AIVC Workshop: 19-20 March 2018
Te Papa, Wellington

Towards higher-performing buildings: The role of airtightness and ventilation

About the organisers

AIVC (Air Infiltration and Ventilation Centre) is the IEA (International Energy Agency) information centre on energy-efficient ventilation.

In recognition of the significant impact of ventilation on energy use, combined with concerns over indoor air quality, the IEA inaugurated the AIVC in 1979. New Zealand is one of the AIVC member countries. The AIVC offers industry and research organisations technical support aimed at optimising ventilation technology. We offer a range of services and facilities, including a comprehensive database on literature standards and ventilation data.

We also produce a series of guides and technical notes. AIVC holds annual conferences and workshops.

ASHRAE, founded in 1894, is a global society advancing human wellbeing through sustainable technology for the built environment. ASHRAE and its members focus on building systems, energy efficiency, indoor air quality, refrigeration and sustainability within the industry. Through research, standards writing, publishing and continuing education, ASHRAE shapes tomorrow's built environment today.

BRANZ - Inspiring industry to provide better buildings for New Zealanders.

BRANZ is the independent and impartial research, testing and consulting organisation focused on the building industry, funded through the Building Research Levy.

BRANZ works to identify and solve industry challenges and provide insightful research, practical knowledge and guidance that is accessible to all parts of the building and construction industry.

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Introduction

Mark Jones
Programme leader
mark.jones@branz.co.nz

It gives me great pleasure to welcome everyone to this latest AIVC Workshop, *Towards Higher-Performing Buildings: The Role of Airtightness*.

I would like to thank you all for attending, particularly those who have travelled a long way to be here for what will be two days of thought provoking and inspiring presentations and discussions.

It was back in the late 1970s that the International Energy Agency (IEA) recognised that energy costs associated with naturally ventilated houses were poorly understood and so launched a new research consortium, the Air Infiltration and Ventilation Centre (AIVC).

New Zealand first joined the AIVC in 1982 and in 1987 we hosted our first workshop, on Airborne Moisture Transfer. Since then, BRANZ and other New Zealand researchers have forged strong partnerships with our overseas colleagues. Our participation in international organisations, such as the AIVC and the IEA, is crucial to delivering top-quality science. We have valued working alongside experts from around the world, advancing our own knowledge and understanding for the benefit of New Zealand and its building industry.

These collaborations have also influenced our own research direction at BRANZ, where we believe it is time to ask for more from our buildings. This has led to the development of our Warmer, Drier Healthier Buildings research programme in consultation with industry and other key stakeholders. This programme looks at solutions to allow buildings to be warm, dry and healthy over their lifetime. It will also provide the information we need to improve comfort, temperature and heating to support better health outcomes.

The physical condition of places in which we live, work, play and study can affect workers' productivity or the ability of children to learn. Cold air, dampness, air pollutants and mould are linked to asthma, allergies, respiratory infections, rheumatic fever and even mental health issues. Thus, health issues are increasingly shaping building industry priorities. New factors such as climate change and modern indoor-based lifestyles place more pressure on our buildings to perform.

It's not just our older houses and buildings that are to blame. We have seen evidence that new homes do not always provide a healthy indoor environment. There is a trend of modern New Zealand buildings becoming more airtight, suggesting we need to find new ventilation solutions for all our buildings. The huge amount of construction needed as our population expands gives the industry an opportunity to make design improvements from the ground up.

On behalf of BRANZ, I would like to express our gratitude to both the AIVC and ASHRAE for their assistance in organising this workshop. We are looking forward to the next couple of days, as we make further progress together in improving the quality and performance of our homes, schools and buildings.

Mark Jones

Workshop programme

Monday 19th March

9:00	**Session 1: Opening Session: context and policies**		
	Welcome on behalf of BRANZ	Mark Jones	BRANZ
	Context and policies for IEQ, IAQ and ventilation in New Zealand	Hon. Phil Twyford	Minister for Housing and Urban Development and Transport
	The involvement of New Zealand in IEA Energy in Buildings and Communities projects	Michael Donn	New Zealand IEA EBC Executive Member
	Overview of the Air Infiltration and Ventilation Centre (AIVC) and TightVent	Peter Wouters	AIVC Operating Agent
	Activities of ASHRAE related to ventilation and airtightness	Bjarne Olesen	ASHRAE/DTU
	Overall situation in New Zealand regarding energy performance (policy, standards, regulations, …)	Christian Hoerning	EECA
	Interactive voting	Mark Jones	
10:45	**Coffee break**		
11:05	**Session 2: Indoor Environmental quality, ventilation and health**		
	Why do we care about IAQ Metrics?	Max Sherman	LBNL
	Indoor Environmental Quality: Comfort-Health-Productivity	Bjarne Olesen	ASHRAE
	The health effects of sub-standard housing on children.	Nevil Pierse	He Kainga Oranga
	Annex 68 presentation (Design and Operational Strategies for High IAQ in Low Energy Buildings)	Jelle Laverge	Ghent University, Belgium
12:40	**Lunch break**		
13:40	**Session 3: Indoor climate and air quality**		
	Future Cooling Needs of Buildings and the role of ventilation	Mat Santamouris	University of New South Wales
	Indoor climate and ventilation in school buildings	Robyn Phipps	Massey University
	New Indoor Air Quality and Thermal Comfort (IAQ&TC) guidelines for school buildings	Bernie Cruise	Ministry of Education
	Methodology to assess the exposure to cooking emissions in combination with the efficiency of range hoods	Willem De Gids	VentGuide, Netherlands
15:15	**Coffee break**		
15:35	**Session 4: Ventilation performance**		
	Demand controlled ventilation: design guidelines and performance characterisation in Belgium.	Arnold Janssens	Ghent University, Belgium
	Expected temperature distribution in NZ homes using MVHR	Peter McDowall	BRANZ
	Panel discussion on ventilation and IEQ	Moderator Greg Overton	
	Short presentation by industry representatives (2' each)	Various	
17:30	**Reception**		

Tuesday March 20, 2018

9:00	**Session 5: Building and ductwork airtightness**		
	Measuring airtightness of dwelling with a domestic ventilation system	Wouter Borsboom	TNO, Netherlands
	Airtightness in New Zealand homes and appartments	Steve McNeil	BRANZ
	"Lessons in air tightness and air quality from the Japanese sick house experience"	Andy Russell	Proctor group
	Air Tightness Requirements in For High Performance Homes in Mild Climates	Iain Walker	LBNL
10:35	**Coffee break**		
10:55	**Session 6: Quality assurance for ventilation and airtightness**		
	Quality and compliance of ventilation systems : on-going developments, lessons learnt, future challenges	Peter Wouters	AIVC Operating Agent
	Ventilation, moisture and mould in old and new homes in NZ	Manfred Plagmann	BRANZ
	Ventilation and Airtightness, different relationship for different quality of buildings	George Zhang	Center for Sustainable Built Environment, Hunan University
	Panel discussion on airtightness issues	Moderator Greg Overton	
12:25	**Session 7: Summing up and closing session**		
	Interactive voting + discussion	Manfred Plagmann	
	Future events / closing of the workshop	Manfred Plagmann	
13:00	**End**		

Presentation abstracts

OVERVIEW OF THE AIR INFILTRATION AND VENTILATION CENTRE (AIVC) AND TIGHTVENT

Peter Wouters, INIVE, Belgium

The AIVC (Air Infiltration and Ventilation Centre) is the information centre of the IEA (International Energy Agency) on energy efficient ventilation. Created in 1979, its activities are steered by the representatives of its member countries. These member countries are from Europe, North America, and Asia. Also, New Zealand is a member country. The AIVC organises an annual conference and workshops (as this one in Wellington), organises webinars, produces various reports and works on specific projects related to ventilation for indoor climate control, indoor air quality and airtightness.

TightVent is a market focused platform created in 2011 with a specific focus on building and ductwork airtightness.

"ENERGY PERFORMANCE OF NEW ZEALAND'S HOUSING STOCK – AN OVERVIEW"

Christian Hoerning, Senior Sector and Technology Analyst, Energy Efficiency and Conservation Authority (EECA)

Whilst the residential sector accounts for a relatively small proportion of New Zealand's overall energy use and energy greenhouse gas emissions, there is potential for unlocking significant public and private benefits from improving household energy efficiency. Addressing New Zealand's legacy of cold, damp homes can result in significant cost savings, predominantly from improved occupant health and reduced mortality, especially for vulnerable groups. In addition, household energy use is dominated by the use of electricity. Electric space heating and lighting are largely responsible for winter peak electricity demand, with associated electricity infrastructure costs and higher greenhouse gas emissions from fossil fuel generation. The Energy Efficiency and Conservation Authority (EECA) is a New Zealand government agency which delivers a range of interventions to improve the performance of homes through improved energy efficiency. This includes grants for home insulation, information on and promotion of energy efficient behaviours and technologies to consumers through ENERGYWISE, and the regulation of energy-using products and appliances.

WHY DO WE CARE ABOUT IAQ METRICS?

Max Sherman, LBNL, USA

Ventilation is the common thread of this workshop. It is of interest from an energy perspective because it costs energy both to move and condition outdoor air, but the main reason we care about ventilation is that it is the common method to control exposures to indoor-generated contaminants. Various ventilation metrics can be used to define smart ventilation that provides the save dilution of indoor-generated contaminants, but it does so at a lower energy or power cost. Such features have been integrated into ASHRAE Standard 62.2 for example. Ventilation is not, however, of interest by itself, but rather as a means to provide acceptable indoor air quality (IAQ). If we are to move away from simple ventilation systems (and their equivalents) and to high-performance means of providing IAQ, it is necessary to have some quantitative measures of the overall performance of the system from an IAQ rather than ventilation perspective. While individual contaminants can often be measured quantitively, it is not easy to combine disparate contaminant levels together to get an over-arching valuation. For this reason LBL and others have been working towards developing IAQ metrics that can provide such an overarching valuation and thus are amenable to optimization. This presentation will talk about the efforts underway and discuss features of a putative metric.

INDOOR ENVIRONMENT – HEALTH COMFORT AND PRODUCTIVITY

Bjarne Olesen, DTU, Denmark

People spend in industrialized countries more than 90 % of their lives in an artificial indoor environment (home, transportation, work). This makes the indoor environment much more important for people health and comfort than the outdoor environment. In typical office buildings the cost of people is a factor 100 higher than energy costs, which make the performance of people at their work significantly more important than energy costs. The task is to optimize indoor environmental conditions for health, comfort and performance while conserving energy, since more than one third of current global energy consumption is used to maintain indoor environments. Detailed field investigations of the indoor environment in hundreds of large office buildings in many parts of the world have documented that the indoor environmental quality is typically rather mediocre, with many people dissatisfied and many suffering from sick-building syndrome symptoms.

Recent studies under laboratory conditions and in the field have shown a significant influence of the indoor environment on people's productivity. Also studies on people sick leaves show a very high loss of work time and performance, which have significant economic consequences for companies.

The paper presents an update on today's requirement for a healthy and comfortable environment. The paper will mainly be dealing with the indoor thermal environment and air quality. Several standards and guidelines are specifying requirements related to comfort and to health; but the productivity of people is not taken into account. Recent studies showing that comfortable room temperatures, increased ventilation above normal recommendation, reduction of indoor pollution sources and more effective ventilation increases the performance of people. The results indicate increase of productivity of 5-10 %. Also based on the laboratory studies a 10 % increase in dissatisfaction decreases the productivity with around 1 %.

THE HEALTH EFFECTS OF SUB-STANDARD HOUSING ON CHILDREN

Nevil Pierse, Department of Public Health, He Kainga Oranga

As children spend the majority of time at home, residential thermal conditions are important. The World Health Organization recommends a minimum indoor temperature of 20°C, and below 16°C warns of health implications. The latest national study on indoor temperature in New Zealand, conducted between 1999 – 2005, reported that the majority of homes are colder than recommended. We then present some big data on the possible scale of the problem and the opportunity for intervention. In this presentation we look at some of the studies done by He Kainga Oranga the Housing and Health research programme on insulation, heating and indoor temperature. We will highlight future work in the area and how the Well Homes group are tackling the problem in the Wellington region.

ANNEX 68 PRESENTATION (DESIGN AND OPERATIONAL STRATEGIES FOR HIGH IAQ IN LOW ENERGY BUILDINGS) PRODUCTIVITY

Jelle Laverge, Ghent University, Belgium

Annex 68 is an international collaboration facilitated by IEA's EBC community. It focuses on the impact of high energy performance construction in residential buildings on the indoor air quality in the dwellings. It consists of 5 subtasks: metrics, sources, modeling, design and case studies. In this presentation, a short overview of the full work in the annex is combined with a presentation of 2 reference experiments that have been carried out in the annex. These reference experiments are set up as common exercises for modelers, starting with a very simple 1 room, 1 pollutant situation and then proceeding to a full 'studio' apartment. Finally, the implications for design guidelines that follow from the different subtasks in the annex will be discussed.

FUTURE COOLING NEEDS OF BUILDINGS AND THE ROLE OF VENTILATION

Mat Santamouris, University of New South Wales, Australia

Cooling of buildings currently represents a considerable fraction of the total energy consumption in the world. Global and local climate change in combination with the projected population increase and economic development is expected to increase tremendously the future cooling energy demand of buildings and make it the dominant energy component. The present paper aims to present and discuss the details of the framework which defines the present and future cooling energy consumption of the building sector. The more recent quantitative and qualitative data concerning the penetration of air conditioning around the world are presented and analyzed. The main technological, economic, environmental and social drivers that determine the market penetration of air conditioning are identified and their impact is investigated. The potential future evolution of the main parameters that define the cooling energy consumption and in particular climate change, the population increase, income growth, potential technological improvements and the main socioeconomic drivers are investigated and existing forecasts are presented. Proposed methodologies to predict the future cooling energy consumption of the building sector are reported and discussed, while existing estimates and predictions regarding the future cooling energy consumption of individual buildings as well as of the total building sector are documented, evaluated and analyzed. Based on the explored inputs and forecasts, a model to predict the future cooling energy consumption of both the residential and commercial sector is developed. Three scenarios based on low, average and high future development, compared to the current development, are created and the range of the expected cooling energy demand in 2050 is predicted under various boundary assumptions. It is calculated that the average cooling energy demand of the residential and commercial buildings in 2050, will increase up to 750% and 275% respectively.

USING OF A SOLAR AIR HEATER TO IMPROVE THE INDOOR AIR QUALITY IN 12 NEW ZEALAND CLASSROOMS: A CASE CONTROLLED FIELD TRIAL.

Robyn Phipps, Massey University

New Zealand classrooms are typically cold and damp in winter and have high levels of airborne bacteria. Schools largely single storey small buildings that are dependent on natural ventilation; however 40% of teachers don't open the window. Schools use around two thirds of their total energy budget on heating and reducing this expense is imperative. We observed that solar radiation is aligned with the school day and trailed a solar air heater (SAH) as a device to supplement existing heating and ventilation strategies. The trail was conducted in 12 matched and adjacent primary classrooms Palmerston North over two winters. All classrooms were fitted with a SAH at the commencement of the stud. The treatment classrooms used their SAH operational for a school term, while the adjacent control classroom had their SAH disabled. The treatment/control status of each pair of classrooms was reversed the following school term.   We found that the classrooms using the SAH were warmer and dryer, had significantly less $C^{0}2$ and particulate matter and used two thirds less energy for heating.

'NEW INDOOR AIR QUALITY AND THERMAL COMFORT (IAQ&TC) GUIDELINES FOR SCHOOL BUILDINGS'

Bernie Cruise - Team Leader, Engineering & Design, Ministry of Education

The Ministry of Education has recently introduced new Indoor Air Quality and Thermal Comfort (IAQ&TC) guidelines (version 1.0, September 2017). This replaces the Ministry's earlier 2007 document that covered Indoor Air Quality, Heating and Insulation. A short introduction will be provided to the Ministry's large property portfolio that includes 2,100 schools and 30,000 buildings with background on the need to replace the previous 2007 guidelines. The new IAQ&TC document will be presented with a brief summary of the holistic and integrated approach being taken towards building design that considers acoustics, ventilation, daylight, heating, cooling, and building usability.

METHODOLOGY TO ASSESS THE EXPOSURE TO COOKING EMISSIONS IN COMBINATION WITH THE EFFICIENCY OF RANGE HOODS

Willem de Gids, TNO, Netherlands

The purpose of this presentation is to open the discussion towards a methodology to assess the performance of residential rangehoods based exposure to people in homes, which make use of the capture efficiency measured in a laboratory setting. To compare range hoods as a product it makes sense to measure a capture efficiency. But for people in a dwelling finally the exposure to pollutants from cooking is more relevant. For the approach of exposure of people in homes not only the efficiency but also the way people in front of the rangehood behave and the ventilation of the room in which cooking takes place play a role. Two measurement methods for determining the efficiency in laboratory setting and a possible approach to derive from efficiency to exposure will be discussed.

DEMAND CONTROLLED VENTILATION: DESIGN GUIDELINES AND PERFORMANCE CHARACTERISATION IN BELGIUM

A. Janssens, Research group building physics, construction and services, Ghent University, Belgium

The Belgian ventilation market is highly driven by energy performance regulations. In new residential buildings two types of ventilation systems prevail: mechanical exhaust ventilation and balanced ventilation with heat recovery. Regulations encourage the application of demand controlled ventilation to improve indoor air quality and energy efficiency.

This presentation gives an overview of methods developed in the last decade in Belgium to assess and characterise the performance of demand controlled ventilation. The design, operation and monitored performance of some typical systems are discussed.

EXPECTED TEMPERATURE DISTRIBUTION IN NZ HOMES USING MVHR

Peter McDowall, BRANZ

Whole house heat recovery ventilation in residential dwellings where spot heating is used

New Zealand homes tend to be heated on an individual room basis particularly in older stock. Typically, only one or two of the communal rooms are heated resulting in many of the unheated room temperatures being just above outside temperatures, particularly if they are not directly adjacent to the heated room. In this study we used temperature data from 16 occupied homes in the Hutt Valley, New Zealand over winter 2017 to model the potential impact of a heat recovery ventilation system on the whole house environment. We applied a multizone heat recovery ventilation model with empirically obtained parameters to a simple two zone home with a heated and unheated room. We investigated the effects of differing levels of insulation and considered not just cost but also benefits to both the occupants health and the building itself.

MEASURING AIRTIGHTNESS OF DWELLING WITH A DOMESTIC VENTILATION SYSTEM

Wouter Borsboom, TNO, Netherlands

The presentation is aimed to present a new and rapid methodology to test airtightness of new or energy efficient retrofitted dwellings. A common method is to use a blower door to measure the airtightness of the building. This uses a calibrated external fan to create a pressure difference between the outside and the inside of the building. Disadvantages are that it's rather time consuming and the testing equipment is bulky and costly. It takes time to install the blowerdoor and also the inlets and outlets of the ventilation system must be sealed. The new methodology uses the ventilation of the dwelling itself. This is possible because modern buildings are airtight and when outlet or inlets are closed, a substantial pressure drop can be generated. The pressure drop is lower then in case of a blower door, therefore a reference vessel is used which is placed in the building. Test results of field studies of this methodology compared with blowerdoor test are presented.

AN EXPLORATION OF AIRTIGHTNESS TRENDS IN NEW ZEALAND HOMES AND APARTMENTS, WHAT ARE WE ACHIEVING AND WHAT BARRIERS ARE THERE TO DOING BETTER?

Steve McNeil, BRANZ

Airtightness is an important component to achieving warm, dry and healthy buildings. However, it cannot be considered in isolation. Airtightness needs to be considered in view of the wider topics of insulation, ventilation and also thermal bridging. This presentation will give background on the trends in New Zealand residential dwellings, including our newest data since the WAVE airtightness survey in 2009. From here the presentation will centre on what these results mean in practice, particularly talking about the common misconception that the n50 (air changes at 50Pa pressure difference) result is the infiltration rate of a building. Confusion like this represents a barrier to the wider adoption of airtightness targets. We propose a possible remedy to this confusion by moving to a permeability based metric ($m^3/hr/m^2$@50Pa), which then brings it into line with other building performance metrics (like R-Value). This has several other advantages, particularly when it comes to reducing energy loads in larger buildings.

LESSONS IN AIR TIGHTNESS AND AIR QUALITY FROM THE JAPANESE "SICK HOUSE" EXPERIENCE

Andy Russell, Proctor Group

A major revision of the Japanese Building Standard Law encompassing both material selection and ventilation was introduced in 2003 to specifically address "sick house" problems. Evidence of unhealthy indoor VOC levels was attributed to increased use of manufactured materials, the successful delivery of air-tight enclosures and occupancy behaviour.

Sources of contamination were addressed by mandatory reporting of VOC emission rates and restrictions on the installation of emitting materials based on risk to indoor air contamination. With respect to ventilation, previous requirements for minimum total window size of 5% of floor area were seen to fail due to the increasing prevalence of air conditioning in summer and reluctance to open windows in winter. The new law mandated 24 hour mechanical ventilation with regulatory provision for supply only, exhaust only and balanced ventilation systems.

Anecdotal evidence from recent construction in Australia questions the reliance on infiltration to provide sufficient make-up air and questions the reliance on occupants opening windows. Air-tightness may eventually be taken seriously for low rise residential buildings, and as products and skills follow, Australia might deliver good results allowing for low cost effective ventilation strategies. However, regulation needs to consider occupant behaviour and seriously consider a continuous ventilation requirement. This is one of several valuable lessons from Japanese regulation and their evolution of effective ventilation for air-tight buildings.

AIR TIGHTNESS REQUIREMENTS IN FOR HIGH PERFORMANCE HOMES IN MILD CLIMATES

Iain Walker, LBNL

High performance homes are being designed and built to have tight building envelopes and mechanical ventilation. This allows for better control of air flow in buildings to reduce energy loads, moisture and structural issues, and better control Indoor Air Quality (IAQ). In recent years in both the US and Europe standards have come into place that limit the envelope leakage for all new homes – and these same limits are often applied in home retrofit programs. In this presentation we will discuss the energy implications of limiting envelope leakage in energy use and indoor air quality with a focus on milder climates where the energy impacts on mechanically ventilated homes may not be so clear.

QUALITY AND COMPLIANCE OF VENTILATION SYSTEMS: ON-GOING DEVELOPMENTS, LESSONS LEARNT, FUTURE CHALLENGES

Peter Wouters, INIVE, Belgium

Ventilation systems for IAQ control are more and more common in most countries. The presentation deals with quality issues of ventilation systems, as well as frameworks for quality control and compliance frameworks. Examples of several countries are presented. Also findings of the EU QUALICHeCK project are presented.

VENTILATION AND AIRTIGHTNESS, DIFFERENT RELATIONSHIP FOR DIFFERENT QUALITY OF BUILDINGS

Prof. Guoqiang Zhang, Institute for Sustainable Urbanization and Construction Innovation, Hunan University, China

National Center for International Research Collaboration in Building Safety and Environment, Ministry of Science and Technology, China

Email: gqzhang@188.com   URL: www.ChinaSBE.com/gzhang

History of building ventilation and air tightness in China is reviewed. It is identified that in different climate zones of China, ventilation and air tightness of buildings are treated in different way. In Hot Summer and Cold Winter(HSCW) climate zone, building ventilation and air tightness play the most important role in keeping good indoor environment from ancient times, and in realize energy efficiency in modern eras, thus building ventilation and air tightness are twin concepts which are important measures linking indoor air quality and energy conservation in buildings. However, as ventilation and air tightness are not characteristics of some material or products as envelope insulation, but comprehensive effect of space design, products as windows and doors and behavior of residents/automation, standards related to building ventilation and air tightness in China has not been developed as good as material related technologies like building envelope insulation. The implementation of building ventilation and air tightness are still in a low level stage which is a very important factor for the low quality of buildings China.

Ventilation related research in Hunan University(HNU) has been reviewed. Industry ventilation and CFD application in China were led by HNU since 1980s, and in 2001, the 4th International Conference on Indoor Air Quality, Ventilation and Energy Conservation in Buildings was hold in Hunan University, through which the importance of role of ventilation were introduced to China through international cooperation and communication. As national representative of China, HNU has been taking part in IEA related Annexes and has been doing continue research in ventilation, including editing of the first national level standard in natural ventilation design currently. At the same time, basing on the fact that the local government taking building industry as a priority in Hunan Province, HUN has developed a China Construction 4.0 Platform(www.construct4.cn), which aims promoting urbanization and construction quality and realizing sustainability. The platform implements an expo, a forum and conference annually. Basing on the platform, though international cooperation and innovation, quality assurance strategic model and supporting technologies including building ventilation and air tightness will be developed, demonstrating products and projects will be implemented.

By **Stephen McNeil**, BRANZ Materials Scientist

The nitty gritty on airtightness

A current BRANZ Building Research Levy project looking at airtightness trends of our houses needs your help.

BRANZ'S Weathertightness, Air quality and Ventilation Engineering (WAVE) research project identified a clear trend of New Zealand residential stock being built more airtight than ever before.

This is great if you are seeking to keep as much energy inside the building as possible. However, extra focus needs to be paid on ventilating buildings effectively to avoid indoor moisture problems and the build-up of other contaminants over time. See *New home, old habits* on page 47 for a case study in a modern home.

Understanding blower door results

Airtightness is usually measured with a blower door, and gives an idea of the infiltration rate of a building. There is, however, some confusion about what a blower door can tell you.

A blower door gives an indirect measure of how leaky a construction is from the point of view of air. Typically, the results from a blower door test are reported as x ACH@50 Pa, where x will usually be a number in the range of 1-10 depending on the construction.

The result indicates the number of air changes a building is undergoing with a sustained pressure difference of 50 pascal across the envelope. The 50 Pa, however, is well in excess of typical in-service pressures that drive infiltration in a building. Therefore, it should be stressed that a house with an airtightness of 5 ACH@50 Pa will most definitely not experience an average of 5 air changes per hour in practice.

Rule of thumb to divide by 20

As a blower door result is reported at a reference pressure greater than typically experienced, how do we relate this to normal pressure levels? A rule of thumb to translate a blower door result to typical in-service infiltration is to divide the result by 20.

This does not take factors such as wind speed, direction, site topography and location of leakage openings into account. In reality, the situation is much more complicated, and this rule of thumb can only give an indication of long-term average infiltration.

These factors lead to the variability in infiltration rates being greater for the buildings that are less airtight, which can lead to comfort concerns or homes that prove more difficult to heat consistently. The following results from WAVE show this variability in a little more detail.

Modelling infiltration gave insights

In WAVE, infiltration rates were measured in the BRANZ test building at a range of airtightness levels (using tracer gases). These results were then used to calibrate computer models of the building. See Figure 1 for the output of one of these models for the WAVE test building over a calendar year.

The blue line is the modelled infiltration and the yellow line is the average infiltration calculated from the model. The red line is the recommended average ventilation level (taken from ASHRAE 62.2).

The plots show some key points:

- The average infiltration (yellow line) is below the recommended ventilation rate in all these cases. This should be obvious, as we cannot expect uncontrolled infiltration to deal with all contaminants. It is interesting to note that, as a building is made progressively more airtight, infiltration reduces in a non-linear

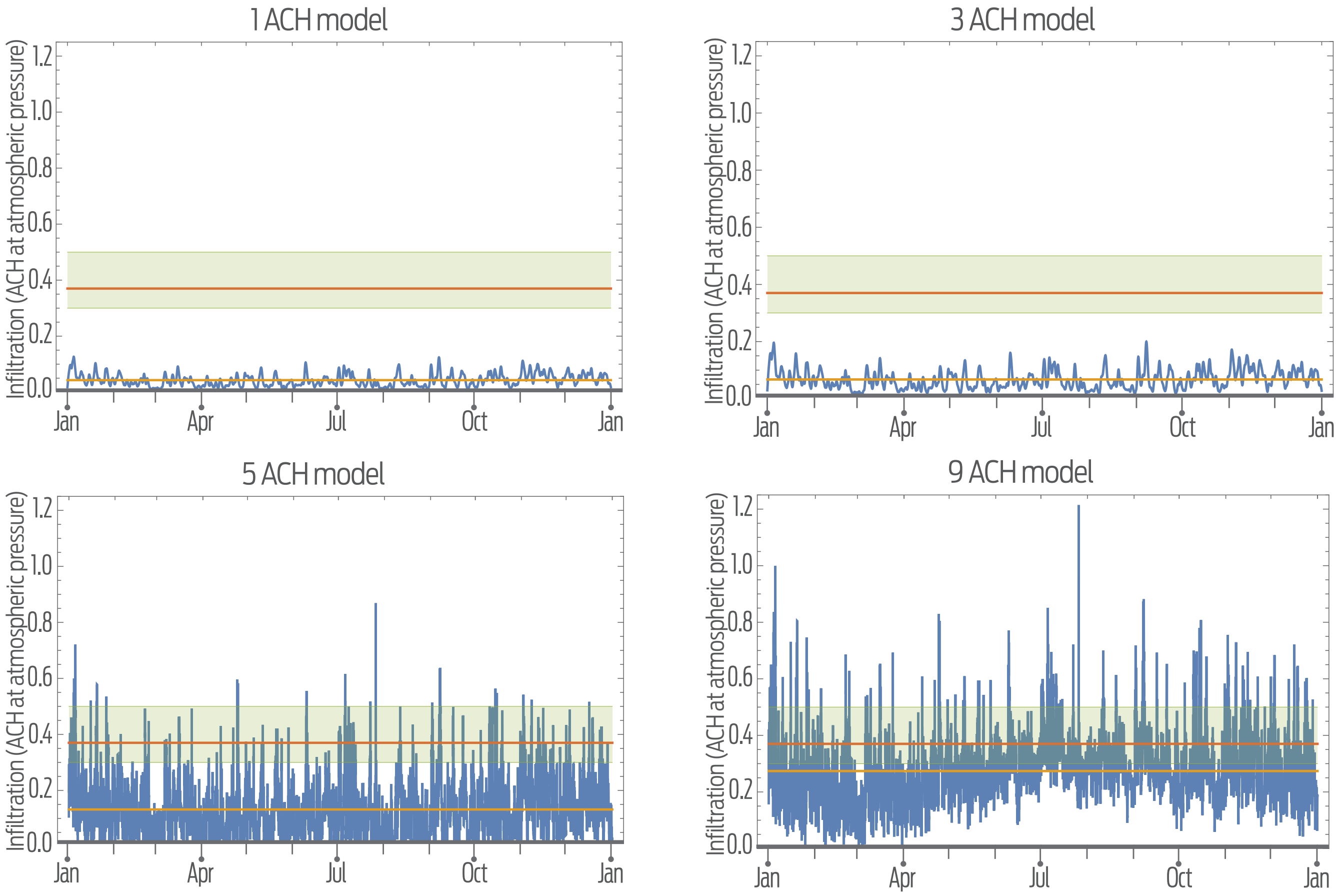


Figure 1: Infiltration rates over a year on the BRANZ WAVE test building at Judgeford.

fashion (see yellow lines for each airtightness in Figure 1).

- What is also clear is that the transients or noise in the blue line reduce as the building becomes more airtight. This should make designing supplementary ventilation easier in the tighter building, as the demands of such a system become more closely linked with the activities in the building. They also become more independent of the variation in the environment.

So what does this all mean?

This raises some interesting questions, as we are now seeing plenty of new builds around 3 ACH@50 Pa without any deliberate attempts to make them airtight.

Some thought will need to go into how homeowners ventilate their homes, particularly with education, as old habits can prove to be incompatible with modern buildings.

The airtightness project aims to keep an eye on how our buildings progress, with the national airtightness database feeding into other research projects like energy-efficient ventilation and codes and standards development.

National airtightness database

We need your help populating the national airtightness database.

The Building Research Levy-funded airtightness project is, among other things, seeking to keep an eye on how the airtightness of our buildings is trending with time. Logistically, it's not a simple exercise, as we can only test so many buildings in the field.

The national airtightness database, hosted by BRANZ, allows industry practitioners that are carrying out blower door measurements to submit their results and information about the building under test to grow the dataset.

By collecting this information, our knowledge of the performance of new builds will be much more complete. This will enable sensible discussions around airtightness and what changes in construction techniques mean in terms of Building Code clauses.

Note To submit any data, email it to steve.mcneil@branz.co.nz.

Ventilation options

Sufficient ventilation is crucial as our homes become more airtight. A mix of passive and mechanical options can work well, but all designs should start by getting the source extraction measures right.

BY STEPHEN MCNEIL, BRANZ BUILDING PHYSICIST

VENTILATION IS CENTRAL to providing a healthy indoor environment. We constantly produce contaminants such as volatile organic compounds (VOCs), carbon dioxide (CO_2), moisture, combustion products and cooking odours. Ventilation is the main means available to remove and dilute contaminants in the indoor air.

Airtightness trend

The ventilation stream of BRANZ's WAVE (Weathertightness, Air quality and Ventilation Engineering) programme identified a consistent trend to increasing airtightness of homes. This demonstrated a steadily decreasing amount of background infiltration. In some cases, though, this background infiltration provided a useful dilution of contaminants.

Although this trend is positive from the energy point of view, it is crucial that sufficient ventilation is provided as adventitious openings are closed down by changing building materials and techniques.

Fieldwork has shown the negative consequences of not providing enough ventilation (see *Build* 151, *New homes dripping*). The key issues identified in this work were substitution and poor design and installation.

What does the Building Code say?

The typical method of compliance with clause G4 of the New Zealand Building Code is to provide an opening window area equivalent to 5% of the floor area of a building. There are also elements in clause G4 to demonstrate compliance using active ventilation in polluting spaces like kitchens, laundries etc.

Clause G4 assumes that windows will be opened during normal operation of a home. However, evidence from WAVE suggests this may not be happening as much as is necessary (see *Build* 127, *Changing the air indoors*).

The BRANZ occupant behaviour project (see pages 46-47) is looking into this in more detail and will provide information on how often and how far people are opening their windows.

Ventilation strategy should start passive

In general, the most cost-effective way to add ventilation to a home is to get the passive measures right. Passive ventilation alone cannot usually capture the majority of moisture produced during cooking and bathing so needs to be combined with source extracts. This strategy works well particularly for older homes or where there has been an effort made for passive design.

Mechanical ventilation is seen as a quick fix, but care must be taken with the design of the system as it is easy to overventilate. Control of any active system is going to be crucial to its performance.

The main options for mechanical ventilation include exhaust, supply-only and balanced ventilation – usually with heat recovery.

Passive options

Passive ventilation options include trickle vents, passive stack ventilators and windows:


Trickle ventilators are a good passive option.


Poor installation is often the cause of high moisture levels.

- Pros - typically cheap, easy to fit and with good control for diligent occupiers.
- Cons - ventilation performance is dependent on wind and stack pressures and energy impact, and they require a degree of occupier involvement and education. Extract ventilation is usually required to remove pollutants at source.

Mechanical options

These include extract ventilation, supply ventilation and balanced ventilation with heat recovery.

Extract ventilation

Typical examples include bathroom extract fans and rangehoods. Extract ventilation is an effective way of dealing with moisture at its source and can simply be left on after a polluting event for a few minutes to help remove contaminants.

Care is needed to locate intakes in the optimal position to capture the contaminant source effectively. Where the make-up air is coming from also needs to be considered, for example, an open window or internal door.

- Pros - very effective at source capture, easy to install and cheap.
- Cons - can have an energy impact, though this is minimal as they are run intermittently. They require user intervention.

Supply ventilation

A supply-only system takes roof space air and ducts it to several rooms in the home through ceiling-mounted diffusers. Examples of this style of ventilation system commonly include a bypass where intake air is taken from the eaves of the building in the warmer months.

Drawing air from the roof space doesn't comply with clause G4 which requires ventilation with outdoor air.

- Pros - relatively inexpensive, simple to install. Roof space air can have some energy benefit in the shoulder seasons.
- Cons - roof space air is not the cleanest air source, but filters will help with this. Controlling system flow based on temperature difference alone can lead to additional moisture in the home, although some manufacturers are now incorporating humidity measurement in their controllers.

Balanced ventilation with heat recovery

Balanced ventilation offers a great solution for ventilating your home efficiently. However, it is not well suited to retrofitting. A balanced system requires a very airtight building to be cost effective.

Balanced systems extract air from the building and pass it through a heat exchanger. Intake air is drawn through the other side of the heat exchanger, prewarming the building's replacement air.

Heat exchanger cores can be very efficient - over 90% in some cases - however, systems require two fans to work. Given the temperate climate in New Zealand, it is possible that the energy recovered can be less than the cost to run the fans driving the system.

Given they are trying to get the absolute maximum energy efficiency possible, running ductwork inside the building insulation is an important consideration.

- Pros - very efficient, good track record of use overseas.
- Cons - most expensive option, difficult to retrofit. Requires an airtight building for maximum efficiency. Requires careful commissioning and regular maintenance.

What's next?

With the completion of WAVE, the energy-efficient ventilation project has recently begun. It seeks to answer a raft of questions about getting the right ventilation option into a home to minimise the energy impact while maximising pollutant removal.

Part of this involves investigating just how much of an impact infiltration air is having and what the right ventilation option is given the airtightness of a building.

Although increasing airtightness - by decreasing infiltration - will result in energy saving, there is evidence the relationship is not completely linear. The first part of the energy-efficient ventilation project will investigate this in more detail in the context of our lightweight construction.

Bathroom habits falling short

A companion study to the latest BRANZ House Condition Survey showed surprisingly high humidity levels in our bathrooms – even when not being used – coupled with unacceptably low temperatures.

BY VICKI WHITE, BRANZ DATA ANALYST/REPORTER, AND MANFRED PLAGMANN, BRANZ SENIOR PHYSICIST

THE EFFECTIVENESS of ventilating a house is largely dependent on the behaviour of the occupants. However, little is known about ventilation habits, particularly the frequency and extent of opening windows and internal doors, and the effect this has on indoor environmental quality.

To help address this knowledge gap, BRANZ researchers devised the Occupant Ventilation Behaviour study.

Data collected over 2016 winter

Funded by the Building Research Levy, this research project measured the temperature and relative humidity (RH) in bedrooms and bathrooms of 64 houses throughout New Zealand over the 2016 winter months.

At the same time, sensors were fitted to the internal doors and windows to record how often and by how much they were opened. Measurements were recorded at 15-minute intervals, amounting to some 20 million temperature and relative humidity data pairs over the duration of the project.

Once the sensors were recalled, participants were sent a questionnaire to find out more about their ventilation habits and any problems experienced with damp and mould and comfort in the home.

In addition to the new data collected in this study, all but five of the participating households were also part of the BRANZ 2015 House Condition Survey (HCS). For more on the HCS, see *Rental houses need TLC,* pages 66-67.

Combining the 2015 HCS data with the information in the occupant ventilation behaviour study provides new insights into how householders ventilate their homes and the impact of their behaviours on the indoor environment.

High humidity for long periods

The median RH recorded across all bathrooms over the study period was 67% (range 43-88%) (see Figure 1). One-third of houses had a median RH of 70% or higher, and six houses (10% of participants) 75% or higher.

While we'd expect to see peaks in moisture levels when the bathroom is in use, these should be brief.

However, what we're seeing is a high proportion of houses - over half of study participants - with a relative humidity above 65% at least half the time. Humidity at these levels over sustained periods of time presents greater risk of problems with condensation and mould.

Half the bathrooms too cold

Temperature is also a key factor as a cold bathroom affects more than comfort. The lower the temperature, the more likely condensation and mould will develop, particularly if surfaces, such as walls and ceilings, are cold when moisture is generated.

The average (median) temperature in bathrooms of study participants' homes was 16°C, but this ranged from a low of 8°C to a high of 20°C (see Figure 1). Nearly half of households (48%) had a median temperature

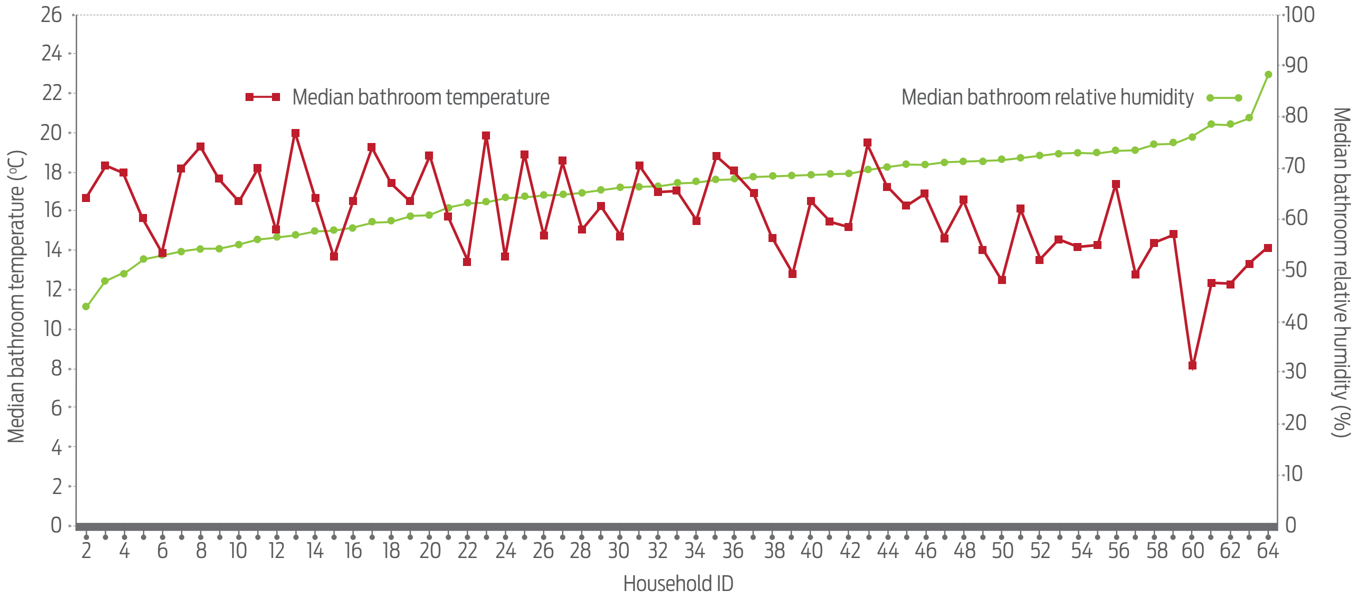


Figure 1: Median relative humidity and temperature in the bathroom of study participants' homes (ordered by RH level).

of less than 16°C in the bathroom, and nearly one-fifth (19%) below 14°C. This means that, for 50% of the study period, these bathrooms were colder than levels recommended for a healthy indoor environment.

Prime site for mould

Combining the relative humidity and temperature data highlights cases where the bathroom was both particularly cold and damp and therefore more susceptible to condensation and mould.

The red bubble in Figure 2 shows a key group of concern. These 10 houses (representing 16% of study participants) had median bathroom temperatures in the coldest 25% (8-14°C) and median RH levels in the top 25% (72-80% RH) of all houses surveyed.

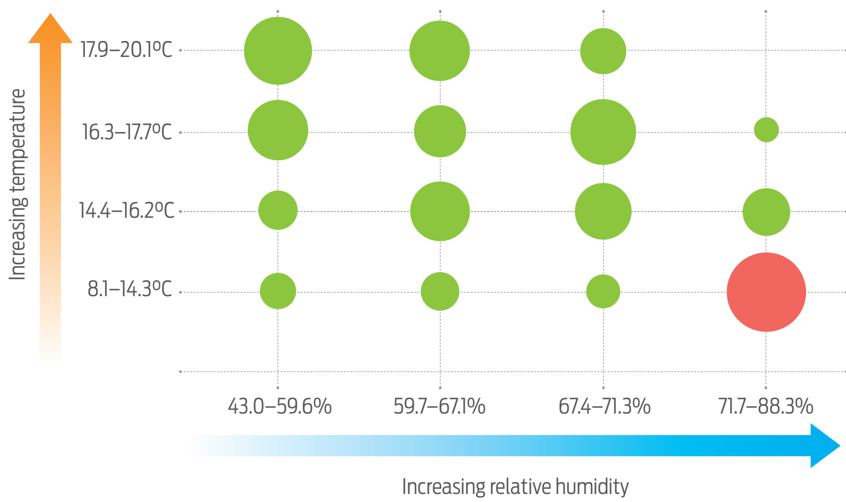


Figure 2: Quartiles of median relative humidity and median temperature in bathrooms of study participant homes (bubble size proportional to number of houses represented).

Good ventilation practice reported

Study participants were asked about how often they opened windows and used an extractor fan whilst and after taking a bath/shower. The responses show a high tendency to ventilate the bathroom – 73% always ventilated the bathroom while showering or bathing and 70% after (see Figure 3).

Use of an extractor fan was more common while showering or bathing, while opening windows was slightly more common afterwards.

Over one-quarter of study participants (27%) did not have an extractor fan in the bathroom (shown by N/A in Figure 3), while 2% did not have openable windows.

Heating and ventilation not enough

These results provide evidence of good practice among study participants in helping to control moisture levels in the bathroom. However, there were still instances of sustained high relative humidity. Comparing occupant-reported ventilation habits with the RH data presents a mixed picture.

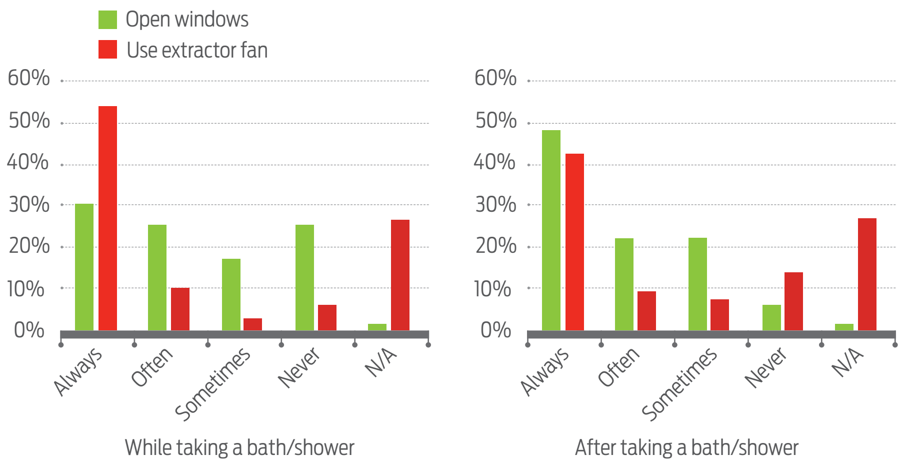


Figure 3: Occupant-reported ventilation practices in the bathroom while and after taking a bath/shower.

Some of the highest levels of relative humidity were recorded in bathrooms where the occupant 'never' ventilated while taking a bath or shower, which is what we might expect. However, houses with similarly high RH said they 'always' ventilated the bathroom. Overall, there was no significant difference in the median RH of bathrooms based on occupant-reported ventilation habits.

Similarly, comparing temperature data with information collected in the HCS about heating systems in bathrooms suggests there was no significant difference in the average temperature of bathrooms with and without heating available.

Controls insufficient or not working well

What does this lack of evidence of any relationship between occupant-reported ventilation habits, heating systems and humidity and temperature data mean?

It suggests that, where systems are available to help control moisture in the bathroom, these are not being used sufficiently or effectively and/or are not functioning adequately.

The fact that occupants largely reported good practice in ventilating the bathroom while and after showering could suggest that householders think they are doing the right thing. However, their actions fall short of what's needed to maintain a healthy environment and minimise the risk of condensation and mould.

Next steps to explore more deeply

Further analysis is being undertaken. This is to understand the drivers behind the relative humidity levels and temperatures recorded and how these relate to occupant ventilation and heating behaviour and problems with condensation and mould.

We will also look more closely at the RH and temperature data in combination with data from the windows and doors sensors. Focusing on high moisture events, this will show:

- how warm or otherwise bathrooms were at the point of high moisture generation
- how quickly moisture levels declined
- for how long and how far windows and doors were open and how long they should be.

Tips for managing bathroom moisture

- **Extract:** If you have an extractor fan, always use it while having a shower or bath, and leave it running afterwards until the moisture has cleared. Opening a window will help airflow, but keep the bathroom door closed to avoid the moist air escaping to the rest of the house.
- **Ventilate:** If there is no extractor fan in the bathroom, open windows during (if not too cold to do so) and after showering/bathing.
- **Heat:** If there is heating available, it will help to warm up the bathroom beforehand - a cold bathroom will increase the likelihood of condensation forming. Open the windows afterwards to allow the moist air to escape, and keep the door closed.
- **Remove:** Wipe excess moisture and condensation from surfaces and windows - droplets take a long time to dissipate, even with the most efficient systems. Dry the wet cloth outside, so the moisture is removed from the room. A shower dome can also help to contain the moisture within the shower cubicle, preventing it from reaching other surfaces.

For more See www.ecodesignadvisor.org.nz/factsheets/.

New home, old habits

By following some easy to implement practices, occupants in a new centrally heated home were able to reduce high levels of internal moisture and enjoy a comfortable indoor environment.

BY MANFRED PLAGMANN, BRANZ SENIOR PHYSICIST

RECENTLY, A BUILDER called BRANZ to ask why a 2-year-old home had excess indoor moisture issues with water condensing on the double glazing.

The 180 m² home has central heating and is occupied by two adults and a school-aged child. The occupants opened some windows a little at various times of the day.

An array of five sensors were set up to monitor the temperature and relative humidity in bedrooms, bathrooms and living areas.

Checking airtightness of buildings

Measuring airtightness at 50 pascal is an agreed method to compare the airtightness of different houses (see *The nitty gritty on airtightness* on page 86).

The airtightness of this house was measured to 3.5 air exchanges per hour at a pressure difference of 50 pascal. This lies well within the airtightness distribution of new homes.

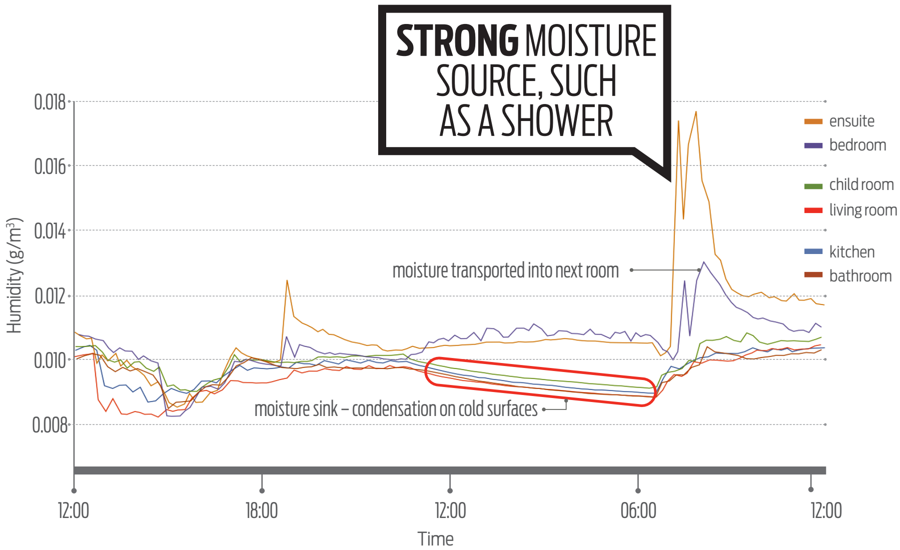


Figure 1: Absolute humidity in the house over 1 day.

As the house is in a relatively sheltered location, the wind-driven background air infiltration was insufficent to ventilate adequately. In normal pressure conditions, the house will not achieve an air exchange of 3.5 times its volume/hr, only an estimated air change of about 0.15-0.2/hr. A sufficiently ventilated building should have an air exchange rate of 0.3-0.5 per hour.

Moisture sources identified

Figures 1 and 2 show measurements from 1 day. The temperature over the day ranged from 16-22°C.

The absolute humidity (see Figure 1) reveals sources and sinks of moisture better than the relative humidity (see Figure 2), as it is only weakly affected by the air temperature.

Moisture from the bathroom is travelling into other parts of the building (see Figure 1). This is because the bathroom ventilation can't cope with the moisture and the bathroom door is either left open or opened after use.

The night-time moisture in the bedroom is also a visible moisture source in Figure 1 with the absolute humidity staying almost constant in this location. In other parts of the house, the moisture content of the air drops due to condensation on cold surfaces.

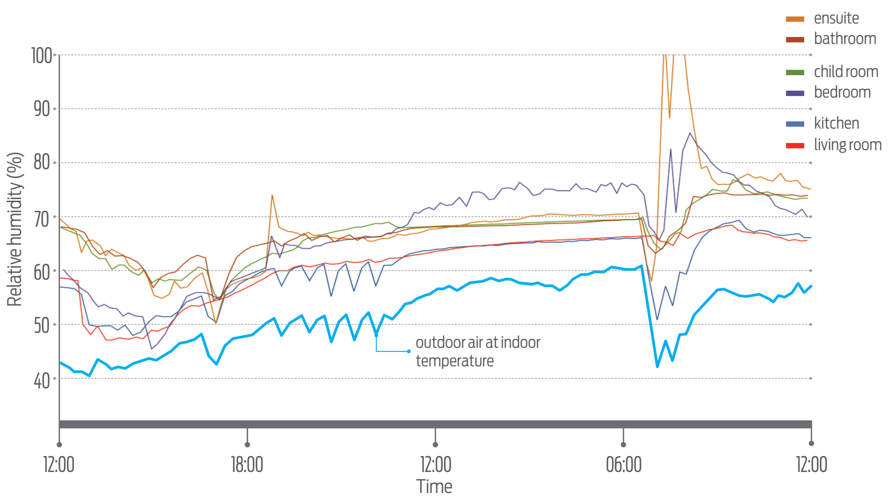


Figure 2: Relative humidity in the house over 1 day.

Relative humidity high

The relative humidity is high throughout the 24 hours with occasional spikes close to 100% for activities such as cooking or showering.

To gauge the drying potential of the outdoor air and effectiveness of extra ventilation, the relative humidity of the outdoor air was calculated at the temperature in the kitchen. The bottom trace in Figure 2 at around 50% shows the relative humidity of the outdoor air at indoor temperatures. A substantial gap of around 10-20% is clearly observable.

This indicates that the moisture problems were due to inadequate ventilation and can be improved with, for example, a manual ventilation scheme.

Solution – contain and ventilate

The results were shown to the owner and the following manual ventilation scheme and source containment discussed:

- Close bathroom door while using bathroom.
- Operate the bathroom fan.
- Heat the house.
- Open windows and doors wide in the morning for 10-15 minutes, enabling a full air exchange before leaving the house.

If possible, containment is the most effective way to reduce moisture. This keeps the space to be ventilated relatively small. The internal doors should be closed, the windows opened and the bathroom ventilation switched on.

Heat, then open windows to dry house

Heating is important as warm air carries more moisture than cold air. To dry out a house, the air has to be heated to drive out moisture in furniture, carpets and wall linings. The windows should then be opened to exchange moist air with the drier outdoor air.

Keep the heating off while the windows and doors are open. This cycle of heating and releasing air ensures that the house returns to a normal moisture regime over a relatively short period.

Significant recovery in just 3 weeks

With the manual ventilation scheme in place, the house returned to a normal moisture level in just 3 weeks. To measure this, the probability of encountering a relative humidity of less than 65% was looked at. This is the level where ventilation should be used to prevent moisture from getting too high.

Probability graphs for 0, 8 and 20 days since the start of the intervention are overlaid in Figure 3. This shows that the indoor air is likely to be below 65% relative humidity for:

- less than half of the time (44%) before the changes
- 62% of the time after 8 days
- 80% of the time after 20 days.

Before the changes, there was very high relative humidity of over 80%. After the 20 days, the maximum relative humidity had fallen to well below 80%.

Comfort levels quickly achieved

The changes to the manual ventilation had significant benefits in just 3 weeks. All that was needed was heating and manually opening windows to do a flush ventilation and achieve a near full air exchange of the house in about 10-15 minutes.

In this case, heating is needed to remove the stored excess moisture. The added benefit is that dry air can be heated better and improves the comfort level. The electricity cost for a flush ventilation of a fully heated house with an indoor-outdoor temperature difference of 10°C is around 1 kWh, depending on house size.

Key points

- Contain moisture e.g. close bathroom door while using shower.
- Use extractors e.g. bathroom fan.
- Heat the house.
- Regularly open windows and doors wide for 10-15 minutes.
- It isn't expensive to flush ventilate and reheat.

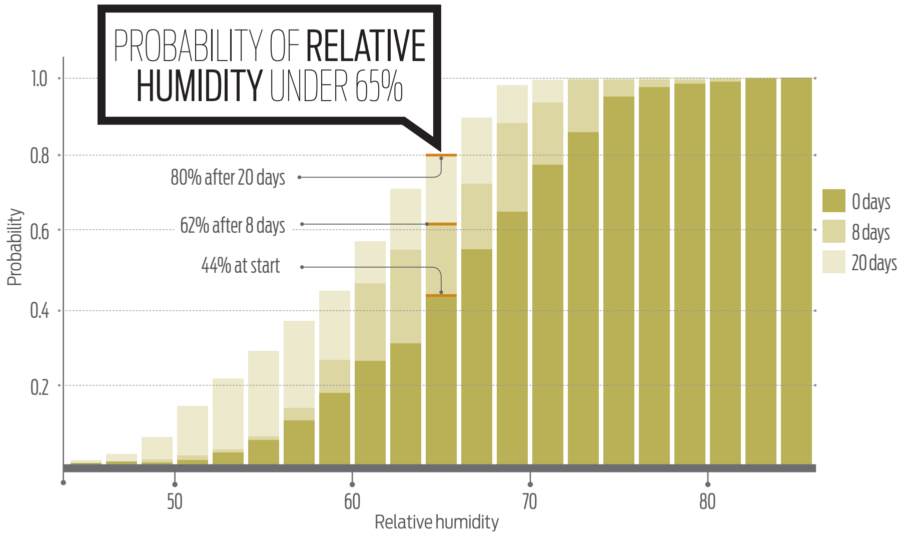


Figure 3: Moisture probabilities at 0, 8 and 20 days after starting manual ventilation.

A breath of fresh air

Just what do Kiwis do to keep their homes free from stuffy air? BRANZ is using science to find the answers and aid in the design of better ventilation systems.

BY MANFRED PLAGMANN, BRANZ SENIOR PHYSICIST

ABOUT 2 YEARS AGO, we acknowledged our lack of understanding of what occupants do when ventilating their homes and why they are doing this.

Understanding home occupant behaviour

We wanted to know whether occupants are:

- regularly opening their windows
- closing internal doors, or whether homes are truly open plan
- using bathroom exhaust fans or rangehoods.

These questions and others have a large impact on the ventilation that occurs in homes and therefore of its moisture load and general indoor air quality. Ventilation behaviour of occupants also has an impact on the effectiveness of installed ventilation systems.

As a lack of ventilation affects health, we need to understand how occupants affect ventilation and the motivation for their actions.

Balancing cleaner air and energy loss

Why should we worry about the amount of ventilation? As with many aspects of life, there is a trade-off. In this case, it is between cleaner air and energy loss. The recommended ventilation rate is about 0.4 air exchanges per hour to maintain a healthy indoor air quality.

For a 100 m^2 home, this means exchanging air with the outdoors at a rate of about 100 m^3/hr. If we go much below this, we experience higher concentrations of pollutants, odours and moisture, resulting in potential adverse health effects and mould growth. If, on the other hand, we overventilate, excess amounts of heating energy will leave the house, resulting in higher than necessary power bills.

Highly effective ventilation systems can be designed, but the effectiveness of any technical solution largely depends on the actions of the occupant, and these are rarely considered.

New project measuring homes

In March 2015, BRANZ started a new project looking at ventilation-related occupant behaviour.

Survey questionnaires and sensors will be used to study up to 100 homes. Data will be collected on how often windows are opened, whether internal doors are closed or open and the temperature and relative humidity in up to four locations in each house.

Homes from across New Zealand will be studied to capture any climatically driven differences in behaviour. Each sensor will contain a single temperature, relative humidity and motion sensor.

Room temperatures, relative humidities and ventilation behaviour in the winter is of primary interest, but some homes will also be looked at over the summer. Homes will be monitored for up to 6 months. During this time, occupants will have access to the real-time temperature and relative humidity data.

Lead to better ventilation design

The data collected from windows and internal doors will be used to derive a statistical model that will enable determination of the likelihood that a certain event occurs given indoor and outdoor climate data.

Being able to predict the circumstances under which a certain behaviour occurs will aid in the design of better ventilation systems. 'Better' in this instance means achieving better indoor air quality using less energy.

Part of a wider global project

To get a critical mass of researchers to help analyse the data and develop the models, BRANZ has joined an international group of researchers working on a larger project of occupant behaviour. This is under the umbrella of the International Energy Agency.

Our study will provide the temperature and humidity profile of residential homes across New Zealand. This will give us an insight into what indoor climate New Zealanders are experiencing and identify potential shortcomings in the quality of the indoor environment.

The motion data will allow the ventilation industry to better target ventilation effectiveness and develop better control methods for ventilation and heating.

Newsletter

AIVC Air Infiltration and Ventilation Centre

@AIVCnews

Foreword

Welcome to the September 2017 edition of the AIVC newsletter. In this issue you will find links and information on newly released AIVC publications and major upcoming AIVC events. Moreover, this issue outlines completed and on-going AIVC projects from 2011 to 2017 and redirects to more detailed information available on our website.

Last but not least, Dr. Andy Persily presents significant advance in the fields of IAQ and ventilation, with a new approach for estimating CO2 generation rates from building occupants.

Please visit our website, follow us on twitter and Linked In and subscribe to our monthly newspaper "Energy Efficiency and Indoor Climate in Buildings" to find out more about our activities.

Also, don't forget to mark your agenda for the following upcoming major events:

• International Workshop "Ventilative cooling in buildings: now & in the future" on 23 October 2017, in Brussels, Belgium

• AIVC International workshop "Towards Higher Performing Homes: The Role of Ventilation and Airtightness" on March 19-20, 2018, in Wellington, New Zealand

• 39th AIVC Conference on September 18-19, 2018 in Juan-les-Pins, France

We wish you a pleasant reading and look forward to seeing you in our future events.

Peter Wouters, Operating Agent AIVC

no 12

September 2017

In this issue

IAQ metrics workshop recordings & presentations available

The AIVC workshop: "Is ventilation the answer to indoor air quality control in buildings? Do we need performance-based approaches?" was held in Brussels, Belgium on 14-15 March, 2017. The event aimed to identify the pros and cons of performance-based approaches and metrics that can be considered to assess the indoor air quality (IAQ) performance of ventilation systems, as well as to draft guidelines for their use in standards and regulations.

The presentations of the workshop are now available at the AIVC website.

Recordings of the presentations that follow are also available on YouTube:

• Indoor carbon dioxide as metric of ventilation and IAQ: Yes or No or Maybe? Andrew Persily, NIST, USA

• What can ('t) perceived air quality indices tell you about indoor air quality? Pawel Wargocki, DTU, Denmark

• Considerations on IAQ metrics from regulatory and compliance point of view – Use of IAQ metrics in practice, Peter Wouters, BBRI, Belgium

AIVC Indoor AIr Quality metrics workshop[h] Brussles, Belgium, March 14-15 2017

AIVC Air Infiltration and Ventilation Centre

A New Approach to Estimating Carbon Dioxide Generation Rates from Building Occupants

Andrew Persily, NIST

Indoor CO2 concentrations have been prominent in discussions of building ventilation and indoor air quality (IAQ) since the 18th century. More recent discussions have focused on the impacts of CO2 on building occupants as well as the use of indoor CO2 to estimate ventilation rates and to control outdoor air ventilation rates. While the rates at which building occupants generate CO2 are key to these applications, the rates currently in use are not based on recent concepts or data. However, the fields of human metabolism and exercise physiology have studied human activity for many decades, focusing on rates of energy expenditure, oxygen consumption and CO2 generation. A new method for estimating CO2 generation rates from building occupants, based on the principles and data from these fields, has recently been developed and is described in detail in Persily and de Jonge, 2017 [4].

The ventilation and IAQ fields have long used the following equation to estimate CO2 generation rates from building occupants [2]:

$$V_{CO2} = 0.00276\, A_D MRQ / (0.23RQ + 0.77)$$

where V_{CO2} is the CO2 generation rate per person (L/s); A_D is the DuBois surface area of the individual (m^2); M is the level of physical activity, sometimes referred to as the metabolic rate (met); and RQ is the respiratory quotient, i.e., the ratio of the rate at which CO2 is produced to the rate at which oxygen is consumed. This equation first appeared in the ASHRAE Fundamentals Handbook in 1989 and was included in the recent 2017 version. The Handbook also contains a table of metabolic rates for various activities, which has remained unchanged since 1977 and is based on references predominantly from the 1960s.

The first step in the new approach is to estimate the basal metabolic rate (*BMR* in units of MJ/day) of the individuals of interest based on their sex, age and body mass. The next step is to estimate the occupants' level of physical activity, *M*. Persily and de Jonge [4] contain equations to estimate *BMR* and tables of *M* values for various activities from recent references [3], [1]. The product of *BMR* and *M*, in units of MJ/day, is then converted to L of oxygen consumed per unit time. The CO2 generation rate can then be expressed in L/s at an air pressure of 101 kPa and a temperature of 273 K, assuming *RQ* equals 0.85, as follows:

$$V_{CO2} = BMR\ M\ 0.000484$$

This new approach for estimating CO2 generation rates from building occupants constitutes a significant advance in the fields of IAQ and ventilation and should be considered in future applications of CO2 in ventilation and IAQ studies and standards. In addition, the sources of physical activity data identified should be incorporated into the references that currently use older and much more limited data sources.

References

[1] Ainsworth, B., et al. (2011) The Compendium of Physical Activities Tracking Guide, Arizona State University: *https://sites.google.com/site/compendiumofphysicalactivities/*

[2] ASHRAE. (2017). Fundamentals Handbook, Atlanta, GA, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

[3] FAO. (2001). Human Energy Requirements. Report of a Joint FAO/WHO/UNU Expert Consultation, Geneva, Food and Agriculture Organization of the United Nations, Food and Nutrition Technical Report Series 1.

[4] Persily, A.K. and de Jonge, L. (2017). Carbon Dioxide Generation Rates of Building Occupants. Indoor Air, Accepted: 14 March 2017. 10.1111/ina.12383.

AIVC projects (2011-2017)

In line with AIVC's ambition to maximise its impact on the dissemination of information on research and development in the fields of ventilation and air infiltration, the AIVC Board has launched several projects since the beginning of 2011. So far 8 projects have been completed and 7 projects are in progress. Project outcomes include topical sessions at AIVC and other conferences, workshops, webinars, publications and many more.

Completed projects:

1. Development and applications of building air leakage databases
2. Philosophy for setting building airtightness requirements
3. Testing, reporting and quality schemes for building airtightness
4. Ventilative cooling
5. Improving the quality of residential ventilation systems
6. Ventilation and health
7. Quality of methods for measuring ventilation and infiltration in buildings

On-going projects:

1. Competent tester schemes for building airtightness testing
2. Residential cooker hoods
3. Fan energy use and eco-design requirements (under definition)
4. Rationale behind ventilation requirements and regulations (under definition)
5. Utilization of heat recovery
6. Integrating uncertainties due to wind and stack effect in declared airtightness results
7. Indoor Air Quality-IAQ metrics

Short descriptions and major outcomes of each project can be found at the AIVC website at: http://www.aivc.org/resources/collection-publications/aivc-projects.

AIVC Air Infiltration and Ventilation Centre

23 October 2017, International Workshop, Brussels, “Ventilative cooling in buildings: now & in the future”

The current development in building energy efficiency towards nZEB buildings represents a number of new challenges to design and construction. One of these major challenges is the increased need for cooling in these highly insulated and airtight buildings, which is not only present in the summer period but also in the shoulder seasons and in offices even in midwinter. Ventilative cooling can be an energy efficient solution to address this cooling challenge in buildings.

The objective of this workshop is to discuss the implementation of ventilative cooling and its role to guarantee good thermal summer comfort in commercial, educational and residential buildings.

Topics addressed:

- Design guidelines
- Solutions and technologies
- Demonstration in current buildings
- Energy performance calculation
- Recommendation for standards
- Future challenges and opportunities

This workshop will present the outcomes of IEA EBC Annex 62, discuss with experts from industry and interact with the audience through interactive voting and group discussion.

The event will be held on Monday October 23, 2017 at the BBRI offices (Boulevard Poincaré 79, 1060) in Brussels, Belgium.

The workshop is an initiative of IEA-EBC annex 62 & venticool and is hosted by INIVE-BBRI & KU Leuven.

Participation to the workshop is free, but requires you to register for the event. To register, please fill in the registration form and send to Mr. Stéphane Degauquier sd@bbri.be

Further information on the programme, speakers etc. is available here.

New AIVC Publications

The AIVC is very pleased to announce the release of three new publications!

• Contributed report 16: Towards compliant building airtightness and ventilation systems

A collection of 23 factsheets, specifically related to ventilation and airtightness issues, field data, and solutions, delivered in the framework of the EU QUALICHeCK project.

• Ventilation Information Paper 36: Metrics of Health Risks from Indoor Air

A summary of the discussions of the AIVC workshop on IAQ metrics held in March 2017

• Ventilation Information Paper 37: Impact of Energy Policies on Building and Ductwork Airtightness

An analysis of policy instruments used and changes observed in practice in terms of building and ductwork airtightness, using as reference mostly publications from AIVC and TightVent led events from 2011-2015.

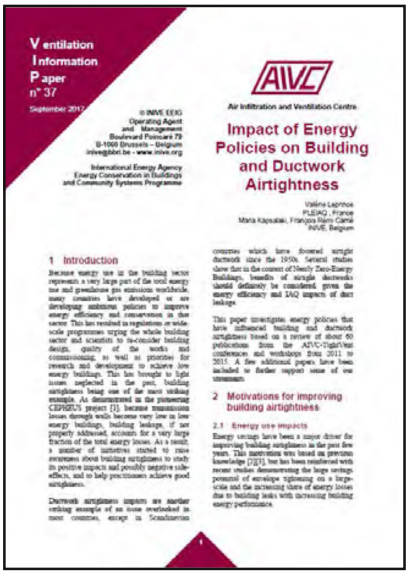
The documents are now available for download at: http://aivc.org/resources/collection-papers/aivc-publications.

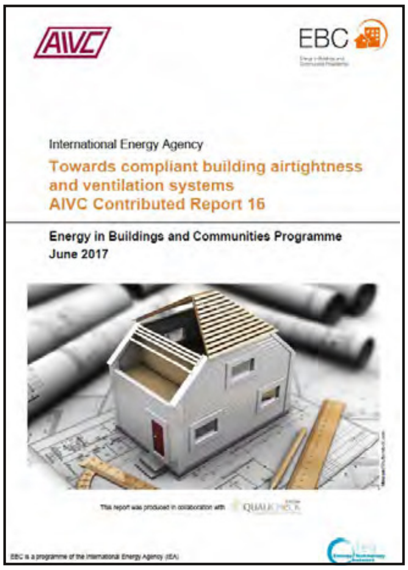
AIVC International workshop on ventilation & airtightness

The workshop will be held on March 19-20, 2018 at the Museum of New Zealand Te Papa Tongarewa. The title of the workshop is: “Towards Higher Performing Homes: The Role of Ventilation and Airtightness”.

If you want to be kept informed please subscribe at: http://news.inive.org

More information will follow soon so stay tuned.





Air Infiltration and Ventilation Centre

SAVE THE DATE: 18-19 September 2018, 39th AIVC conference, Juan-les-Pins, France

The 39th AIVC conference will be held on 18 and 19 September 2018 in Juan-les-Pins (France) together with the 7th TightVent conference and the 5th venticool conference. More information will follow so stay tuned.

13 -14 September 2017 - 38th AIVC & 6th TightVent conference in Nottingham, UK

Over 160 participants at the 38th AIVC conference. Final programme is available here. More information on the outcomes of this conference will be posted on the AIVC website

NEWSPAPER: "Energy Efficiency and Indoor Climate in Buildings"

The monthly online newspaper “Energy Efficiency and Indoor Climate in Buildings “ contains relevant information on the Air Infiltration and Ventilation Centre (AIVC), the international platform on ventilative cooling (venticool) & IEA EBC annex 62-ventilative cooling, the building and ductwork airtightness platform (TightVent Europe), the Indoor Environmental Quality – Global Alliance (IEQ-GA), the QUALICHeCK project and the Dynastee network.

The paper is available at the first of every month at: http://news.inive.org/

Subscribe to get informed on a monthly basis on the various platforms’ activities.

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DISCLAIMER: Conclusions and opinions expressed in contributions to AIVC’s Newsletter represent the author(s)’ own views and not necessarily those of the AIVC

No 11 ● DECEMBER 2017

Foreword

We are happy to introduce to you the 11th newsletter of the venticool platform of December 2017!

Our first two articles, provide feedback on the ventilative cooling workshop in Brussels followed by the final IEA-EBC Annex 62 expert meeting in Gent in October, 2017. Further on, Professor Maria Kolokotroni presents the summing-up of the ventilative cooling track at the 38th AIVC-6th TightVent-4th venticool joint conference held in Nottingham, UK on 13-14 September, 2017. Christoffer Plesner from Velux, follows up on his last article on new work items recently approved by CEN and ISO with regard to ventilative cooling.

As usual, this edition provides detailed information on upcoming events in the field of ventilative cooling. A major venticool event is the upcoming 39th AIVC-7th TightVent & 5th venticool joint conference: “Smart ventilation for buildings” in Juan-les-Pins, France on 18-19 September 2018, with a specific track largely devoted to ventilative cooling. We hope to see you there.

For more frequent updates, please visit our website, follow us on twitter and Linked In and subscribe to our monthly newspaper "Energy Efficiency and Indoor Climate in Buildings" to find out more about our activities. We wish you a pleasant reading.

The venticool team

@venticool

IEA EBC Annex 62- Ventilative Cooling- 8th Expert Meeting, Gent, Belgium, October 24-25, 2017

Per Heiselberg, Aalborg University

16 delegates from 10 countries attended the 8th expert meeting. The host was KU Leuven, Faculty of Engineering Technology, Technology Campus Ghent, Associate Professor Hilde Breesch.

This was the final project meeting and the main focus was to complete the final reports of the project. They include a Guide Book for ventilative cooling design, a Source Book for ventilative cooling technology and a book of Case Studies with 15 well-documented examples of application of ventilative cooling solutions and their performance. These publications will be available in the beginning of 2018 from the IEA and venticool websites.

The meeting also included a discussion of recommendations for standards, legislation and compliance tool to improve the application of ventilative cooling in new and existing buildings in the future. These recommendations are based on a thorough analysis of international standards in the field and of the present legislation as well as the compliance tools used in 8 European countries. The full background report as well as a short summary with recommendations will also be available in the beginning of 2018.

Happy participants after completion of the last meeting of Annex 62 meeting at KU Leuven, Gent, Belgium

In this issue

Feedback from Brussels workshop on ventilative cooling, 23 October 2017

62 persons from 15 countries attended the international workshop on "ventilative cooling in buildings: now & in the future" held in Brussels, Belgium on 23 October 2017. This workshop aimed at discussing the implementation of ventilative cooling as well as its role to guarantee good thermal summer comfort in commercial, educational and residential buildings. The programme firmly built on the results of IEA-EBC Annex 62, namely:

- The ventilative cooling potential excel tool that allows to assess the effectiveness of ventilative cooling solutions taking into account climate conditions, building envelope thermal properties, occupancy patterns, internal gains and ventilation needs
- A book with design guidelines derived by the expert group which should be under review in the next weeks
- An overview of the ability of national energy performance calculation methods to properly take into account ventilative cooling solutions
- An overview of solutions and technologies that can be implemented, including lessons learnt from 15 case studies analysed within the project
- An analysis of relevant CEN and ISO standards and the identification of gaps to fill to increase the adoption of ventilation cooling solutions

The interaction with the audience after these presentations, reflected the interest and need for such tools. These tools will be gradually available on our website.

In the discussions, besides purely ventilative cooling solutions, appropriate solar shading was often mentioned as a pre-requisite. Several thought that Phase Change Materials (PCM) and personal comfort solutions (e.g., using micro-evaporators) could be major new elements influencing future design solutions.

It was also acknowledged that, while ventilative cooling solutions can be effective on multiple aspects including comfort, energy use, power demand and costs, it also requires more work at design stage, possibly with dynamic simulations including airflow modelling, as well as more post-occupancy care, in particular to inform occupants. Several attendees also stressed the need to learn from user interaction and that "visible" automatic controls (e.g. window opening or solar shading controls) need to be understandable for user acceptance.

There were debates about the objectives of the smart readiness indicator (https://smartreadinessindicator.eu/) to be included in the future Energy Performance of Buildings Directive. Since only its broad contours are defined at this stage, it is clearly too soon to assess the relevance of a single indicator for the scope foreseen and how this could affect the uptake of ventilative cooling; however, in principle, accounting for electricity grid management and indoor climate would converge with the goal sought with ventilative cooling solutions.

The development of Building Information Modelling (BIM) could also be seen as an opportunity for ventilative cooling as it could ease thermal comfort evaluation and, thereby, encourage designers to look into efficient solutions to prevent overheating. Nevertheless, the structuring of the huge amount of data to be included in BIM objects to cover possible applications, could be a serious hurdle to make this happen in the near future.

This workshop was also the occasion to discuss a new IEA-EBC Annex proposal building on the findings of IEA Annex 62, but looking more broadly at the issues of smart overheating prevention and cooling in changing urban environments. The scope goes beyond the boundaries of the building, addressing also heat island mitigation and outdoor comfort, and includes active cooling as a complementary measure to passive techniques. The goal is to foster "resilient" cooling solutions, i.e., solutions that either maintain or adapt to maintain their function as outdoor temperatures rise without augmenting stress on the outdoor environment.

In summary, there is no doubt that overheating prevention and cooling will be high on political agendas with the effects of global warming, which we are just starting to experience.

The workshop showed an alternative path to the generalisation of full mechanical cooling capacity implementation which would be both energy demanding and detrimental to urban heat island and the adoption of passive cooling techniques. The discussions further stressed challenges and opportunities for research and technology development on resilient cooling to fight and adapt to climate change, in a constantly evolving context of regulations and information technology. This could be the core theme of a new IEA-EBC project.

Ventilative cooling summary from AIVC 2017 conference

Maria Kolokotroni, Brunel University London

The joint 38th AIVC, 6th TightVent and 4th venticool Conference on 'Ventilating Healthy Low-energy Buildings' was held in Nottingham, UK, 13-14 September 2017. The programme consisted of plenary sessions and 3 parallel tracks, one devoted to Ventilative Cooling in four sessions (20 papers) and 17 papers in poster sessions. Two sessions were topical proposed by IEA EBC Annex 62 plus one discussion session. One topical session focused on case-studies [6, 18, 23-25] including houses, offices, a large space and shopping malls. O'Sullivan [26] presented preliminary conclusions (~20 buildings), completed post 2010 studied by Annex 62 participants. The second topical session was devoted to Indicators and Strategies/Components. Flourentzou [37] presented energy performance indicators with following papers [15, 31-34] on experiences from offices to renovated dwellings to supermarkets and shopping malls where potential is high. Peter Holzer chaired the discussion session on the proposal for a new IEA EBC Annex on Resilient Cooling.

The paragraphs that follow attempt to group papers according to Technology Readiness Levels (TRL) - Figure 2, and compare with TRLs of those presented two years before at the 26th AIVC conference in Madrid (35 papers).

1. Low TRL: 16 papers were presented on simplified design tools and inter-model comparison of more complex tools for better prediction with emphasis on overheating dissipation. In many cases only boundary conditions are different – ie external conditions (weather data) and internal conditions (use of space) [1-16]. More papers were presented (11 in Madrid) and were similar in scope.

2. Mid TRL: 6 papers presented performance assessment of prototypes through laboratory experiments and/or simulation. A variety of components was presented such as phase change materials and radiant panels combined with ventilation [19, 20], adjustable jets [21], façade improvement [22] bulk air flow measurements [18] including hot climates [17]. Number of papers was less than in Madrid (10) with more emphasis on experimental results.

3. High TRL - 14 papers presented performance verification with data from operational buildings [23-36] for a variety of buildings types. In Madrid the number was similar (13) where in general measurements did not include ventilation/air flow but parameters related to environmental and thermal comfort performance. In Nottingham, more papers included ventilation/air flow measurements. Energy indicators are still investigated but work on health impact has increased.

The need for more explicit reference to Ventilative cooling within building energy performance regulations was discussed [37] with more work initiated by IEA EBC Annex 62.

In conclusion, based on papers presented, work towards more explicit reference to ventilative cooling in energy regulations has progressed, evidence from operational buildings has progressed including health impacts but less work on component development was reported. The complete article including the full list of referenced papers is available here.

New standardization projects on ventilative cooling and natural and hybrid ventilation systems

Christoffer Plesner, VELUX

New Work Items (NWI's) relevant to ventilative cooling applications have been approved by the European Committee for Standardization (CEN) and the International Organization for Standardization (ISO) (see venticool newsletter June 2017 . The scope of this work is to make technical documents focusing on design aspects of ventilative cooling, and natural and hybrid ventilation systems in residential and non-residential buildings.

The projects are progressing well and have now officially started under CEN/TC 156 (Ventilation for buildings) and ISO/TC 205 (Building environment design). Some of the projects have developed further than others, e.g. the ISO standard (see below) where some of the contents have already been discussed. The others are still in the initial phase of setting up task groups and discussing the scope.

The initiated projects are planned as Technical Specifications (normative documents of lower status than EN Standards), an EN standard under CEN/TC 156, and as an ISO standard under ISO/TC 205.

More specifically, three projects relevant to ventilative cooling applications, have already started:

Ventilative cooling systems:

- Main focus: Thermal comfort (prevent overheating)
- Document type: Technical specification
- Work started in WG/21 in CEN/TC 156

Natural and hybrid ventilation systems in non-residential buildings:

- Main focus: Indoor air quality
- Document type: Technical specification
- Work started in WG/20 in CEN/TC 156

Design process of natural ventilation for reducing cooling demand in energy-efficient non-residential buildings:

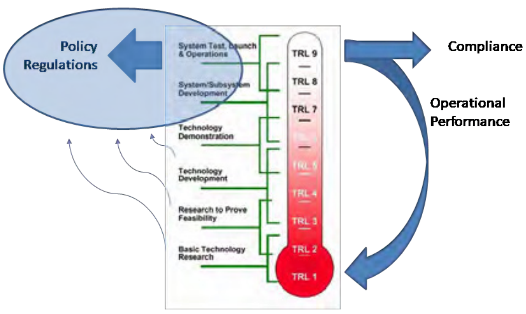
- Main focus: Thermal comfort (design process to prevent overheating)
- Document type: ISO standard
- Work started in WG/2 in ISO/TC 205

and, one project is upcoming:

Expansion of Natural and Hybrid ventilation in residential buildings in upcoming "Revision of EN 15665:2009 and CEN/TR 14788:2006":

- Main focus: Indoor air quality
- Document type: EN standard
- Work started up in WG/2 in CEN/TC 156

The technical documents are a good opportunity to define design aspects and processes of ventilative cooling and natural and hybrid ventilation systems on the European and International scene e.g. by applying findings from the venticool platform and the upcoming IEA EBC Annex 62 reports on ventilative cooling.



Technology Readiness Levels; adapted from: NASA Technology Readiness Levels - https://en.wikipedia.org/wiki/Technology_readiness_level

18 -19 September 2018 - 39th AIVC & 5th venticool conference in Juan-les-Pins, France

The 39th AIVC- 7th TightVent & 5th venticool conference "Smart ventilation for buildings" will be held on 18 and 19 September 2018 in Juan-les-Pins, France. The conference will consist of 3 parallel tracks largely devoted to:

- Smart ventilation, Indoor Air Quality (IAQ) and health relationships
- Ventilation and Airtightness
- Ventilative cooling – Resilient cooling

Specific topics of interest on ventilative cooling-Resilient cooling include:

- Thermal comfort and ventilation;
- Coupling of ventilation with cooling systems;
- Ventilative cooling (design, technologies, components, controls, case studies);
- Bioclimatic architectural design towards better summer performance
- Technologies of passive cooling and overheating prevention
- Personal comfort control during the hot season
- Efficient part-time or zonal cooling, including options of precooling
- Technologies and control strategies towards energy flexible buildings

Important dates

- Deadline for abstract submission: March 1, 2018
- Notification of abstract acceptance: April 1, 2018
- Deadline for full paper submission: June 10, 2018

The conference is organised by:

- CETIAT, the French technical centre for the heating, ventilation and air conditioning industries
- ADEME, the French environment and energy management agency
- INIVE, the International Network on Ventilation and Energy Performance on behalf of the AIVC, TightVent Europe and venticool.

For more information and to submit your abstracts, please visit: http://www.aivc2018conference.org

What is ventilative cooling?

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

What is venticool?

venticool is the international ventilative cooling platform launched in October 2012 to accelerate the uptake of ventilative cooling by raising awareness, sharing experience and steering research and development efforts in the field of ventilative cooling. The platform supports better guidance for the appropriate implementation of ventilative cooling strategies as well as adequate credit for such strategies in building regulations. The platform philosophy is to pull resources together and to avoid duplicating efforts to maximize the impact of existing and new initiatives.

Disclaimer

Conclusions and opinions expressed in contributions to the venticool Newsletter represent the author(s)' own views and not necessarily those of venticool partners.

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To join venticool please visit: http://venticool.eu/venticool-contact/

TightVent Europe

BUILDING AND DUCTWORK AIRTIGHTNESS PLATFORM

November 2017

Newsletter No13

Foreword

Welcome to the November 2017 issue of the TightVent Europe newsletter. In the current edition, Professor Arnold Janssens presents the highlights of the airtightness track at the 38th AIVC-6th TightVent-4th venticool joint conference held in Nottingham, UK on 13-14 September, 2017. Further on, Dr. Sylvain Courtey gives an overview of the newly launched Eurovent certification programme for Ventilation Ducts.

As in previous editions, this issue provides detailed information on upcoming events in the field of ventilation & airtightness. A major TightVent event is the upcoming 39th AIVC-7th TightVent & 5th venticool joint conference: “Smart ventilation for buildings” in Juan-les-Pins, France on 18-19 September 2018, with a specific track largely devoted to ventilation and (building) airtightness. Moreover, the AIVC is organising a workshop on ventilation & airtightness which will take place on March 19-20, 2018 in Wellington, NZ.

Please visit our website, follow us on twitter and Linked In and [subscribe] to our monthly newspaper "Energy Efficiency and Indoor Climate in Buildings" to find out more about our activities.

We wish you a pleasant reading and look forward to seeing you in our future events (see our Events Calendar on page 4).

The TightVent team

18 -19 September 2018 - 39th AIVC & 7th TightVent conference in Juan-les-Pins, France

The 39th AIVC- 7th TightVent & 5th venticool conference "Smart ventilation for buildings" will be held on 18 and 19 September 2018 in Juan-les-Pins, France. The conference will consist of 3 parallel tracks largely devoted to:

– Smart ventilation, Indoor Air Quality (IAQ) and health relationships
– Ventilation and Airtightness
– Ventilative cooling – Resilient cooling

It will consist of a mixture of well prepared and structured sessions focused on the conference topics, presentations on invitation and presentations arising from the call for papers.

Specific topics of interest on ventilation and (building) airtightness include:

– Energy rating of ventilation product and systems
– Innovative ventilation concepts and combined systems
– Fan energy demand
– Heat recovery issues (freezing, natural ventilation)
– Risks related to building airtightness
– Durability of building and ductwork airtightness
– Energy and IAQ impact of envelope and ductwork leakage
– Field data and case studies
– Infiltration measurement techniques and IR thermography
– Compliance schemes and barriers to innovation
– Ventilation in renovated buildings

Important dates

– Deadline for abstract submission: March 1, 2018
– Notification of abstract acceptance: April 1, 2018
– Deadline for full paper submission: June 10, 2018

The conference is organised by:

– CETIAT, the French technical centre for the heating, ventilation and air conditioning industries
– ADEME, the French environment and energy management agency
– INIVE, the International Network on Ventilation and Energy Performance on behalf of the Air Infiltration and Ventilation Centre (AIVC), TightVent Europe and venticool (the international platform for ventilative cooling).

For more information please visit: http://aivc2018conference.org/

In this issue

Feedback from the 38th AIVC & 6th TightVent conference: Summary of the airtightness track

Arnold Janssens, Professor of Building Physics, Ghent University, Belgium

The airtightness track at the AIVC 2017 conference consisted of 23 presentations organised in 5 sessions of which 3 were topical sessions with a number of invited presentations. Most of the airtightness topics in the call for papers for the conference were represented in the papers in the airtightness track:

- Durability of building and ductwork airtightness
- Energy impact of envelope and ductwork leakage
- Field data and case studies
- Infiltration measurement techniques
- Design and construction approaches for airtight buildings

A topical session discussed methods to assess the durability of airtightness. The session covered field measurements, accelerated ageing in laboratory, seasonal variations and also exposure loads of the air barrier. Valérie Leprince [1] presented a comprehensive review of studies dealing with durability of building airtightness and proposed an experimental protocol for artificial ageing. Her paper won the conference best paper award. A study by the Belgian Building Research Institute quantified the effect of different types of ageing (wind load, temperature and humidity variations) on the airtightness of both masonry and wood frame walls using laboratory tests. This type of information is very relevant for building practice.

Another topical session discussed recent work to integrate uncertainties due to wind and stack in declared building airtightness results. Guidelines were presented to reduce the experimental error both in situations with low and high wind speeds (> 6 m/s). Christophe Delmotte presented the weighted line of organic correlation as a more appropriate technique to take into account uncertainties in measured air flow rates and pressure differences (e.g. at zero-flow), compared to the ordinary least squares regression technique.

Several presentations in other sessions were dealing with the development and analysis of building air leakage databases. Building airtightness testing is mandatory in the UK, France, Ireland and Denmark. Field measurement data are available in 6 European countries. Most of the time, databases are managed by testers' qualification bodies and contain mainly data of new residential buildings. The large volume of data are used to identify trends and analyse failure rates compared to regulatory requirements or design targets for indoor air quality or energy use, as a study by the Air Tightness Testing and Measurement Association in the UK explained. The development of a new database characterising the airtightness of the existing housing stock has been launched in Spain.

Ductwork airtightness was receiving less attention than building airtightness. Adeline Bailly [3] presented a ductwork airtightness measurement scheme and database developed in France. She discussed figures regarding main characteristics of the buildings and ventilation systems in which ductwork airtightness measurements were performed, showing increasing application of tests in residential buildings.

1. Leprince, V., B. Moujalled and A. Litvak. 2017. Durability of building airtightness, review and analysis of existing studies. Proceedings of the 38th AIVC Conference, Nottingham UK, 1-14.
2. Delmotte, C. 2017. Airtightness of Buildings – Considerations regarding the zero-flow pressure and the weighted line of organic correlation. Proceedings of the 38th AIVC Conference, Nottingham UK, 770-779
3. Bailly Mélois,A. and B. Moujalled. 2017. About 1,000 ductwork airtightness measurements performed in new French buildings: database creation and first analyses. Proceedings of the 38th AIVC Conference, Nottingham UK, 310-317.

Summing up of airtightness track at the 38th AIVC - 6th TightVent – 4th venticool joint conference

Best paper award, Valérie Leprince et al. 38th AIVC-6th TightVent – 4th venticool joint conference

TightVent Europe
BUILDING AND DUCTWORK AIRTIGHTNESS PLATFORM

AIVC Workshop on airtightness & ventilation, 19-20 March 2018, Wellington, NZ

New Zealand homes and apartments have become more and more airtight and have reached a level of airtightness that requires dedicated ventilation. Despite the fact that there is no airtightness requirement in the New Zealand Building Code, new homes regularly reach an airtightness level of 2-3.5 ACH50. This can be a welcome trend as it allows controlled ventilation and therefore control of the energy demand of the building. Many newly built homes, however, experience excess moisture and mould problems in living areas and/or roof cavities, due to a combination of occupant behaviour and a lack of ventilation. The goals of a healthy home environment and energy efficiency can sometimes pull in opposite directions, requiring us to find a trade-off between health and energy saving. Do we need dedicated airtightness and ventilation targets in the Building Code to reach an optimal set point for ventilation related energy use and health outcomes? How can this be achieved?

The objective of this workshop is to discuss and identify ways to improve the quality of our homes with respect to airtightness and ventilation, as well as discussing the impact suboptimal performance has on energy consumption and health of the occupants. Also of interest are the impacts of mandatory airtightness targets and how best to implement these, if at all.

Specific topics include:

- Indoor air quality in schools and residential buildings
- Ventilation and its impact on energy and health outcomes for occupants
- Airtightness of New Zealand buildings - trends and requirements

The workshop discussions will be based on detailed presentations from international and national researchers. Interaction between participants will allow exchange of ideas and experiences.

This workshop will be held on March 19-20, 2018 at the Museum of New Zealand Te Papa Tongarewa. The title of the workshop is: "Towards Higher Performing Homes: The Role of Ventilation and Airtightness".

For further information please visit: https://goo.gl/hJYaju

Eurovent certification programme for ventilation ducts

Dr. Sylvain Courtey, Managing Director, Eurovent Certita Certification

Eurovent Certita Certification is pleased to announce the launch of a new certification programme for Ventilation Ducts (DUCT).

The DUCT programme has been developed in 2015-2016 with the support of a dedicated launching committee.

The first release of the Operational Manual (OM) and Rating Standards (RS) apply to rigid and semi-rigid ventilation ductwork systems divided into the following sub-programmes:

- Rigid metallic ductwork systems with circular cross-section (DUCT-MC)
- Rigid metallic ductwork systems with rectangular cross-section (DUCT-MR)
- Semi-rigid non-metallic ductwork systems predominantly made of plastics (DUCT-P)

All ranges of products that fall into the relevant sub-programme scope and are promoted by the Applicant/Participant shall be certified. The "certify-all" principle applies not only to Europe but to all markets.

The certification programme is based on product performance testing by independent laboratories as well as manufacturing facility auditing. The product performance testing will enable the verification of the following ratings accuracy:

- Air tightness class (all sub-programmes)
- Positive and negative pressure limits (all sub-programmes)
- Dimensions (DUCT-MC and DUCT-MR)
- Minimum and maximum service temperatures (DUCT-P)
- Resistance to external pressure (DUCT-P)

Air leakage and strength testing shall be conducted in accordance with EN 12237:2003 (DUCT-MC and DUCT-P) or EN 1507:2006 (DUCT-MR).

For tests related to service temperatures and resistance to external pressure (DUCT-P) the method is described in the Rating Standard RS 2/C/004P-2016.

Manufacturers of ventilation ducts are invited to contact ECC at apply@eurovent-certification.com for any further information.

Publication of certified data is available at www.eurovent-certification.com

***Eurovent Certita Certification** is a major European certification body in the field of HVAC-R, operating 38 certification programmes and generating about € 12 million in turnover. Eurovent Certita Certification provides voluntary third part certification services on the full range of HVAC-R products, whatever their final use, either in residential domestic buildings or in industrial facilities for instance. Eurovent Certita Certification is offering various certification schemes tailored to the needs of manufacturers and stakeholders on their specific markets. It focuses on certifying products' performances as well as data needed to implement regulations. The main quality marks currently proposed are the marks "Eurovent certified performance", NF, CSTBat, and the European Keymark. On a market ever more demanding in terms of energy performances and environmental challenges, Eurovent Certita Certification supplies certified data at a European level and provides the needed confidence.*

TightVent Europe

BUILDING AND DUCTWORK AIRTIGHTNESS PLATFORM

Partners

Impact of Energy Policies on Building and Ductwork Airtightness

A new Ventilation Information Paper (VIP), has been released by the Air Infiltration and Ventilation Centre (AIVC), which analyses both the policy instruments used (regulatory requirements and incentives, specific programme requirements, quality frameworks for testers and builders) and the changes observed in practice in terms of building and ductwork airtightness over the past 5 years, using as reference mostly publications from AIVC and TightVent Europe led events.

The review begins with the motivations for improving building airtightness, including energy use impacts, building durability, indoor air quality (IAQ) impacts, and safety of occupants. Mandatory building airtightness testing has come gradually into force in the United Kingdom, France, Ireland and Denmark. It is also considered in many other European countries, either as regulatory or programme requirements, mostly because of the increasing weight of building leakage energy impact on the overall energy performance of low-energy buildings. Because of legal and financial issues due to wrong tests, several countries have developed qualification schemes for building airtightness testers and also airtightness databases that prove to be very useful for monitoring policies and building stock.

As for ductwork airtightness, this issue is rarely addressed despite significant energy savings and/or IAQ impacts associated. The feedback as well as energy and IAQ analyses of the recently introduced Effinergie requirements in France would be very helpful to make progress on this issue.

The paper is available at: http://aivc.org/resource/vip-37-impact-energy-policies-building-and-ductwork-airtightness

Events Calendar

- **September 18-19, 2018**: 39th AIVC –7th TightVent-5th venticool joint conference "Smart ventilation for buildings", Juan-les-Pins, France.
- **March 19-20, 2018**: AIVC Workshop "Towards higher-performing buildings: The role of airtightness and ventilation", Wellington, New Zealand.

Product news from our partners

Minneapolis BlowerDoor: The innovative DG-1000 pressure gauge

The DG-1000 convinces with its intuitive use, clear structure, and modern design. Its high-resolution touch screen and intelligent micro-processor provide you with the functions of a modern mini-computer. Users can install the latest firmware updates free of charge at any time. The DG-1000 comes equipped with an integrated WiFi module and the Software TECTITE Express 5.1 for measurements according to ISO 9972 and EN 13829. It is compatible with all presently existing BlowerDoor Measuring Systems In combination with the Minneapolis FlowBlaster System the DG-1000 allows the precise measurement of the air flow at supply and exhaust air valves to test the function of ventilation and air-conditioning systems. Further information is available at: www.blowerdoor.com

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Learn more about TightVent founding partners and new partners.

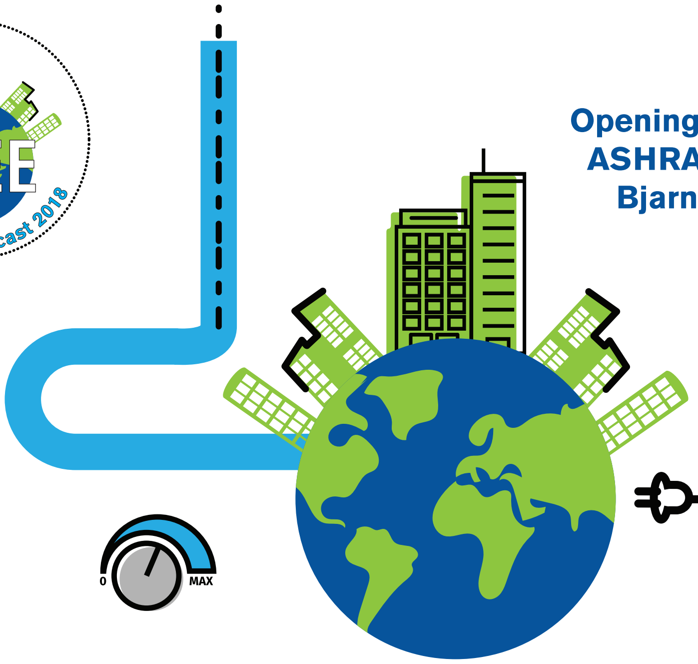
NOTES:

Making Energy Efficiency a Reality

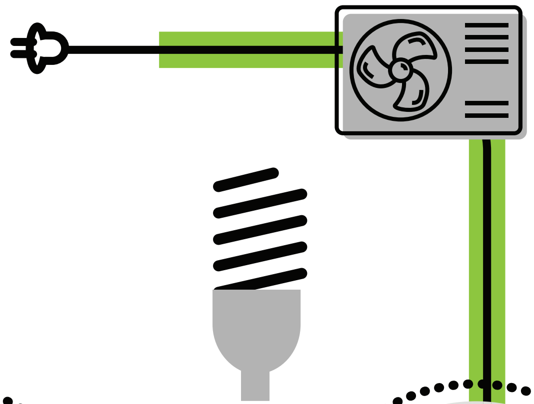
FREE ASHRAE Webcast I April 19, 2018 from 1:00 — 4:00 p.m. EDT

Watch On Demand from April 20 — May 4, 2018

Is advanced technology alone solving the case for energy efficiency?



Opening remarks by ASHRAE President Bjarne W. Olesen



Meet Our Presenters

Tom Durkin
PE, LEED AP, ASHRAE Fellow

Mark Frankel
ASHRAE, AIA, LEED Fellow

R. Christopher Mathis
ASHRAE

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What occupation within the building industry are you in?

(Please tick where appropriate)

- ☐ Builder
- ☐ Designer
- ☐ Engineer
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- ☐ Architect
- ☐ Other: ______________________ (Please specify)

Did the presenters clearly outline and explain the topic?

Unclear ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 Clearly outlined

Comments

____

How useful will the information be in your work?

Not useful ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 Very useful

Comments

____

Do you agree to contact by email or phone to discuss how the information has been used?

☐ Yes ☐ No

Were your expectations met?

☐ Not met ☐ Met ☐ Exceeded

If not, why not?

____

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____

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Was the seminar time suitable for you?

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____

Was the venue/food satisfactory?

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____

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