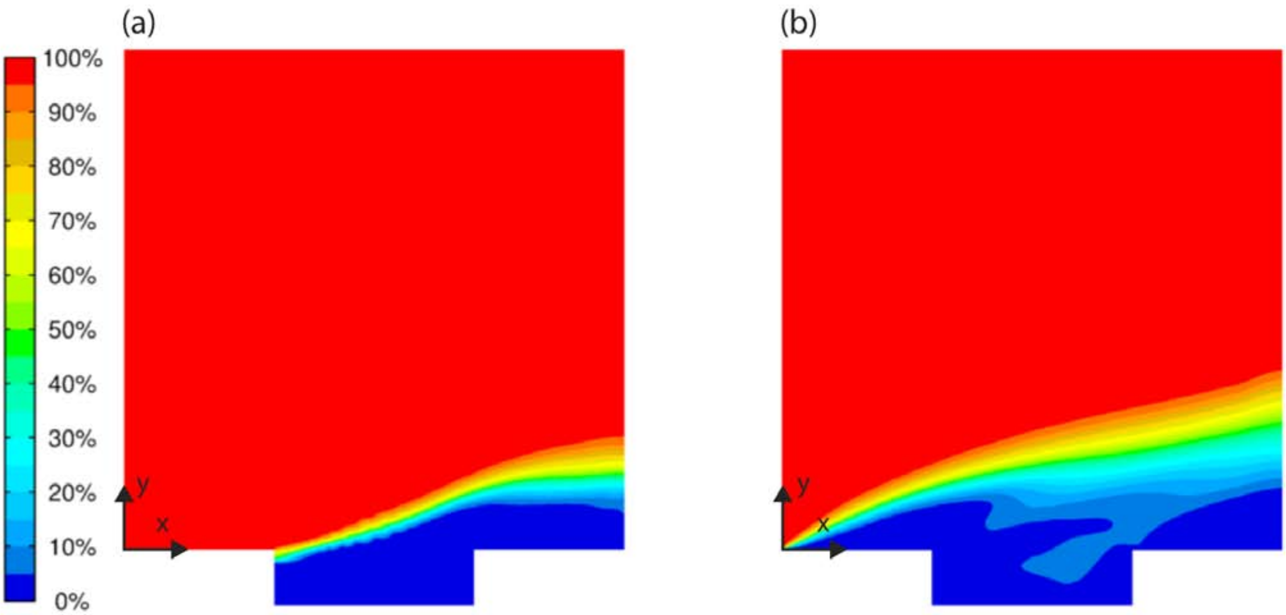


Figure 5. Concentration field of the relative particle concentration at section z = 0.4m for (a) configuration 1 and (b) configuration 2. Contaminated air velocity was 0.30m/s, HEPA-filtered air velocity was 0.10m/s.

the wound (**Figure 4 and 5**). In general, simulated particle concentrations showed similar trends as the measurement results although results were more positive compared to the measurements.

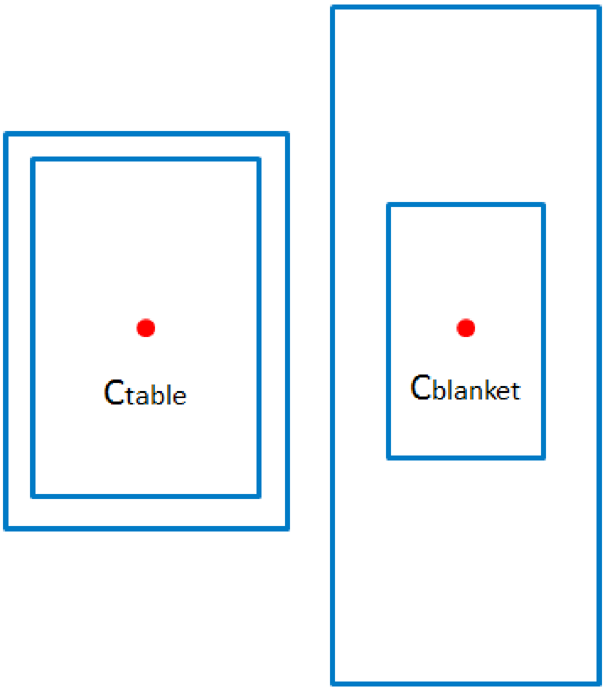
In conclusion, based on the results of the parameter study a supply velocity of 0.40m/s and 0.30m/s was used in the full-scale setup for configuration 1 and configuration 2 respectively. Furthermore, for configuration 1 the non-isothermal situation could not be neglected in the full-scale setup and was therefore taken into account as well.

Full-scale study – method

Next, the performance of a prototype of the local ventilation systems was explored in a full-scale mock-up OT at Interflow, illustrated by **Figure 6**. Particle measurements (≥0.5µm) were performed in

Figure 6. Full-scale test setup of the ventilating blanket and instrument table of configuration 1 (left) and configuration 2 (right) in the mock-up of the OT, the blue arrows indicate the clean airflows.

Table 1. Median (range) of the relative particle concentration [%] for particles ≥0.5µm (N=60). The topview at the right side shows location of the measurement positions.



	Series 1	Series 2
$C_{blanket}$		
Configuration 1	5.0 (1.0-10.5)	0.9 (0.2-6.7)
Configuration 2	1.7 (0.5-4.5)	6.1 (0.8-28.5)
C_{Table}		
Configuration 1	1.7 (0.5-3.1)	0.7 (0.3-1.9)
Configuration 2	0.0 (0.0-0.0)	N/A

Figure 7. Smoke tests for the long and short side for the configuration 1 blanket (left, middle) and the short side for configuration 2 (right).

an at rest situation, without people, according to the Dutch guideline (VCCN RL7, 2014). There was no additional ventilation in the OT and the fans for the local ventilation devices were placed outside the OT. A relative particle concentration was derived by comparing the particle concentration in the middle of the wound area and at the table with a reference point in the contaminated periphery. Measurements were divided over two series to improve the reliability of the data. Furthermore, smoke tests were conducted to visualize the airflows.

Full-scale study – results and discussion

The results of the full-scale measurements are demonstrated by **Table 1**. Regarding the ventilated blanket, a significant difference was observed between the two measurement series of the same configuration. The differences were probably caused by imperfections of the hand-made prototypes. Smoke tests showed that for configuration 1 turbulent air was supplied from the long side of the blanket, while a more constant airflow was supplied from the short side (**Figure** 7, left and middle). Regarding configuration 2, entrapment of contaminants in a local eddy above the wound area caused a high range of relative particle concentrations (**Figure** 7, right). Summarizing, configuration 1 yielded significant lower relative particle concentrations in the wound area than configuration 2. However, a relative particle concentration of 0.1%, as required by the WIP (2014), was not met for both configurations.

The instrument tables of both configurations demonstrated more uniform results compared to the ventilated blankets. The instrument table of configuration 2 satisfied the Dutch standard, while the instrument table of configuration 1 demonstrated significantly higher relative particle concentrations.

Future applications

According to the Dutch guideline the full-scale measurements showed that only the ventilated instrument table of configuration 2 was sufficient. For this reason, this could be a promising solution for application in OTs, for instance as an addition to the vertical UDF system to enlarge the clean area. Although results of the other ventilation devices did not satisfy the guideline, they might be used as an addition to OTs with a mixed ventilation system to improve the air quality at wound level and around the instruments. Furthermore, the local ventilation devices might be applied outside the OT where in that case operations can occur more safely (i.e. during field operations, operations in treatment rooms). ■

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Passive Cooling Measures for Single-Family Houses

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Within this paper a variation study of passive cooling measures – measures without technical effort – of single-family houses is presented. Constructive and user caused changings are implemented into a basic version of a typical single-family house. TRNSYS is used as simulation software. Measures are considered that reduce both, heat entry into the building and internal heat loads. Shading, night-time ventilation, glazing, insulation standard, internal masses and internal thermal loads are examined. The heating and the cooling demand of the building is compared with the basic version.

Keywords: passive cooling, single-family house, simulation with TRNSYS, shading, night-time ventilation, glazing.

During the past decades requirements concerning the insulation of residential buildings have increased. Thus, transmission heat losses through the building envelope have been reduced and improved air tightness causes lower ventilation losses. The building is decoupled more and more from external climatic conditions and the utilization of the building has a higher impact on the energy consumption. Most measures ensuing from energy-saving regulations focus on lowering the heating demand. They can further generate a cooling demand during the hot season, if an upper temperature limit is defined. In residential buildings, especially single-family houses, cooling is not currently common, whilst it is considered state of the art in office buildings.

For the cooling of buildings there are active measures which need auxiliary power and measures without technical effort. This paper focuses on measures without technical effort. Passive measures subsume all methods which decrease heat fluxes into the building and reduce internal thermal loads.

The paper examines passive cooling measures of single-family houses in a variation study using the simulation software TRNSYS. In the first step a basic version of a typical single-family house is created. Then, constructive and user caused changes are implemented in the model. The heating and cooling demand of the building is compared with the basic version.

Method

Cooling measures without technical effort are implemented in a model of a single-family house that serves as basic version.

The following categories of measures are examined: shading, night-time ventilation, glazing, insulation standard, internal masses and internal thermal loads.

The simulation software TRNSYS is used for the variation study. TRNSYS (TRaNsient System Simulation) is a software that can simulate the thermal behaviour of buildings and plants. The time of simulation is one whole year, meaning 8.760 hours and the simulation time increment is 10 minutes.

As a result, the building energy demands of the models are calculated according to the guidelines VDI 2067 Part 10 [1]. It is used as evaluation criterion since no technical measures with additional energy effort are to be discussed.

Basic version

Building geometry

The basic version of the building is designed for four persons. It consists of eight rooms located on two floors. The total habitable area of the house is A = 144 m². The ridge of the roof is aligned north to south, so the slopes of the saddle roof point east and west. **Figure 1** shows the general arrangement of the building model.

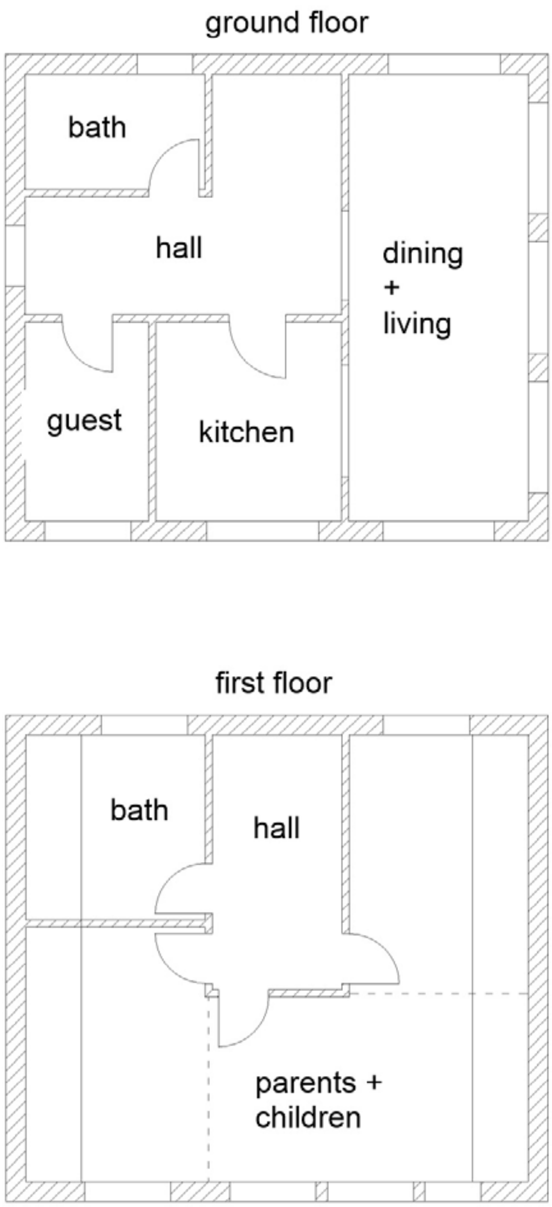

Figure 1. General arrangement of the building model.

The building is constructed according to the insulation standard of the German Energy Saving Ordinance (EnEV 2009). It has double-pane heat insulation glazing and lightweight internal walls. All rooms of the basic version are unshaded and are exposed to direct solar radiation.

Boundary conditions of the simulation

Climate data of North Rhine-Westphalia (North-West part of Germany) are used for the simulation.

In order to model the resident's behaviour, the air change due to infiltration varies depending on occupancy. The determination of the air changes refers to DIN EN 15251:2012-12 [2]. When unoccupied, all rooms will have an air change of n = 0.11 h^{-1}. During busy time the air change augments to n = 0.60 – 0.64 h^{-1} for each room according to the ratio between room area and room volume.

Utilization

The utilization of the building is determined by temperature inputs, attendance profiles of the residents and load profiles of the electrical appliances. The thermal heat emitted by persons, by electrical appliances and by lighting is part of the energy balance of the room. In **Table I** the required heating and cooling temperatures of each room are shown. During night-time the air temperature set value is lowered by 4 K.

Table I. Required heating and cooling temperatures of each room.

Rooms	Heating temperature in °C	Night-time reduction* in °C	Cooling temperature in °C
Bedroom, living room, kitchen, guest room, hall	20	16	26
Bathroom	24	20	26

* between 11:00 p.m. and 06:00 a.m.

Simulation variants

Within the variation study 13 cooling measures without technical effort are investigated. The study aims to evaluate the measures according to their energy efficiency and to determine the measure that leads to the minimal cooling demand of the building.

Shading

Sunshade is often used to protect rooms against heat entry due to radiation. It reflects and absorbs part of the radiation and lowers the amount which enters the room. The variation study examines the efficacy of external shutters, external blinds whose blades are positioned at a 45 degree angle and internal shading. The reduction factor F_C indicates the amount of the total incoming radiation which enters the room with the shading in place. According to DIN 4108-2:2011-10 [3] the reduction factor for external shutters is set to F_C = 0.1, for external blinds to F_C = 0.25 and for internal shading to F_C = 0.75. If the ambient temperature exceeds the limit of ϑ= 5°C and if the solar radiation exceeds 50 W/m², the shading will be lowered.

Night-time ventilation

This concept intends to raise the air change in the building during night-time in order to remove the solar and internal heat loads occurring during day-time. The air change is afforded by natural ventilation; no mechanical equipment is used. The augmented air change is added to the existing. Two variants of night-time ventilation are simulated. The air change is set to n = 2 h^{-1} and n = 4 h^{-1}. Night-time ventilation will be turned on if the ambient temperature is at least 2 K below the room temperature and off if the indoor temperature falls below ϑ = 20°C.

Change of glazing

A variant analyses the impact of reducing the total energy transmittance (*g-value*). The value describes the proportional amount of energy which heats up the room due to direct transmission and secondary heat dissipation mechanisms (irradiation, convection). The building of the examined variant is equipped with triple-pane heat insulation glazing. The total energy transmittance of the glazing is g = 0.407 (basic version: g = 0.598). The heat transfer coefficient (*U-value*) of the window is not changed.

Variation of insulation standard

The modification of insulation standard is part of the study. The quality of the overall insulation is numbered by the transmission heat loss referred to the exterior surface H_T'.

- In a variant the insulation standard is increased according to German Energy Saving Ordinance (EnEV 2013). The transmission heat loss referred to the exterior surface is H_T' = 0.36 W/(m²·K) (basic version: H_T' = 0.40 W/(m²·K)).
- In another variant the insulation standard is reduced according to German Energy Saving Ordinance (EnEV 2002). The transmission heat loss referred to the exterior surface is H_T' = 0.49 W/(m²·K).
- A building erected between 1984 and 1994 is examined as well. The outer walls are not insulated and single-pane windows with U = 2.83 W/(m²·K) are used. The transmission heat loss referred to the exterior surface area is H_T' = 1.01 W/(m²·K). Additionally the air change due to infiltration is that of an old building.

Consideration of internal masses

The simulation software TRNSYS uses a multiple-zone model which considers the heat capacity of the air volume and of the walls. No thermal masses of furnishing are taken into account. The following variants investigate the effect of an increased heat capacity.

- The internal walls are designed solid. Sand lime brick is used as construction material. The thickness of the wall is not changed but the heat transfer coefficient of the solid wall is ten times higher than of the lightweight wall.

- This variant takes into account the influence of furnishing. Furnishing is modelled as internal walls which influence the thermal behaviour of the room due to their mass. They also exchange radiation with their surrounding surfaces.

Reduction of internal thermal loads

Internal thermal loads normally consist of heat gains from residents, electrical appliances and lighting. During the heating period the energy demand is lowered by internal thermal loads, whereas in case of cooling a greater cooling load has to be dissipated. In order to decrease the cooling demand a reduction of internal thermal loads is modelled.

- The users' behaviour, including the occupancy as well as the utilization of electrical appliances and lighting, is changed. The basic version schedules that one parent stays at home and one parent as well as the two children are absent over the day. In a variant the scenario is changed so that all residents are absent from morning to evening on weekdays. Consequently, no electrical appliances are used during that time.

- Electrical appliances and lighting emit thermal energy. In the simulation the assumption is made that the thermal power output equals the electrical power consumption. In a variant the thermal output of electrical appliances is reduced by assuming appliances of the best energy efficiency class available on the market.

Table II gives a summary of all 13 simulated variants.

Table II. Summary of the simulated variants.

Variants	Characteristics	Numbering
Shading	External shutters	Variant 1
	External blinds	Variant 2
	Internal shading	Variant 3
Night-time ventilation	Air change = 2 h^{-1}	Variant 4
	Air change = 4 h^{-1}	Variant 5
Glazing	Reduction of total energy transmittance	Variant 6
Insulation standard	Increase according to EnEV 2013	Variant 7
	Decrease according to EnEV 2002	Variant 8
	Old building	Variant 9
Internal masses	Solid internal walls	Variant 10
	Influence of furnishing	Variant 11
Inner thermal loads	Change of user behavior	Variant 12
	Reduction of thermal output	Variant 13

Results

The results of the TRNSYS simulation are plotted in **Figure 2**. The heating and cooling demands in kWh/a of the basic version (B) and of the variants (V1 to V13) are shown.

The basic version requires 4.975 kWh/a for heating and 5.568 kWh/a for cooling of the single-family house.

Table III illustrates the relative demands with the basic version being the reference. Due to the implemented measures the cooling demands of 11 variants are reduced, in return, the heating demands of 8 variants are increased. Mostly, a reduced cooling demand causes an increased heating demand.

Table III. Percental comparison with the basic version.

	Heating demand in %	Cooling demand in %	Total demand in %
B	**100**	**100**	**100**
V1	110	18	62
V2	107	28	65
V3	100	98	99
V4	117	73	94
V5	125	60	91
V6	99	54	75
V7	92	106	99
V8	131	84	106
V9	510	43	263
V10	96	91	93
V11	99	104	102
V12	101	93	97
V13	103	93	77

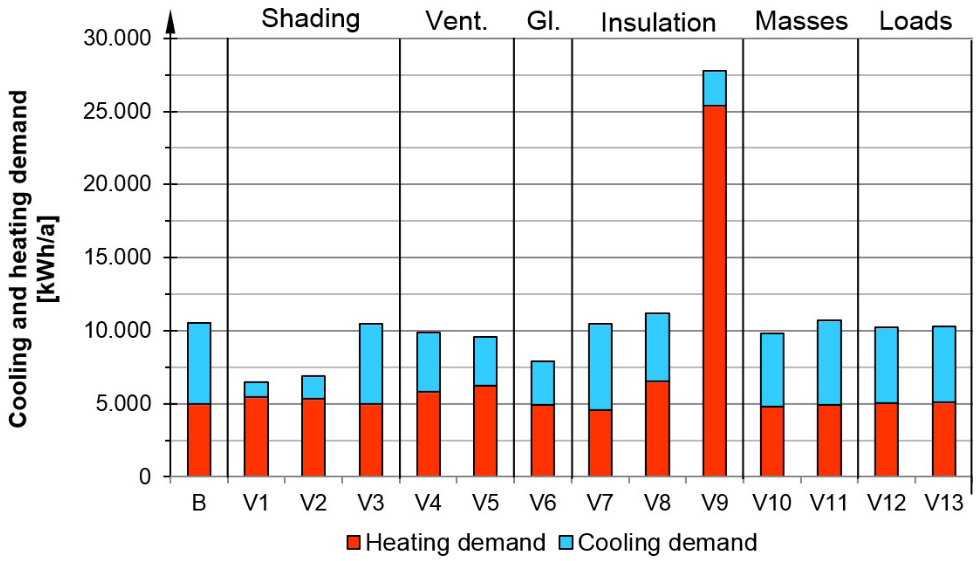

Figure 2. Plot of the results.

The results are discussed below:

- V1: External shutters are most effective regarding the cooling demand and the total demand. The cooling demand can be lowered to 1.007 kWh/a, i.e. a reduction by 82 % of the cooling demand of the basic version. During seasonal transition time the shutters withhold solar gains for heater support. That is the reason why the heating demand increases by 10 %.
- V2: External blinds are the next best option. For cooling 1.579 kWh/a are required corresponding to a reduction by 72 %. Heating demand increases by 7 %. The advantage of blinds compared to shutters is the higher light transmission into the room.
- V3: Regarding energy savings, internal shading is not reasonable. No effect is achieved concerning the heating demand, the cooling demand decreases by a mere 2 %.
- V4: It is quite profitable to increase the air change during night-time. The cooling demand of the simulated building decreases by 27 % down to 4.051 kWh/a. Night-time ventilation is active all year, i.e. also during wintertime. This fact leads to an increase of heating demand by 17 %.
- V5: Doubling the air change lowers the energy demand for cooling by 40 % whilst increasing that for heating by 25 %. In total 9 % of the energy demand can be saved.
- V6: Glazing with a lower total energy transmittance is the third best option to decrease the total energy demand. It is an advantage that they reduce the cooling demand by 46 % without increasing the heating demand.
- V7: A higher insulation standard gives rise to a diminished transmission heat loss. Thus, the heating demand decreases by 8 %, whereas the cooling demand increases by 6 %.
- V8: A lower insulation standard raises the heating demand by one third, to 6.540 kWh/a. In return, the cooling demand of the building is reduced by 16 %.
- V9: Old buildings have almost no insulation and quite a high infiltration rate through the building envelope. The missing insulation decreases the cooling demand by 57 %. In contrast, the heating demand jumps up to 25.375 kWh/a, meaning a sharp rise to more than fivefold.
- V10: Solid internal walls act as a heat storage. During heating period the walls absorb the heat and emit it into the room later, resulting in the heating demand being reduced by 4 %. On days with a high room temperature the walls absorb part of the cooling load which leads to a decrease of the cooling demand by 9 %.
- V11: The heating demand of the model which examines the influence of furnishing is decreased by just 1 %. This can be explained by the rather low heat capacity of the furnishing. Contrary to expectations the cooling demand increases by 4 %. This fact can be explained as follows: Furnishing is represented as additional internal walls whose surfaces absorb heat radiation from outside. The modelling of furnishing as internals walls is thus not realistic.
- V12: If the user behaviour is modified, assuming a reduced occupancy of the building, cooling demand is decreased by 7 % whereas the heating demand increases by 1 %.
- V13: The variant with reduced thermal output of electrical appliances achieves similar results. Cooling demand is lowered by 7 %, heating demand increased by 3 %.

Summary and conclusion

The heating and cooling demand of 13 variants of passive cooling measures of a single-family house compared to a basic version is examined. The study aims to determine the measure that reduces the total energy demand of the building.

The results show that external shutters are most effective regarding the reduction of the total energy demand for heating and cooling. They reduce the total energy demand by 38 %, external blinds which still reduce it by 35 %, being the second best option. The building equipped with glazing with a lower total energy transmittance requires 25 % less total energy demand. ■

References

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Testing the use of an active chilled beam technology in a hospital ward mock-up

This article describes a research to study the performance of an active chilled beam at cooling and heating modes in a mock-up of a hospital ward. The research was conducted in accordance with ASHRAE 55-2004 and ANSI/ASHRAE/ASHI 17-2013 standards in a certified aerodynamics laboratory.

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Within the framework of the research a test chamber was built up to represent a typical hospital ward for three patients.

Air velocity and temperature measurements were taken in the test chamber to quantitatively determine the critical air parameters in humans' occupancy zone at cooling and heating scenarios using chilled beams technology.

Introduction

In mixing ventilation systems indoor air quality is highly dependent on air mixing effectiveness. In cooling case it is necessary to control air distribution in order to prevent excessive air velocity and draft rate occurrence in human's occupancy zone. In heating case there is a risk of air stratification in the room, when a layer of fresh and warm air mass builds up right below the ceiling, whereas layer of stuffy and relatively cooler air mass settles in human's occupancy zone. Therefore it is important to select the right system to deliver fresh air at the desired temperature and to meet comfort requirements.

Hospital wards have strict hygienic requirements, therefore a proper and regular air exchange is critical. Fresh air cannot be simply delivered by opening the window, therefore an advanced technology shall be used that can meet the strictest hygiene and comfort criteria.

Chilled beam technology is primarily used for cooling and ventilation. Active chilled beams deliver primary (fresh) air into the room and recirculates secondary (room) air through its heat exchanger. Recirculated secondary air and the fresh primary air are mixed prior to diffusion in the space. Chilled beam system provides an excellent thermal comfort, energy conservation and efficient use of space due to high heat capacity of water used as a heat transfer medium. The system operation is simple and trouble-free with minimum maintenance requirements. It can also be used for heating.

Typical applications for beam system are office spaces, hotel rooms, hospital wards and retail shops. This study was focused on the application of the active chilled beams technology in hospital wards for heating and cooling purposes.

Methodology

Studies on air movement and distribution within the enclosed spaces are conducted using full-scale test methodology. Full-scale test rooms are used for identification of air terminal devices with regard to the flow they generate.

In this study a full-scale testing methodology was applied to simulate the beam performance in a hospital ward in summer and winter conditions. For that purpose a specially designed test chamber was assembled to represent a three-patient hospital ward (**Figure 1**).

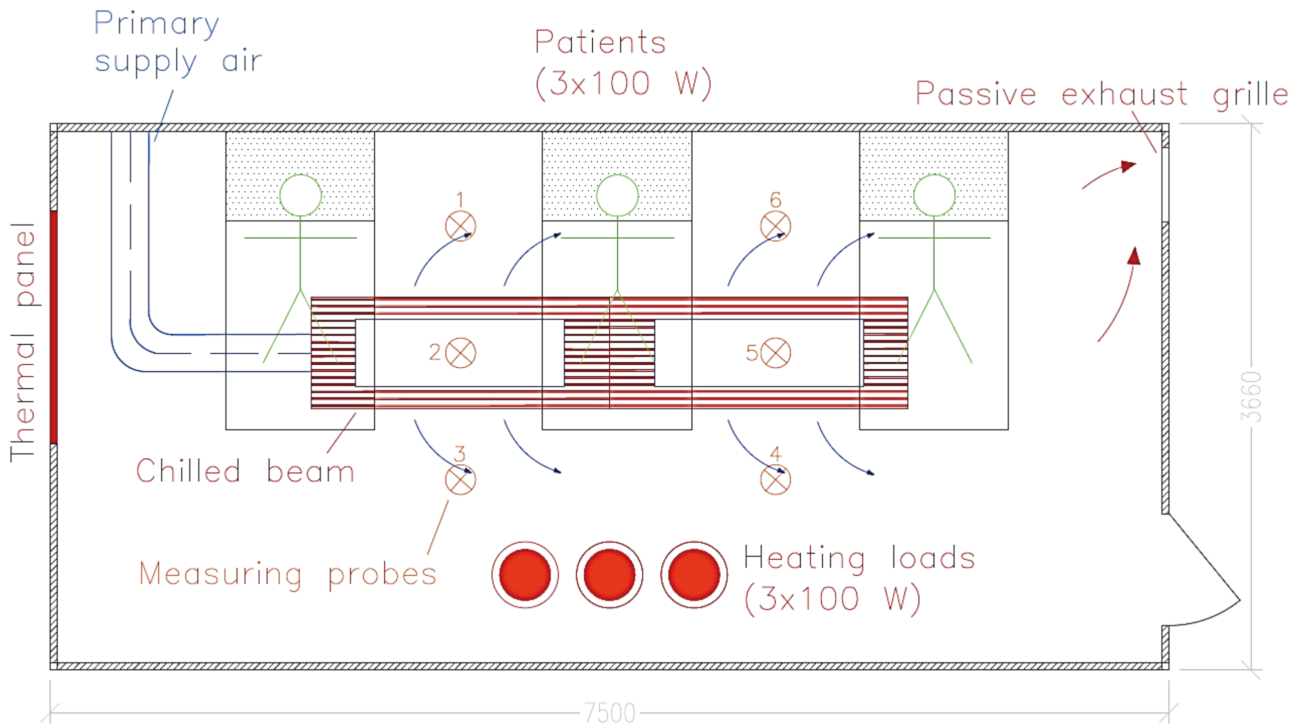


Figure 1. The layout of a full-scale test chamber.

Three beds with 100 W heating load source each were placed within the test chamber to simulate the heat release of a human. On one side of the chamber a thermal panel with integrated heat exchanging copper pipes was installed to simulate solar radiation input for summer case or cold window surface for a winter case. On the other side of the test chamber a passive overflow grille was integrated to eliminate the risk of overpressure and to ensure a heat exchange between the test chamber and adjacent spaces. An additional heating load of 300 W (3x100 W) was placed to account for other factors such as visitors, medical personnel or electrical equipment heat release.

Integrated into suspended ceiling two beam technology prototypes were connected in series to deliver fresh air into the chamber and to ensure heat exchange with max 2 000 W of capacity.

Table 1 shows the testing conditions for summer (cooling) and winter (heating) cases. Airflow rate was set according to the ANSI/ASHRAE/ASHE 170-2013 requirements. Other parameters were set up according to specific characteristics of chilled beam prototypes used for this study.

To check the air mixing effectiveness within the test chamber a smoke test was conducted. A smoke test visually demonstrates an air distribution and diffu-

Table 1. Testing conditions.

Parameter	Cooling	Heating
Airflow, m^3/h	342	342
Supply air temperature[1], °C	18.0 ±0.5	24.0 ±0.5
Room set temperature[2], °C	23.0 ±0.5	21.0 ±0.5
Temperature in the heat exchanger (in/out), °C	14/18	50/42
Room heating/cooling loads, W	1 600	1 768
Beam cooling/heating capacity[3], W	1 638	1 786
Thermal panel temperature, °C	40.0 ±1.0	16.0 ±1.0

1 In the beam outlet.
2 Desired temperature at the height level of 1.1 m above the floor.
3 Cooling capacity to compensate the heating loads; heating capacity to compensate the heating loads.

sion pattern and shows the appearence of such risks as air mass stratification, short-circuiting or excessive turbulence.

Air temperature measurements were taken constantly every 60 seconds throughout the test. Temperature measurement probes were placed at 3 levels of a standing occupant ankle, waist and head area (0.2, 1.1 and 1.8 m above the floor accordingly) and at 2.2 m above the floor level (400 mm under the beam) as it is shown in **Figure 2**.

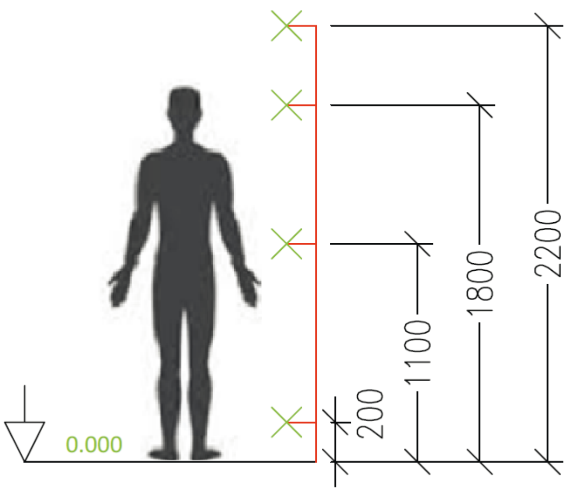


Figure 2. Vertical profile of the measurement points (human's silhouette is added as a height level reference).

Results and discussions

Cooling scenario

In the cooling case the supply air temperature from the beam outlet was set to 18.0±0.5°C in order to keep room temperature below 23.0°C.

Some turbulence was observed near the thermal panel area as the panel was heated up to imitate the input solar radiation through the window. Cool supply air from the beam confronts the warm air mass near the window area and this creates intense mixing which leads to increased air velocity and excessive turbulence. When the thermal panel was off, the turbulence did not occur.

In the patient area under the beams air velocity was relatively low ($v < 0.2$ *m/s*) with insignificant velocity deviation factor, eliminating the risk of excessive turbulence and draft rate ($T_u < 40$, $DR < 20$).

In cooling case no concerns appeared regarding the air mixing effectiveness as the smoke coming from the beam dissipated quickly and evenly within the volume of the test chamber and did not stratify in one particular zone. Also, the passive overflow grille did not disrupt the air circulation pattern. No short-circuiting or extract effect occured through the grille.

Temperature gradient for cooling scenario also showed that the air was distributed and mixed properly throughout the test. As it is shown in **Figure 3** the temperature profile has a steady and uniform shape without substantial deviations at any of 4 height levels. A little cooler temperatures are observed right above the floor at the ankle area and right below the beam which indicates, that at the humans activity area the heat loads are present at a denser degree and thus keep the temperature slightly higher. Wider temperature range right below the beam also indicates that air induction takes place.

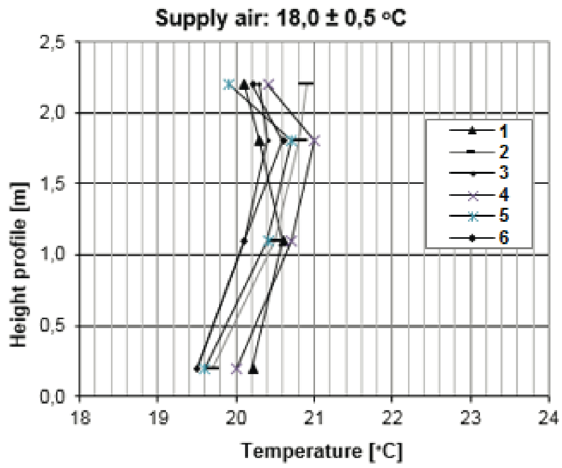


Figure 3. Temperature profile for cooling scenario.

Heating scenario

In the heating case the supply air temperature from the beam outlet was set to 24.0 ±0.5°C in order to keep the room temperature at 21.0 ±0.5°C.

Thermal panel in this case was connected to a cold water circuit to imitate a cold window surface. This did not cause any turbulence, as the air velocities throughout the test chamber were considerably below 0.2 m/s.

Some degree of air mass stratification was observed as the temperature measurements at the upper level differed quite significantly from those below. At the ankle area temperature ranged between 20.5÷21.1°C, whereas at the 2.2 m height level temperature varied from 23.2 to 23.9°C (**Figure 4**).

Smoke test validated that warm supply air tends to accumulate at the upper part of the test chamber prior to entering the human's occupancy zone. However, after continuous observation the air within the test chamber mixed thoroughly. So, while the temperature gradient stays relatively high (>3,0°C), the overall air mixing effectiveness was satisfactory ensuring that at certain point the fresh supply air will dilute with stuffy room air.

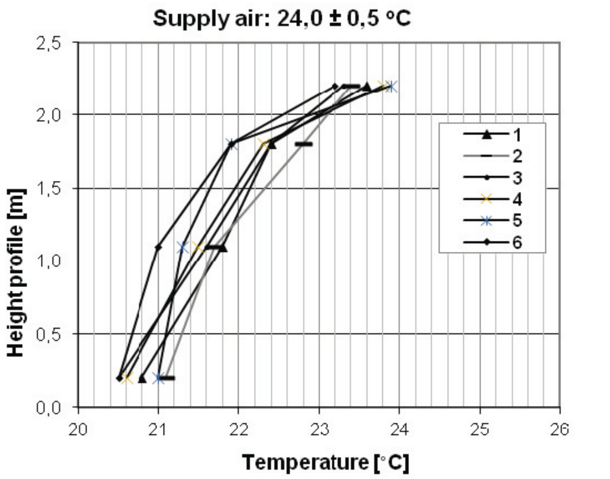


Figure 4. Temperature profile for heating scenario.

Conclusions

This study solely focused on the performance of beam technology at cooling and heating scenarios when strict hygiene and temperature conditions are to be met.

In the cooling scenario the main concern is the occurence of excessive air velocities, turbulence intensity and draft rate in the human's occupancy zone, however, this study showed that with chilled beams technology these parameters are kept below the critical values even when additional heating loads and solar radiation were introduced into the room.

Smoke tests validated that the air mixing throughout the test chamber was sufficient ensuring the necessary exchange rate.

When analyzing the measurements for the heating scenario, the risk of air stratification and insufficient mixing emerged, however, the smoke test showed that at a certain point the fresh supply air will dilute with stuffy room air ensuring the necessary air exchange.

If the building envelope is tight enough and outdoor air infiltration risk is prevented, airborne cooling and heating via beam systems is an effective way to deliver fresh air and ensure the desired room temperature significantly reducing the costs for other cooling or heating equipment.

Supply air flowrate and water inlet temperature in the beam can be varied to maintain room temperature setpoint according to the air temperature conditions outdoors and heating loads indoors. Increasing the supply air temperature and decreasing supply air flowrate can save energy, but it causes reduced air circulation and thus leads to low indoor air quality risk. Increasing the supply airflow will improve air circulation and mixing effectiveness within the room, but it will increase energy consumption. ■

DCV system solution: *Only as much as necessary – not as much as possible*

KURT TRUNINGER, Product Manager, BELIMO Automation AG, www.belimo.eu

The DCV technology (Demand Controlled Ventilation) measures the conditions in a room and calculates the amount of energy actually required. It is applied to regulate the fans according to the demand. Devices used are sensors and control devices for CO_2, VOC, temperature and so on. The required air volume is supplied to the room by precise volumetric flow controllers – a technology known as variable air volume (VAV).

Performance adjustment of the fans via the real ventilation system's demand

Efficient fan control is a vital part of a DCV system. Next to variable speed drive-controlled fans, EC fans are increasingly being implemented. To adapt the fan power made available to the ventilation system, the DCV system must gauge the ventilation system's requirements and set a suitable setpoint. In a pressure feedback Fan Optimiser system only as much pressure as required is produced to transport the current volume through the air duct system. The goal is to operate the system with the least pressure loss.

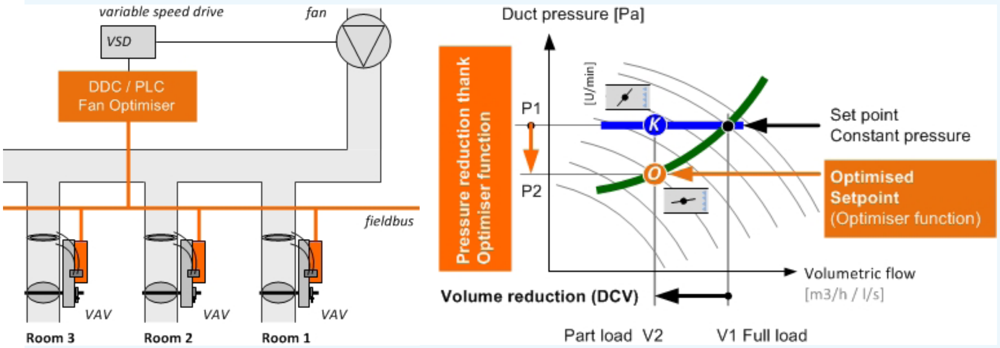
The Fan Optimiser function permanently monitors the damper positions of each VAV box. If the dampers eliminate the surplus of supply pressure, this pressure will be lowered – in contrast to the pressure controlled systems where the supply pressure corresponds to the full load operation. Thus not as much as possible.

System design of a pressure feedback Fan Optimiser system

a) DDC controller: Bus master devices with custom-programmed Fan Optimiser application
b) Fan Optimiser hardware: Device with preconfigured, ready-to-use Fan Optimiser function, e.g. COU24-A-MP

In both versions the VAV-Compact controllers are integrated into the control system via the field bus (MP-Bus®, LON, Modbus, KNX) and the damper positions evaluated by the Fan Optimiser.

If the system is configured as a bus system, or if a bus system is already installed, then there are basically no additional hardware costs. The duct pressure control equipment and the complex adjustments are not required.



System overview with system diagram.

Potential savings – Case study

For a comparison in an office building the Fan Optimiser application was programmed into a DDC controller. The VAV controllers are connected to the DDC controller by the MP-Bus. In addition to the Fan Optimiser, the system also has a conventional duct pressure control for taking comparative measurements. Either control function can be selected in order to compare the two strategies under identical operating conditions.

The measured current difference on the chosen day was an impressive saving of 64%.

Over the course of a year the savings would probably lie between 20% and 50%, depending on the system and the part-load conditions.

Fields of application

- VAV system in office buildings, hotels, hospitals, etc.
- Variable volume systems for controlled residential ventilation

Benefits of a Fan Optimiser system

- Compliant with EN 15232, Class A
- No reduction in comfort
- Compensates for design errors
- Easy commissioning, finds its own operating point automatically
- Energy-optimised, minimal pressure loss
- Reduced noise, thanks to lower duct pressure
- Short payback time, low operating costs ■

VAV-Compact from Belimo with NFC interface

Complete, efficient, intelligent

The VAV-Compact from Belimo is a cost-optimised unit comprising differential pressure sensor, controller and actuator, and has been setting standards in volumetric flow control in rooms and zones since 1990. The highly sensitive sensor technology for precise Δp recording allows even the smallest of volumetric flows to be controlled and guarantees the implementation of modern, demand-controlled ventilation concepts according to DIN EN 15232. Simple integration in DCV systems (Demand Controlled Ventilation) with fan optimiser function and pressure feedback reduces consumption following the principle of "not as much as possible, but exactly as much as required".

The unique operating concept of the VAV-Compact devices helps to reduce energy consumption and operating costs. Set points/actual values and damper positions are displayed using the Belimo Assistant app for instant assessment of system efficiency. Any corrections needed are communicated directly to the VAV unit via the smartphone. The NFC (Near Field Communication) interface eliminates the need for a cable connection. VAV units that are hard to access as they are

mounted in concealed locations can be operated directly from the control cabinet, floor splitter or CR24 room controller thanks to the ZTH EU service tool. The tried and tested PC-Tool also displays trend functions using graphic illustrations. All set and actual values can be saved and printed out at any time offline or online. ■

More information: www.belimo.eu

The best solution for air quality and energy efficiency is Friterm high efficiency run around coils heat recovery systems

Indoor air quality and energy consumption are the important topics in the design and construction stages of the building's life. Contrary to heat pipes, plate heat exchangers (recuperators) and rotary heat exchangers (regenerators) no junction of the air flows is required at the building energy recovery system for coil energy recovery loop systems. Through the absolute separation of extract air flow and outdoor air flow the coil energy recovery loop system is the first choice for buildings with high hygienic demands such as medical applications. As the several heat exchangers are connected to each other by a heat transfer fluid (brine), feed-in and feed-out of thermal energy in the coil energy recovery loop system is possible.

At lower air velocities in the heat exchangers higher temperature differentials are reached. In addition the overall efficiency of the coil energy recovery loop systems increases due to the lower air side pressure losses.

The heat exchangers are made of corrosion resistant material and are cleanable. The special design with fins which are technically flat and produced out of one piece in air direction is complying with the requirements of

- DIN EN 13053:2012-02, 6.4
- DIN 1946-4:2008-12, ,6.5.8.1+2
- VDI 3803-1:2010-02, 5.2.3
- VDI 6022-1:2011-07, 4.3.16
- AHU-Guideline 01:2014-08, 5.6 [2]

Friterm produces different tube geometries for coil energy recovery loop systems to perfectly match the market requirements. For energy

Friterm high efficiency heat exchanger for coil energy recovery loop systems.

recovery loop systems with high temperature differentials a special circuitry for multiple cross-counterflow is a must. ■

Magister CW

Magister CW by CIAT is a vertical chilled-water close control unit specially designed to meet the requirements of data centres, computer rooms, switchboard rooms, electrical equipment rooms and other rooms with high thermal loads. Magister CW is 25% more energy efficient than previous versions and uses 20% less power than other models on the market, which amounts to savings of up to €5000 each year! Magister CW is available in five models with capacities ranging from 10 to 130 kW.

Such energy performance is made possible by Magister CW's highly optimised fan motor assemblies, which consist of centrifugal plug fans (for enhanced air handling efficiency) associated with EC motors (for optimum energy efficiency).

Magister CW uses CIAT's microRC2 controller to self-adjust its operation on both the water and the air circuits. The automatic controller adjusts the fan speed according to the thermal loads of the room and uses a 0-10V signal to control the valve and finely adjust the unit's operation to required levels. An optional enthalpic free cooling module can be added which allows fresh outdoor air to be drawn into computer rooms when their internal temperature and humidity levels reach a certain threshold.

Data centre applications require the very highest levels of reliability. The entire Magister CW range is built with 25 mm double-skin construction and features M0 fire insulation (Euroclasse A1). Optional redundancy functions can be installed to interconnect up to 10 units so that, in the event that one unit fails, the others will automatically take over. Thanks to the RS485 Modbus board, the smallest malfunctions (fan motor assembly, humidifier, abnormal variations in input power, etc.) are detected in real time and relayed as alarms to the supervision system.

Magister CW is designed to facilitate maintenance. All its compartments are accessed via hinged doors on the front panel, the fan and motor are directly coupled, and the filtration system is fitted on a mount for easier handling.

Furthermore, Magister CW is 20% smaller than previous models. In order to achieve the highest efficiency with chillers and operate longer in free cooling mode, the water and air temperature ranges in data centre applications are increasingly higher. The Magister CW fan is therefore more powerful and delivers higher air flows. As a result, it delivers more power for the same footprint.

Magister CW is part of CIAT's CIATRONIC System data centres offer. It combines chilled water production, free cooling and air diffusion. The speed variation of the EC motors, associated with the flexibility offered by water, provides a perfect solution for the changing requirements in data centres. CIAT's solutions constantly adapt to the needs of Tier 4 data centres, be they changes in their classification, changes in their thermal loads over time or needs for modularity.

CIAT's CIATRONIC System includes its AQUACIAT POWER chillers, Opera dry coolers, the Cristopia thermal energy storage system, ITEX plate heat exchangers to isolate the secondary network, the solution for direct free cooling with the Airtech air handling unit, and Magister precision close control units. ■

EPBD standards – what's going on after the enquiry?

The Energy Performance of Buildings Directive (EPBD) refers to European standards to be taken into account in the calculation of the energy performance of buildings and systems. Under a Mandate from EU to CEN, more than 40 standards have been under preparation or revision since mid-2013. REHVA Journal 1/2015 focused on the ongoing preparation work of the second generation of EPB standards. The aim of this summary is to give some highlights of the CEN enquiry phase and the ongoing post-enquiry phase.

— JORMA RAILIO, Chair REHVA Technical and Research Committee, jorma.railio@gmail.com

Public enquiry for the majority of the standards is now over, with a few exceptions.

The overarching standard prEN 15603, disapproved at the formal vote in late 2014, is now under major revision. A new draft is ready, parallel ISO and CEN enquiry is expected to start in September 2015 and formal vote in 2016, in order to have the new EN 15603 (renamed as EN-ISO 52000-1) published in 2016. One main challenge is the clarification of the key definitions. The overarching standard will not give any requirements beyond the scope of the EPBD. As in all EPB standards this standards has a normative Annex A that could be used as a template for National Annexes and an informative Annex B where all default values and choices needed to use the standard are given. This to give allow the flexibility that may be needed to follow current national building regulations and traditions.

The results of ten draft standards under CEN/TC 228 are now available. Eight drafts are approved and two drafts have been disapproved. The draft standards considered not to be acceptable were Space emission systems (prEN 15316-2) and Heat pump systems (prEN 15316-4-2) At the CENTC228WG4 meeting in June the objections have been resolved.

The following standards, and the related Technical Reports, from CEN/TC 156 have been selected as pilots by REHVA:

- Indoor climate input data (revision of EN15251) (prEN 16798-1 and prCEN/TR 16798-2). The CEN enquiry started in late May and will close on 20 September 2015.
- Ventilation and air conditioning for non-residential buildings (revision of EN 13779) (prEN16798-3 and prCEN/TR 16798-4)
- AC and ventilation inspections (revision of EN 15240 and EN 15239) (prEN16798-17 and prCEN/TR 16798-18)

On prEN 16798-1, REHVA members and supporters can now give their comments directly to REHVA office, but also on national level, by attending relevant national committees or using public national commentary on internet.

According to the summary by REHVA liaison Olli Seppänen, the new draft prEN 16798-1 is much shorter than the current EN 15251 from 2007. Also the Annexes are much shorter than before. Detailed material, and long tables are in the Technical Report prCEN/TR 16798-2. It should be noted that the values presented in the standard are not based on the health of the occupants but on subjective evaluation of the indoor environment. As such they should not be used as a basis of heath based ventilation building codes. Main objective of the standard is to unify the input values for energy calculations. Significant change from 2007 version is that National Annexes A1-A5 are now normative, only A6 (WHO guideline values) and A7 Occupancy schedules are informative. The default value Annex B1 – B7 is informative. According to the standard the absolutely lowest ventilation rate is 4 L/s per person providing that indoor air pollutants at the same time are below WHO guideline values and building is very low polluting.

Concerning the two other standards, as well as four more standards prepared by CEN/TC 156, CEN enquiry closed on 27 April 2015. The outcome of the enquiry indicates approval of all drafts, apart from prEN 16798-13 Calculation of cooling systems – Generation.

For items most interesting to REHVA, prEN 16798-3 (revision of EN 13779) and prEN 16798-17 (inspection of airconditioning and ventilation systems), the outcome of the enquiry was mostly positive, but also major comments were given by several CEN members, especially on prEN 16798-3.

The changes in the overarching standard will probably influence in the final contents of all other standards. This has been noted by several CEN member bodies at the CEN enquiry. A few countries had voted negative, because of feeling that the necessary changes in the overarching standard will change all other EPB standards significantly.

Many comments received at the enquiry also pointed out the need for better consistency between the individual standards. This has been noted among the WG's, at least within TC 156.

The post-enquiry work has started in the relevant Working Groups. CEN/TC 156/WG23 has proceeded in revision of prEN 16798-17 so that a proposal for final draft will be discussed in the WG already in July 2015. The comments received were only some 60, mainly editorial and minor technical comments, so a quick revision has been possible. Some critical comments received were related to the open situation on the overarching standard and thus not possible to be dealt with by any individual WG. How to coordinate the work of different TC's, is a critical issue still to be solved.

Concerning prEN 16798-3, the situation is much more challenging. The number of received comments was nearly 800. CEN/TC 156/WG20 will need at least three meetings to discuss all comments, and several experts have volunteered to study comments on different chapters in order to prepare proposals for final texts, then to be discussed at the WG. In parallel, also the draft Technical Report prCEN/TR 16798-4 will be studied and modified accordingly. There are still a few major "headaches": how to justify keeping items important to IAQ and ventilation but not directly related to the EPBD in the standard, how to make the use of Annexes more flexible and practicable. Also the Standard and the Technical Report must make together a useful and consistent package. On technical issues, the SFP values of air handling units and systems, and air filtration, have raised a high number of comments, so further discussions are still needed to make these issues clear and practical in the final standard.

The next stage, draft FV versions of the standards to be submitted to CEN or ISO secretariat, is scheduled to April 2016. So the second generation of EPB standards and related technical reports should be published around the end of year 2016. ■

REHVA High Level Policy Conference Workshop at EUSEW2015 in Brussels

The 10th European Sustainable Energy Week (EUSEW 2015) took place in June in Brussels with a high level opening policy conference session "Energy Efficiency first" stressing the commitment of the EU to enforce energy efficiency in the Energy Union. REHVA was invited by DG Energy to organise a high level policy workshop during EUSEW 2015 with the title "Heating, cooling and ventilation: how to achieve the largest savings in buildings pursuing the EU's energy strategy?" on 17 June in Brussels. The successful event was organised in cooperation with EVIA, EHPA, and EPEE. REHVA and EVIA released a joint policy paper for the upcoming EPBD review during the event demanding IEQ and minimum ventilation requirements to be included in the revised EPBD.

— ANITA DERJANECZ (REHVA Policy and Project Officer) & FRANK HOVORKA (REHVA Vice-president)

"Energy Efficiency First"

The 10th edition of the European Sustainable Energy Week (EUSEW 2015) took place in Brussels with up to 70 challenging sessions in the high-level Policy Conference (16-18 June) and many side events and Energy Days attracting more than 2700 participants during the week. The policy conference started with a high-level opening session including the interventions of Climate Action and Energy Commissioner Miguel Arias Cañete and Member of European Parliament **Claude Turmes** to set the political vision for the "Energy Efficiency First" principle. The speakers stressed the commitment of the EU to strictly force the implementation of the EU energy efficiency related directives and policies. Cañete pointed out again the importance of buildings energy efficiency and stated that the Commission will follow a "zero tolerance" approach against member states not complying with the related EU regulations.

REHVA high level policy workshop at EUSEW2015

REHVA was invited by DG Energy to organise a high level policy workshop on **"Heating, cooling and ventilation: how to achieve the largest savings in buildings pursuing the EU's energy strategy?"** The workshop was organised on 17 June in cooperation with EVIA, EHPA and EPEE. Around 100 participants attended the event representing different involved sectors like HVAC industry, local authorities and regional energy agencies. The workshop explored how to use and deploy innovative building technologies to improve the energy efficiency of the European building stock, as well as the technical and non-technical challenges faced when planning and implementing energy refurbishments. The practice oriented workshop highlighted innovative system solutions and good examples of smart and sustainable buildings and districts. The aim was to generate a cross-sectorial discussion about how to upscale the use of energy efficient technologies in buildings and what are the key challenges and opportunities from the point of view of the different stakeholders to significantly improve the energy performance of the existing European building stock.

"Full implementation and strict enforcement is the first priority to establish the Energy Union" [1]

Paula Rey Garcia, Buildings Team Leader from DG Energy summarized the EU policies for the improvement of buildings energy efficiency and stressed the strong commitment of the European Commission to strictly enforce EU buildings energy efficiency regulations – including EPBD and EED - as stated also in the Energy Union Communication released in February 2015.

Concerning the upcoming EPBD review Rey Garcia announced that a public consultation will be launched on EPBD in the coming weeks and invited stakeholder organisations like REHVA to share their opinion and position about the issue with the European Commission.

REHVA vice-president Frank Hovorka presented the importance of indoor environmental quality linked to buildings energy efficiency and stressed that IEQ and energy performance requirements shall be set and complied at the same time. With the Energy Efficiency Directive, Ecodesign and the recast EPBD, the way has been paved for the improvement of energy efficiency. We now need the same kind of strong signals in terms of indoor air quality and look forward to supporting policymakers in finding the best solutions to achieve this.

1 Energy Union Communication, February 2015

EVIA Technical Director, Claus Händel presented the potential in demand controlled and heat recovery ventilation for high performance buildings pointing out that more energy efficient ventilation systems imply also improved indoor air quality besides reducing the energy consumption of buildings. He suggested considering two aspects in the upcoming revision of EPBD: requirements on net energy need for ventilation and the inclusion of an IAQ Indicator in the energy performance certificate. EHPA Manufacturers Committee Chair, Eric Delforge and Torben Funder-Kristensen from EPEE presented interesting case studies using innovative heat pump and smart grid system solutions in buildings and districts.

REHVA invited the Federation of European Energy Agencies (FEDARENE), its EU level partner organisation, as speaker represented by Vice-president, Christiane Egger. She spoke about the important role of regions in the transition to high energy performance building highlighting the Upper Austrian case of a "carrots, sticks and tambourines" policy approach that has successfully stimulated the NZEB market development.

The event concluded with a panel discussion and questions from the audience moderated by Sonja van Renssen from Energypost. The discussions were continued in a lively networking cocktail joined also by Marie Donnelly, Director of DG Energy.

REHVA – EVIA joint position paper on IEQ

REHVA published at the day of the workshop with EVIA the following policy paper targeting the upcoming EPBD review profiting from the high visibility during EUSEW 2015. The paper was handed over also to DG Energy speaker Paula Rey Garcia during the workshop.

Europe needs smart regulation for energy efficient and healthy buildings

European people living in urban areas **spend up to 90 % of their life in buildings**. Indoors, people are **exposed to up to 5-times higher pollution**, which cause a wide range of diseases and health problems. A poor indoor environment quality (IEQ) also reduces productivity, performance at work and in schools. There is significant scientific evidence on the health benefits of improved indoor air quality (IAQ) through source control, ventilation technology and adequate filtration of incoming air.

Buildings energy performance has gained a lot of attention in the past decade due to European policies and energy efficiency targets. Improving the energy efficiency of buildings is a key priority of the EU Energy Union. However the European Energy Performance of Buildings Directive (EPBD) was implemented in most Member States without paying attention to indoor environment quality by setting minimum ventilation and IEQ requirements. **Indoor environment quality and minimum energy performance requirements shall go hand in hand.** Implementing energy efficiency measures in buildings (thermal insulation of envelope, tight windows, etc.) without a holistic approach might create even new IEQ problems like poor indoor air quality, formation of harmful mould, overheating of buildings. There is a danger that energy is saved while the indoor air quality is deteriorated, causing health problems and decreased workforce productivity.

EU projects[2] and studies[3] revealed the lack of appropriate and harmonised regulations on IEQ and ventilation across EU Member States. The recast Energy Performance of Buildings Directive (EPBD) mentions that indoor climate cannot be compromised. **The upcoming EPBD review shall** strengthen this important statement and **prescribe binding minimum ventilation and IEQ requirements to be defined, audited and reported in a harmonised way in building regulations** across Europe. Ventilation energy demand shall be calculated and expressed in a transparent way, and not be hidden in total heating and cooling energy demand.

We fully support the energy refurbishment of the European building stock to nearly zero energy level but we call for appropriate legislation on indoor environment quality ensuring that energy efficiency initiatives do not jeopardize the health and comfort of building occupants. Leading European HVAC technologies enable us to build and renovate energy efficient, healthy and comfortable buildings.

European legislation, standards and policy measures have to make sure that indoor environment quality requirements are set and complied on the way of transition to a high energy performing European building stock. ■

[2] Health-based ventilation guidelines for Europe, HealthVent project, www.healthvent.eu,

[3] Indoor air quality, thermal comfort and daylight. An analysis of residential building regulations in 8 Member States. BPIE, 2015.

World Sustainable Energy Days – mark the date!

Leading international conference on sustainable energy in February 2016 in Wels/Austria

The **WORLD SUSTAINABLE ENERGY DAYS** (WSED), one of the largest annual conferences in this field in Europe, offer a unique combination of events on energy efficiency and renewable energy. In 2015, the event attracted over 750 participants from 64 countries! The conference takes place from 24-26 February 2016 in Wels/Austria and is organised by the OÖ Energiesparverband, the energy agency of Upper Austria.

Die **WORLD SUSTAINABLE ENERGY DAYS 2016** offer up-to-date information on technologies, policies and markets, are a global meeting place for the sustainable energy community and a great platform for interaction and business contacts.

6 CONFERENCES on biomass, sustainable buildings, energy services:

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

3 HANDS-ON EVENTS

- Major Tradeshow on renewable energy and energy efficiency
- Technical site-visits
- Cooperation Platform

CALL FOR PAPERS & Speakers

We look forward to receiving your contributions on the following topics: renewable energy sources, energy-efficient and sustainable buildings, pellets, sustainable energy technologies, markets and policies, energy efficiency services.

Deadline: 09 October 2015, further details: www.wsed.at/call

Registration & information:

Conference-website www.wsed.at and OÖ Energiesparverband, Landstraße 45, 4020 A-Linz,
T: +43-732-7720-14386, office@esv.or.at, www.esv.or.at

World Sustainable Energy Days 2016

LAND OBERÖSTERREICH

OÖENERGIESPARVERBAND

eu.bac elects Jean Daniel Napar (Siemens) as new president

DR PETER HUG
eu.bac Managing Director)
peter.hug@eubac.org
www.eubac.org

European Building Automation and Controls Association (**eu.bac**), is pleased to announce the appointment of Jean Daniel Napar as its new president. He succeeds Jean Yves Blanc (Schneider Electric) who led the association for six years. eu.bac wishes Mr Blanc all the best for the future and thanks him for his leadership and dedication.

"It is an honour for me to be elected president of an association that provides such a strong voice for our industry. I am passionate about achieving a level playing field with European- wide market standards and regulations and ensuring that our industry receives the recognition it deserves from the corridors of power in Brussels as well as from the various EU countries. Building automation and controls is the enabler and key industry for energy performance in buildings. This is why it is important for us to implement global and European standards and methods such as heating controllers and to enlarge the scope to home automation, eu.bac certification and labelling, as well as eu.bac system and energy performance contracting, to promote our industry in the markets and in the political arena," said Jean Daniel (Dan) Napar.

As one of the founders of eu.bac, Dan has been a part of its efforts for many years and emphasises that new members from the industry are always welcome. Jean Daniel Napar, Chief Technology Officer of Siemens BT France and Vice-President Strategy CPS Siemens BT worldwide, brings with him over 30 years of experience in the BAC industry. He has a strong background in specification, R&D, manufacturing, roll out and commercialization for all product ranges: components, products, system and services.

He is heavily involved in creating a global approach in BAC for EU directives/national regulations/certification/labelling (using the same reference for BAC in the EU provides a KEY cost reduction for customers who benefit from economy of scale). He also has a strong involvement in standardization in France, the EU and worldwide for products and communications protocols (BACnet, KNX, Lon where he worked on streamlining for 20 years) as well as energy efficiency.

Jean Daniel Napar.

eu.bac is the European Building Automation and Controls Association. It represents the major European manufacturers of products and systems for home and building automation. eu.bac founded the European Association of Energy Services Companies (eu.esco) for promoting Energy Performance Contracts as the solution for more energy efficiency in existing buildings. For a full and updated overview of our membership, please see www.eubac.org ■

Summary of the panel discussion on packaged ammonia liquid chillers

A panel discussion on Packaged Ammonia Chillers was organized during the 6th IIR Conference Ammonia Refrigeration and CO2 Technologies on 16-18 April in Ohrid, R. Macedonia.

The phase-out of CFC and HCFC (e.g. R22), and now a reduction scheme for the EU market availability of HFC refrigerants cause an urgent necessity to find an alternative refrigerant for liquid chillers. One of the best solutions is the ammonia chillers. Ammonia is an ozone- and climate-friendly refrigerant.

The topics that were discussed during the panel discussion (on packaged ammonia chillers, providing chilled water, glycol or brine for air conditioning or process cooling purposes) were higher COP as advancement, reduced ammonia charge, dry expansion systems, ammonia semi-hermetic compressors, compact design, new low-charge heat exchangers, Aluminium micro-channel, shell & plate, air-cooled chillers and indirect cooling.

Andy Pearson from UK, Star Refrigeration Ltd stated that the main reason delaying the uptake of natural refrigerant chillers seems to be the price. This is partly volume-related and partly materials and production techniques. We must also recognize that HFC chillers are the result of decades of development work to drive down to a low price point and it is difficult to compete with that. However, we must also note that end-users are now requiring one additional element of functionality in their chillers, namely that they should have no global warming impact. It is unreasonable to ask for additional functionality yet to expect the same price as the item which cannot provide that feature. Increased use of ammonia chillers by industry will help to drive down the selling price, but this needs to be only to a level that is still economic for the manufacturers, otherwise there is no point in them getting involved. End users must also resist the temptation to interfere: when they buy an HFC chiller it is usually the catalogue item with standard components and controls, but when an ammonia chiller is specified it often required complying with purchaser's specifications and so it is a bespoke design. The manufacturers are happy to do this, and it undoubtedly delivers a higher quality product but it is not possible for the price of the high volume, standard chiller.

René van Gerwen from The Netherlands, Unilever Engineering Services pointed out that the end-user should not have to bother about the type of refrigerant (synthetic or natural) in a chiller. Ammonia chiller designers should have a close look to equivalent HFC chillers, and 'Steal with Integrity and Pride' all the good design details from these HFC chillers. Ammonia chillers should be intrinsically safe, without requirements for complicated permits or licenses from local authorities. Ammonia chiller suppliers should facilitate the end-user for obtaining local permits and licenses, if required. Operators should not need extensive additional education and training: fool-proof operation. Ammonia chiller suppliers should provide simple and adequate operator training and Standard Operating Procedures as part of their standard delivery. Chiller performance (capacity, efficiency) needs to be guaranteed by an independent body (AHRI, Eurovent or equivalent). Extra capital costs need to be minimized by stripping all 'nice-to-haves' from the basic configuration, resulting in 'like-by-like' alternatives to HFC chillers. Extra capital costs for this sustainable, natural solution need to be justified by proven lower life cycle costs, with acceptable return on investment.

Predrag Hrnjak from the University of Illinois, USA explained that in order to make ammonia chillers competitive on the market they should be made following the same design principles as conventional, designed for commercial refrigeration and air conditioning applications. Current ammonia chillers are very expensive due to overdesigned components and system targeting the same expectations for life as in custom made industrial systems. Compressors should be semi or fully hermetic, light and with full oil return. Charge should be extremely low and we have demonstrated that it could be done.

Extremely low charged systems on the roof or other well vented locations will generate vapor in the case of leak. It will allow ammonia vapor as lighter than air to freely escape, almost unnoticed in the vicinity of the chiller.It is important to establish the total charge of a system that is fully accepted from safety point, similar as R290 has 150g as almost universal. Help from organizations and regulating agencies is needed.

During this discussion, Fons Pennartz from KWA Bedrijfsadviseurs B.V, The Netherlands stated that when companies plan to increase production capacity or renovate installations, they need to know their project budget. They ask for quotations from relevant suppliers. The suppliers give them their lowest budget prices, with low specification, hoping that the project will continue and that they become the preferred supplier. If the project starts and is based on HFC chiller prices, it is almost impossible to compete with ammonia chillers. Even TCO (total cost of ownership) calculations will not convince people to choose for the ammonia chiller. The ultra low budget prices at start prevent the company to buy the more sustainable, energy efficient and more durable solution. In this way the suppliers determine the energy efficiency of companies. These decisions should therefore not be made on project level but on higher management level where the sustainability goals are formulated. Ammonia chillers should be safe by design. Ammonia charge can not be minimized to obtain "safe chillers". Improved and extended sensor technology should indicate eventual leakages and bring the chiller in safe condition. ■

Chairman of Danvak Lars Sønderby Nielsen had the pleasure of presenting the winner of the Fanger's Award - Ana Ionesi - with a diploma and a cheque for the amount of DKK 25.000 at the HVAC conference "Danvak Day", held on 15 April.

Ana Ionesi is this year's winner of the prestigious Professor Fanger's Award

Not an empty seat was available at the conference Danvak Dagen when PhD student Ana Ionesi received Professor Fanger's Award before160 conference participants.

– ZOSIA LAV, Communications Manager, Danvak

Photos: Michael Boesen

According to tradition, the Professor Fanger's Award was presented to a promising young PhD student at a ceremony at the annual conference Danvak Dagen which this year took place on 15th April in Copenhagen, Denmark.

This year's award winner is the Romanian Ana Ionesi who received the honour and a cheque for 25,000 Danish Kroners for the research project "Modeling of Building Energy Dynamics". Ana Ionesi is a PhD student at University of Southern Denmark, where Christian Veje is her dissertation supervisor. He wrote, inter alia, in his nomination:

"Ana possesses eagerness and dedication in her studies and has a strong will to learn. I have always found it pleasant to work with her and she has excellent communication skills. From September 2012 to June 2013 she worked for the final master project in close collaboration with Danfoss, having me as a supervisor, on optimizing the ECL controller for the heating instal-

Modeling of Building Energy Dynamics

The project aim is to investigate the possibility of using energy simulations during building operation in order to increase the overall energy performance. Building models to be used for real time simulations, energy predictions and dynamic control must be delivered.

lation by adding artificial intelligence and creating a self-adaptive system. Due to this master thesis she obtained the highest grade and won the Project Award Contest sponsored by BHJ Foundation, Sønderborg, and a plaque on the wall of fame at SDU. She demonstrated excellent performance in presentation skills and especially a good ability to present complicated material in a comprehensive way.

Ana has shown a top level academic performance and as a consequence of this I have engaged her as a PhD student in my group. She started her project on Model Based Analysis of Building Energy Dynamics covering all energy aspects of residential or commercial buildings. The ultimate goal is to create a simulation-assisted control in building energy management systems, by interfacing the physical model with advanced climate control systems."

When asked how she received the good news about the award, she answered modestly:"I did not expect to get the award. I was very happy to hear the great news and it was a pleasant surprise for me."

Professor Fanger's Award is earmarked for the PhD student's expenses in connection with study tours and Ana Ionesi already knows how she will use the funds: "In September I have to start my change of research environment to Lawrence Berkeley National Laboratory, in California. I will make use of the award to pay part of the accommodation costs which are extremely high in Berkeley. "

Ana Ionesi expects to finish her PhD project in March 2017. Danvak wishes Ana Ionesi good luck with her studies and a fruitful trip to California. ■

Ana Ionesi presenting her ph.d. project "Modeling of Building Energy Dynamics" after receiving the prestigious Professor Fanger's Award.

Professor Fanger's Award

- established by Danvak in 2001 and named after the late Dr. Povl Ole Fanger, professor in indoor environment at Technical University of Denmark (DTU)
- managed and financed by Danvak and given to a promising young PhD student conducting research in the areas of Indoor Environment and Energy
- Award sum of 25,000 DKK. The amount to be used for studies abroad.

Povl Ole Fanger (July 16, 1934 - September 18, 2006) was a professor at DTU, where he conducted research in the field of thermal comfort and perception of indoor environment.

Professor P.O Fanger was one of the most renowned Danish scientists and was counted as the leading researcher in the world in his field. He succeeded in receiving 79 honours from 27 countries, including 15 honorary doctorates at foreign universities. In 2005 he became an honorary member of the Danish Society of Engineers (IDA).

Fanger was employed at DTU from 1959 until his death. When in 2004 he officially retired, he continued as a senior professor at the International Centre for Indoor Environment and Energy, which he had helped to establish.

Memorandum of Understanding between Eurovent and REHVA

Eurovent, the European Committee of HVAC&R Manufacturers and REHVA, the Federation of European Heating, Ventilation and Air-conditioning Associations have signed a Memorandum of Understanding (MoU) on Thursday, 28 May 2015. The two associations are devoted to intensify and strengthen their long-standing partnership, bringing Europe's HVAC&R engineering, R&D and manufacturing sectors closer together while making effective use of synergies.

The MoU was signed by REHVA Secretary General Jan Aufderheijde and Eurovent Secretary General Felix Van Eyken. REHVA and Eurovent commit themselves to formalise their relationship by becoming member/supporter of each other's associations. They explore the option of sharing resources and, where feasible, secretarial services. Furthermore, they have agreed to advocate, promote and regularly participate in each other's key events, to exchange articles and material to be used within each other's PR activities, and aim to jointly increase contacts with the EU and international institutions.

According to REHVA Secretary General Jan Aufderheijde, 'the MoU marks an important step in bringing two truly European associations that have a similar structure and share similar industry ideals even closer together'. The Eurovent Secretary General Felix Van Eyken added that 'none of our two associations can be active in each single field. Many European legislations touch both REHVA's and Eurovent's areas of expertise, which calls for a more intensive and active cooperation.' Van Eyken added that REHVA, as a member of Eurovent's new 'supervisory body', would receive an active role in all energy performance of building related issues.

Both organisations constitute the leading European representatives in their respective fields. With the manufacturing (Eurovent) as well as engineering, research and development (REHVA), they represent two areas that increasingly coalesce. Together, they support energy efficient solutions while acknowledging the importance of a healthy indoor environment. ■

New Chairman for Danvak

– ZOSIA LAV, Communications Manager, Danvak

Lars Sønderby Nielsen

In addition to the title of Business Development Director at Schneider Electric, Lars Sønderby Nielsen can now add the title of Chairman of Danvak – The Danish Society of Heating, Ventilation and Air Conditioning – to his business card. This happened when Danvak elected its new chairman at the Annual General Meeting held on the 27th of March.

Lars Sønderby Nielsen, who has been a member of the Board of Directors since 2011, says about his newly acquired chairmanship:

"I look forward to continuing the work of the Board. We have launched many exciting initiatives, including a new forward-looking strategy for the Society. In short, the aim is to ensure that we are continually relevant for our members and can always offer exactly what is needed in order that our members may be abreast of HVAC development. In addition, Danvak offers a unique combination of continuing education and network, while our field of work occupies an increasingly pivotal role in society. This fact gives us an extremely good point of departure for future work."

Lars Sønderby Nielsen holds a Master degree in engineering from Technical University of Denmark (DTU) and an MBA in General Management from Copenhagen Business School (CBS). ■

REHVA 2015 Annual Meeting

The 59th REHVA General Assembly was held on Thursday 7 May 2015 in Riga, Latvia. It gathered nearly 90 participants from 22 countries. After a welcoming address given by Mrs. Ilze Osa, the Ministry of Economics of the Republic of Latvia, Director of Housing and Construction department, Prof Karel Kabele opened the General Assembly.

In the afternoon, Prof. Karel Kabele presented the 2014 annual report and the activity plans for 2015. The financial report of 2014, the 2015 budget and the 2016 preliminary budget were presented

Stefano Corgnati (REHVA President-Elect, l) and Karel Kabele (REHVA President, r)

by Stefano Corgnati, the treasurer and approved by the quorum.

Two REHVA Fellows were granted to Hans Besselink from TVVL and Anatolijs Borodinecs AHGWTEL/ LATVAC. In the late afternoon, reports from the Standing Committees were presented by their chairs.

At the end of the Assembly REHVA's next president, and successor of Karel Kabele, Stefano Corgnati from AiCARR-Italy was elected for the position of President-elect.

And please save the date already for the next General Assembly, which will be held in combination with REHVA's international CLIMA 2016 Conference **in Aalborg/ Denmark from 20-25 May 2016.**■

REHVA presence at the Healthy Buildings Europe 2015 Conference

The **Healthy Buildings Europe 2015** conference was held from **18-20 May 2015** in Eindhoven, The Netherlands.

This conference was the first example of a new concept to continue the renowned ISIAQ Healthy Buildings conference series at a different pace and parallel at different places around the world, bringing it closer to regional issues and practices. The conference was fully booked with over 450 attendees, 270 papers accepted and 16 workshops.

REHVA has endorsed this conference and organized a workshop.

The theme of REHVA's workshop was: '**European IAQ standardization & EN 15251**'. The moderator of this workshop was Jarek Kurnitski of Tallinn University of Technology in Estonia and also Vice-President of REHVA.

Presentations were made by Jaap Hogeling of ISSO, The Netherlands and REHVA journal Editor-in-Chief; Bjarne Olesen professor at the Technical University of Denmark and Arnold Edeling of Purafil, The Netherlands.

Presenters and moderator of the REHVA workshop, from left to right: Jaap Hogeling; Bjarne Olesen; Arnold Edeling; Jarek Kurnitski.

EN15251 - which specifies how design criteria are established and used for dimensioning of systems - was explained by Hogeling and Olesen. The standard how to establish and the main parameters to be used as input for building energy calculation and long term evaluation of the indoor environment. It is the standard that identifies parameters to be used for monitoring and displaying of the indoor environment as recommended in the Energy Performance of Buildings Directive. Edeling discussed the topic of energy conservation and improved IAQ with existing ventilation standards.

After the short introductions, there was an active interaction with the audience. By raising green or red cards, those present could agree or disagree with showed positions. Not surprisingly, during this workshop, but also in other workshops, the majority often was wondering why we are still working on heating and ventilation, if no one is paying attention to health, comfort and productivity. Not only in research, but also as a consultant; engineers often forget about the people that spend their time indoors. ■

The presentations are available online. http://www.rehva.eu/publications-and-resources/event-presentations/rehva-workshop-eindhoven-20052015/

REHVA Awards 2015

On the occasion of the Annual Meeting 2015, the following members of REHVA Member Associations received a REHVA Award:

Jiří Petlach (STP – Czech Republic) received a REHVA professional award in design and was recognized for his outstanding achievements in the design of HVAC systems and for his contributions to improve energy efficiency and the indoor environment of buildings.

Prof. Zoltan Magyar (ETE – Hungary) received a REHVA professional award in education and was recognized for his outstanding academic achievements and for his contributions to improve energy efficiency and the indoor environment of buildings.

Prof. Arturs Lesinskis (AHGWTEL / LATVAC – Latvia) and **Renato Merati** (AiCARR – Italy) received a REHVA professional award in technology and were recognized for their outstanding achievements in technology and for their contributions to improve energy efficiency and the indoor environment of buildings.

Arturs Brahmanis (AHGWTEL/ LATVAC – Latvia) and **Wilmer Pasut** (AiCARR – Italy) received a REHVA Young Scientist Award and were recognized for their outstanding scientific achievements and for their contributions to improve energy efficiency and the indoor environment of buildings.

The REHVA **Gold Medal**, the highest REHVA recognition, was handed by REHVA President Karel Kabele to **Prof. Francis Allard** in recognition of his outstanding services to REHVA and for his excellent contributions to science and engineering in heating, ventilation and air-conditioning. ■

Prof. Karel Kabele (r) and Jiří Petlach.

Prof. Karel Kabele (r) and Prof. Zoltan Magyar.

Prof. Karel Kabele (l) and Prof Arturs Lesinskis.

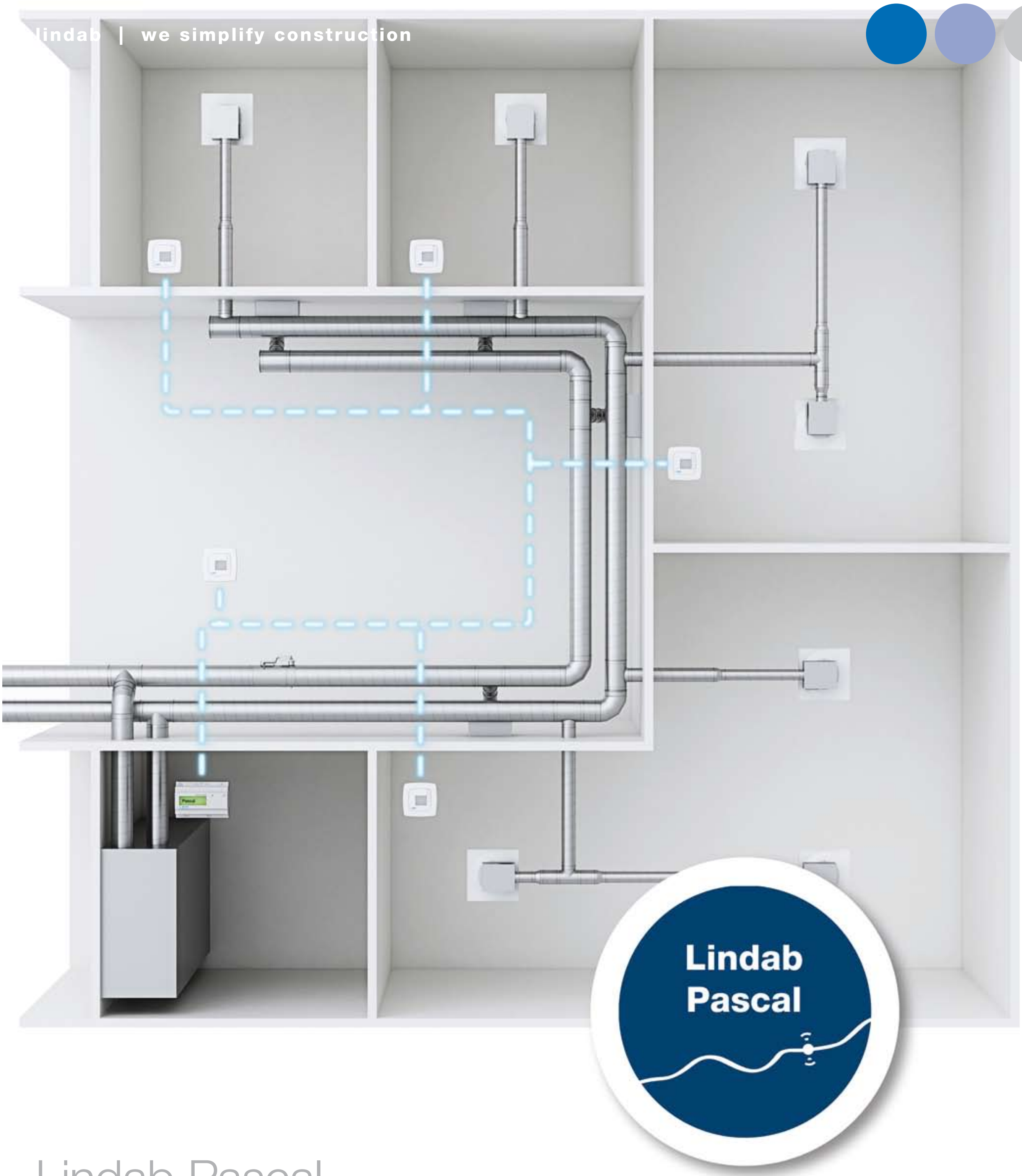
Prof. Karel Kabele (l) and Renato Merati.

Prof. Karel Kabele (l) and Arturs Brahmanis.

Prof. Karel Kabele (r) and Wilmer Pasut.

Prof. Karel Kabele (l) and Prof. Francis Allard.

Prof. Francis Allard.



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VDI-Standards: June, July and August 2015

June:

VDI 2078 "Calculation of thermal loads and room temperatures (design cooling load and annual simulation)"

This standard serves to determine the cooling load, room air temperature and operative room temperature for rooms of all types with and without air-conditioning, taking into account all relevant parameters influencing the thermal response of the room. Installation components affecting thermal response, such as mechanical or natural-draught ventilation and surface heating or cooling, are an integral part of the calculation method not requiring approximations any more. The method has been enhanced significantly with respect to the previous version, e.g. with respect to the coupling between thermal calculation, mode of operation, active installation components and control strategies. Furthermore, an extension and completion of the compatible meteorological data has been achieved, the scope was extended to cover all types of buildings with and without air-conditioning, component cooling and window ventilation. The latter allows calculations serving to demonstrate compliance with summertime insulation requirements. The calculation core for this standard is described in VDI 6007 Part 1, the window model in VDI 6007 Part 2, providing former missing sunshade information.

VDI 6007 part 1 "Calculation of transient thermal response of rooms and buildings; Modelling of rooms"

The calculation method described in this standard serves as the basis for calculations of the instationary thermal response of rooms and buildings. It allows to calculate the loads and room temperatures taking into account the thermal characteristics of the components as well as their instationary response (adiabatic/non-adiabatic). The method, then, also allows to assess the thermal and building-physical properties of rooms and buildings. The standard limits itself to the specification of the calculation core. Further algorithms are only addressed insofar as their description requires further specification in order to achieve comparability of the results. The specific boundary conditions for a given task such as the calculation of the cooling load (VDI 2078) or the energy demand (VDI 2067) are given in the pertinent documents. The algorithms have been completed for the calculation of component cooling/heating to include exterior components.

VDI 6007 part 3 "Calculation of transient thermal response of rooms and buildings; Modelling of solar radiation"

The computation techniques specified in this standard serve as modules for computations of the instationary thermal response of rooms and buildings; they are, therefore, part of the room model as per VDI 6007 Part 1. Contrary to other techniques, the computation of long-wavelength incident and emitted radiation during the cooling design period (CDP) is limited to the computation of the cooling load as specified in VDI 2078, or of room temperatures; it does also apply, though, to a heating design period (HDP) in the case of a computation of the instationary heating load.

VDI/BV-BS 6206 part 1 "Buildings constructed with reusable pre-assembled room units in steel frame construction; Fundamentals"

Buildings constructed with room units in steel frame construction can be used in technically different building configurations. They can be disassembled several times and can be reused with different functions at other locations. The lifetime of these buildings is always limited to a specific period. Special requirements regarding structural integrity, building physics, energy efficiency and deconstructability are to be considered in planning as well as construction and operation. This standard covers the basics of planning, construction and deconstruction of buildings constructed with room units in steel frame construction. The further parts of the series of standards VDI 6206, in preparation, cover specific issues, for example on installation and dismounting.

July:

VDI 3805 part 6 "Product data exchange in the building services; Radiators, heating and cooling convectors with or without fan"

Based on VDI 3805 Part 1, the standard describes a manufacturer and IT system independent and unified data format for the exchange of product data for radiators, heating and cooling convectors with and without fan used in building services.

August:

C VDI 2052 part 1 "Air-conditioning; Kitchens *(VDI Ventilation Code of Practice)*"

This standard provides guidance on air treatment and the dimensioning and design of ventilating and air-conditioning Systems in Commercial kitchens and associated rooms where food is processed and dispensed, kitchenware and equipment is cleaned and foodstuffs are stored. It does not apply to small commercial and household kitchens (rated power < 25 kW). The standard applies in conjunction with DIN EN 13779 and DIN 18869. Odours, air pollutants and humidity must be extracted, disturbances in other rooms and the supply of hygienically objectionable air be avoided. Air shall be exchanged with fresh outdoor air. Specified air temperatures shall be maintained.

VDI 4710 part 4 "Meteorological data for the building services; t,x correlations and wind statistics for 122 European cities"

This standard allows to specify design points (summer and winter) for air temperature, water vapour content, and enthalpy, to be used in the calculation of heating, ventilating and air-conditioning (HVAC) systems in Europe, and can serve as a basis for the analysis of annual energy consumption according to the individual-frequency method. In addition to information regarding the correlations between the air temperature and the water vapour content, a wind statistic including wind speeds and wind directions is provided for each station, thus delivering insight into any non-standard heat transfer conditions to be expected. At the suggestion of REHVA, a compilation of data from 122 stations in Europe, allowing the same processing quality in the vicinity of the stations as for the German stations, is presented here on the basis of the same time period as for Germany (1991 to 2005). For these 122 European stations, the same procedure and basic analysis have been chosen. It is a harmonised proposal which, although surely not meeting all national procedures of system design, provides a good synopsis of the respective climatic situation. ■

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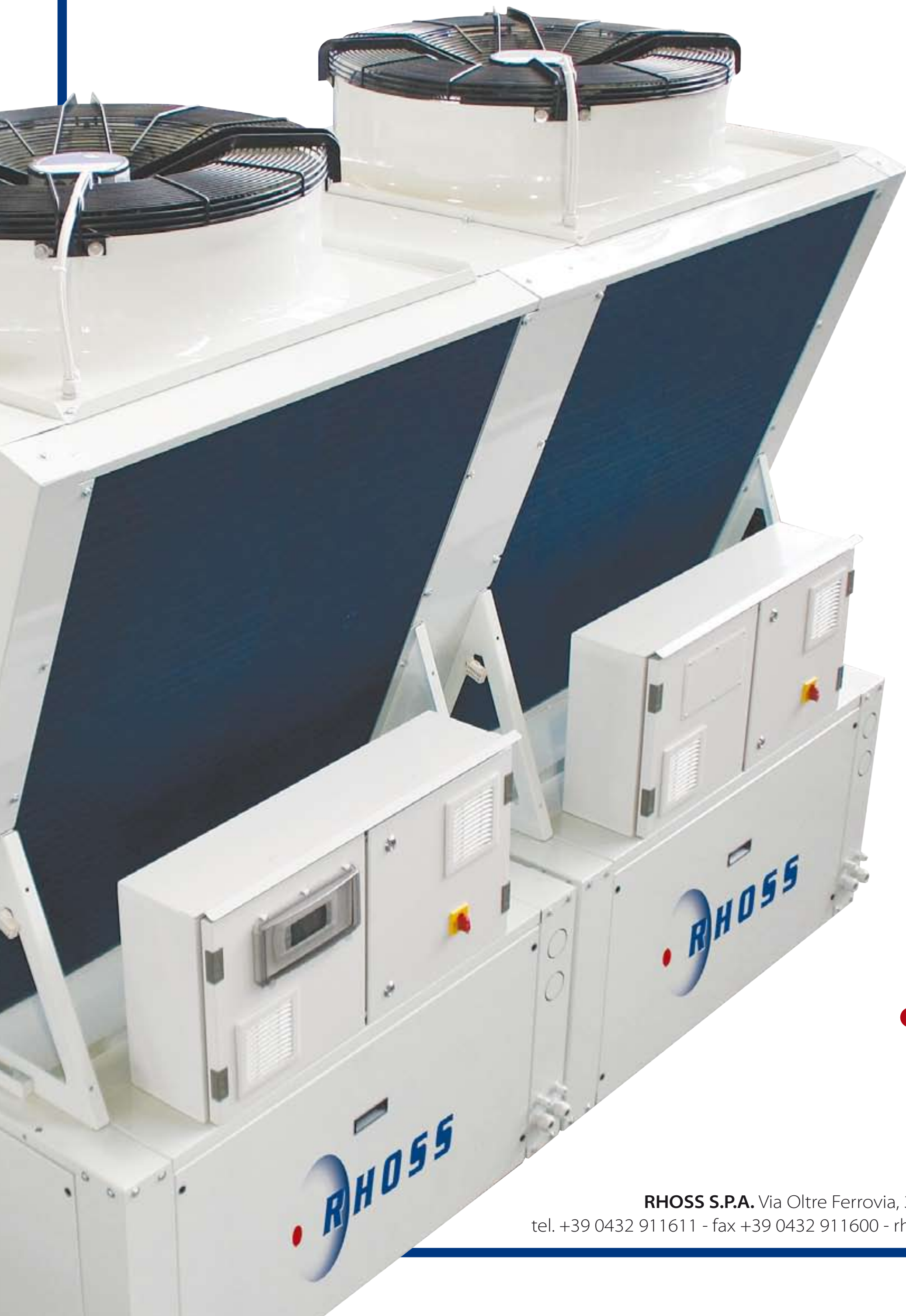

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Send information of your event to Ms Cynthia Despradel cd@rehva.eu

Events in 2015 - 2016

Conferences and seminars 2015

September 10-11	CLIMAMED	Juan Les Pins, France	http://bit.ly/1BPTZMf
September 16-18	SHASE Annual Conference	Osaka, Japan	handa@shase.jp
September 23-24	36th AIVC- 5th TightVent- 3rd venticool	Madrid, Spain	www.aivc2015conference.org
September 24-25	Solar Air-Conditioning: 6th International Conference	Rome, Italy	www.solaircon.com
Sept. 30-Oct. 2	ASHRAE Energy Modeling Conference: Tools for Designing High Performance Buildings	Atlanta, Georgia, USA	www.ashrae.org/EMC2015
October 20-23	Cold Climate HVAC	Dalian, China	www.coldclimate2015.org
October 26-28	11th International Conference on Industrial Ventilation	Shanghai, China	www.ventilation2015.org
December 2-4	46th International HVAC&R Congress and Exhibition	Belgrade, Serbia	http://bit.ly/1Kpf0Wd

Exhibitions 2015

September 15-19	FOR THERM	Prague, Czech Republic	www.for-therm.cz/en
September 23-25	ISH Shanghai & CIHE	Shanghai, China	www.ishs-cihe.hk.messefrankfurt.com
November 2-6	Interclima+Elec	Paris, France	www.interclimaelec.com

Conferences and seminars 2016

Jan 23-27	ASHRAE Winter Conference	Orlando, Florida, USA	www.ashrae.org/orlando
Feb 24-26	World Sustainable Energy Days	Wels, Austria	www.wsed.at/en/world-sustainable-energy-days/
March 8-11	Sustainable Built Environment - SBE 2016	Hamburg, Germany	www.sbe16hamburg.org
March 30-April 2	12th International HVAC+R Technology Symposium	Istanbul, Turkey	www.ttmd.org.tr
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
October 23-26	IAQVEC 2016: international conference on indoor air quality, ventilation & energy conservation in buildings	Seoul, South Korea	www.iaqvec2016.org

Exhibitions 2016

January 25-27	2016 AHR Expo	Orlando, Florida, USA	www.ahrexpo.com
February 2-5	Aqua-Therm Moscow	Moscow, Russia	www.aquatherm-moscow.ru/en
February 24-26	Aqua-Therm Novosibirsk	Novosibirsk, Russia	http://www.aquatherm-novosibirsk.ru/en
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
October 12-14	FinnBuild	Helsinki, Finland	www.messukeskus.com/Sites1/FinnBuild/

The REHVA European HVAC Journal

Register now for 2015!

To maintain the quality of the technical content of the REHVA European HVAC Journal, as of January 2015, REHVA will review its income structure and has decided to charge for a subscription to the REHVA journal. This will allow us to keep original format without including too many advertisements.

This is the result of the increasing cost of shipping and printing due to the high success of the journal. Furthermore, as of 2015, the REHVA Journal issues will be available in a restricted section of the website which incurred development costs. The current subscribers are offered two options:

1. Continue to receive the paper copy for the cost of 60€ per year for REHVA Members or 70€ per year for others and read the eJournal online in the restricted area.

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REHVA

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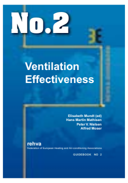
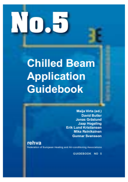
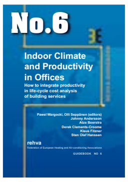


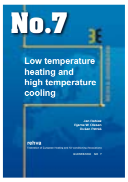
Ventilation Effectiveness. Improving the ventilation effectiveness allows the indoor air quality to be significantly enhanced without the need for higher air changes in the building, thereby avoiding the higher costs and energy consumption associated with increasing the ventilation rates. This Guidebook 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.



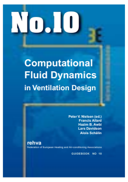
Chilled Beam Cooling. Chilled beam systems are primarily used for cooling and ventilation in spaces, which appreciate good indoor environmental quality and individual space control. Active chilled beams are connected to the ventilation ductwork, high temperature cold water, and when desired, low temperature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



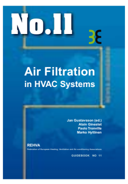
Indoor Climate and Productivity in Offices. This Guidebook shows how to quantify the effects of indoor environment on office work and also how to include these effects in the calculation of building costs. Such calculations have not been performed previously, because very little data has been available.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



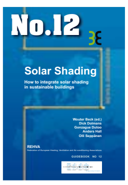
Low Temperature Heating And High Temperature Cooling. This Guidebook describes the systems that use water as heat-carrier and when the heat exchange within the conditioned space is more than 50% radiant. Embedded systems insulated from the main building structure (floor, wall and ceiling) are used in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



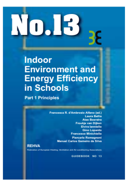
Computational Fluid Dynamics in Ventilation Design. CFD-calculations have been rapidly developed to a powerful tool for the analysis of air pollution distribution in various spaces. However, the user of CFD-calculation should be aware of the basic principles of calculations and specifically the boundary 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.



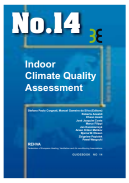
Air Filtration in HVAC Systems. This Guidebook will help the designer and user to understand the background and criteria for air filtration, how to select air filters and avoid problems associated with hygienic and other conditions at operation of air filters. The selection of air filters is based on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



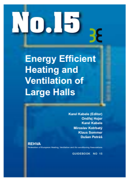
Solar Shading – ***How to integrate solar shading in sustainable buildings.*** Solar Shading Guidebook gives a solid background on the physics of solar radiation and its behaviour in window with solar shading systems. Major focus of the Guidebook is on the effect of solar shading in the use of energy 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.



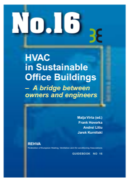
Indoor Environment and Energy Efficiency in Schools – ***Part 1 Principles.*** School buildings represent a significant part of the building stock and also a noteworthy part of the total energy use. Indoor and Energy Efficiency in Schools Guidebook describes the optimal design and operation of schools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



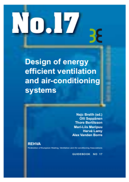
Indoor Climate Quality Assessment. This Guidebook gives building professionals a useful support in the practical measurements and monitoring of the indoor climate in buildings. Wireless technologies for measurement and monitoring have allowed enlarging significantly number of possible applications, especially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



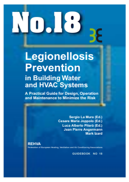
Energy Efficient Heating and Ventilation of Large Halls. This Guidebook is focused on modern methods for design, control and operation of energy efficient heating systems in large spaces and industrial halls. The book deals with thermal comfort, light and dark gas radiant heaters, panel radiant heating, 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.



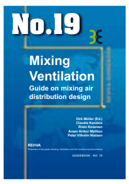
HVAC in Sustainable Office Buildings – ***A bridge between owners and engineers.*** This Guidebook discusses the interaction of sustainability and heating, ventilation and air–conditioning. HVAC technologies used in sustainable buildings are described. This book also provides a list of questions to be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



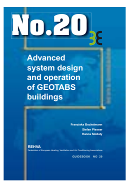
Design of energy efficient ventilation and air-conditioning systems. This Guidebook covers numerous system components of ventilation and air-conditioning systems and shows how they can be improved by applying the latest technology products. Special attention is paid to details, which are often overlooked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



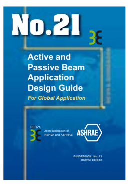
Legionellosis Prevention in Building Water and HVAC Systems. This Guidebook is a practical guide for design, operation and maintenance to minimize the risk of legionellosis in building water and HVAC systems. It is divided into several themes such as: Air conditioning of the air (by water – humidification), 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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