ANNEX 5

EBC
Energy in Building and Communities Programme

AIVC Technical Note 69
40 years to build tight and ventilate right: History of the AIVC

February 2022

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40 years to build tight and ventilate right: History of the AIVC

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Preface

The International Energy Agency

The International Energy Agency (IEA) was established in 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme. A basic aim of the IEA is to foster international cooperation among the 30 IEA participating countries and to increase energy security through energy research, development and demonstration in the fields of technologies for energy efficiency and renewable energy sources.

The IEA Energy in Buildings and Communities Programme

The IEA co-ordinates international energy research and development (R&D) activities through a comprehensive portfolio of Technology Collaboration Programmes (TCPs). The mission of the IEA Energy in Buildings and Communities (IEA EBC) TCP is to support the acceleration of the transformation of the built environment towards more energy efficient and sustainable buildings and communities, by the development and dissemination of knowledge, technologies and processes and other solutions through international collaborative research and open innovation. (Until 2013, the IEA EBC Programme was known as the IEA Energy Conservation in Buildings and Community Systems Programme, ECBCS.)

The high priority research themes in the EBC Strategic Plan 2019-2024 are based on research drivers, national programmes within the EBC participating countries, the Future Buildings Forum (FBF) Think Tank Workshop held in Singapore in October 2017 and a Strategy Planning Workshop held at the EBC Executive Committee Meeting in November 2017. The research themes represent a collective input of the Executive Committee members and Operating Agents to exploit technological and other opportunities to save energy in the buildings sector, and to remove technical obstacles to market penetration of new energy technologies, systems and processes. Future EBC collaborative research and innovation work should have its focus on these themes.

At the Strategy Planning Workshop in 2017, some 40 research themes were developed. From those 40 themes, 10 themes of special high priority have been extracted, taking into consideration a score that was given to each theme at the workshop. The 10 high priority themes can be separated in two types namely 'Objectives' and 'Means'. These two groups are distinguished for a better understanding of the different themes.

Objectives: The strategic objectives of the EBC TCP are as follows:

- reinforcing the technical and economic basis for refurbishment of existing buildings, including financing, engagement of stakeholders and promotion of co-benefits;
- improvement of planning, construction and management processes to reduce the performance gap between design stage assessments and real-world operation;
- the creation of 'low tech', robust and affordable technologies;
- the further development of energy efficient cooling in hot and humid, or dry climates, avoiding mechanical cooling if possible;
- the creation of holistic solution sets for district level systems taking into account energy grids, overall performance, business models, engagement of stakeholders, and transport energy system implications.

Means: The strategic objectives of the EBC TCP will be achieved by the means listed below:

- the creation of tools for supporting design and construction through to operations and maintenance, including building energy standards and life cycle analysis (LCA);
- benefitting from 'living labs' to provide experience of and overcome barriers to adoption of energy efficiency measures;
- improving smart control of building services technical installations, including occupant and operator interfaces;
- addressing data issues in buildings, including non-intrusive and secure data collection;
- the development of building information modelling (BIM) as a game changer, from design and construction through to operations and maintenance.

The themes in both groups can be the subject for new Annexes, but what distinguishes them is that the 'objectives' themes are final goals or solutions (or part of) for an energy efficient built environment, while the 'means' themes are instruments or enablers to reach such a goal. These themes are explained in more detail in the EBC Strategic Plan 2019-2024.

The Executive Committee

Overall control of the IEA EBC Programme is maintained by an Executive Committee, which not only monitors existing projects, but also identifies new strategic areas in which collaborative efforts may be beneficial. As the Programme is based on a contract with the IEA, the projects are legally established as Annexes to the IEA EBC Implementing Agreement. At the present time, the following projects have been initiated by the IEA EBC Executive Committee, with completed projects identified by (*) and joint projects with the IEA Solar Heating and Cooling Technology Collaboration Programme by (☼):

Annex 1: Load Energy Determination of Buildings (*)
Annex 2: Ekistics and Advanced Community Energy Systems (*)
Annex 3: Energy Conservation in Residential Buildings (*)
Annex 4: Glasgow Commercial Building Monitoring (*)
Annex 5: Air Infiltration and Ventilation Centre
Annex 6: Energy Systems and Design of Communities (*)
Annex 7: Local Government Energy Planning (*)
Annex 8: Inhabitants Behaviour with Regard to Ventilation (*)
Annex 9: Minimum Ventilation Rates (*)
Annex 10: Building HVAC System Simulation (*)
Annex 11: Energy Auditing (*)
Annex 12: Windows and Fenestration (*)
Annex 13: Energy Management in Hospitals (*)
Annex 14: Condensation and Energy (*)
Annex 15: Energy Efficiency in Schools (*)
Annex 16: BEMS 1- User Interfaces and System Integration (*)
Annex 17: BEMS 2- Evaluation and Emulation Techniques (*)
Annex 18: Demand Controlled Ventilation Systems (*)
Annex 19: Low Slope Roof Systems (*)
Annex 20: Air Flow Patterns within Buildings (*)
Annex 21: Thermal Modelling (*)
Annex 22: Energy Efficient Communities (*)
Annex 23: Multi Zone Air Flow Modelling (COMIS) (*)
Annex 24: Heat, Air and Moisture Transfer in Envelopes (*)
Annex 25: Real time HVAC Simulation (*)
Annex 26: Energy Efficient Ventilation of Large Enclosures (*)
Annex 27: Evaluation and Demonstration of Domestic Ventilation Systems (*)
Annex 28: Low Energy Cooling Systems (*)
Annex 29: ☼ Daylight in Buildings (*)
Annex 30: Bringing Simulation to Application (*)
Annex 31: Energy-Related Environmental Impact of Buildings (*)
Annex 32: Integral Building Envelope Performance Assessment (*)
Annex 33: Advanced Local Energy Planning (*)
Annex 34: Computer-Aided Evaluation of HVAC System Performance (*)
Annex 35: Design of Energy Efficient Hybrid Ventilation (HYBVENT) (*)
Annex 36: Retrofitting of Educational Buildings (*)
Annex 37: Low Exergy Systems for Heating and Cooling of Buildings (LowEx) (*)
Annex 38: ☼ Solar Sustainable Housing (*)
Annex 39: High Performance Insulation Systems (*)
Annex 40: Building Commissioning to Improve Energy Performance (*)
Annex 41: Whole Building Heat, Air and Moisture Response (MOIST-ENG) (*)
Annex 42: The Simulation of Building-Integrated Fuel Cell and Other Cogeneration Systems (FC+COGEN-SIM) (*)
Annex 43: ☼ Testing and Validation of Building Energy Simulation Tools (*)
Annex 44: Integrating Environmentally Responsive Elements in Buildings (*)
Annex 45: Energy Efficient Electric Lighting for Buildings (*)
Annex 46: Holistic Assessment Tool-kit on Energy Efficient Retrofit Measures for Government Buildings (EnERGo) (*)
Annex 47: Cost-Effective Commissioning for Existing and Low Energy Buildings (*)
Annex 48: Heat Pumping and Reversible Air Conditioning (*)
Annex 49: Low Exergy Systems for High Performance Buildings and Communities (*)
Annex 50: Prefabricated Systems for Low Energy Renovation of Residential Buildings (*)
Annex 51: Energy Efficient Communities (*)
Annex 52: ☼ Towards Net Zero Energy Solar Buildings (*)
Annex 53: Total Energy Use in Buildings: Analysis and Evaluation Methods (*)
Annex 54: Integration of Micro-Generation and Related Energy Technologies in Buildings (*)

Annex 55: Reliability of Energy Efficient Building Retrofitting - Probability Assessment of Performance and Cost (RAP-RETRO) (*)
Annex 56: Cost Effective Energy and CO_2 Emissions Optimization in Building Renovation (*)
Annex 57: Evaluation of Embodied Energy and CO_2 Equivalent Emissions for Building Construction (*)
Annex 58: Reliable Building Energy Performance Characterisation Based on Full Scale Dynamic Measurements (*)
Annex 59: High Temperature Cooling and Low Temperature Heating in Buildings (*)
Annex 60: New Generation Computational Tools for Building and Community Energy Systems (*)
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Working Group - Energy Efficiency in Educational Buildings (*)
Working Group - Indicators of Energy Efficiency in Cold Climate Buildings (*)
Working Group - Annex 36 Extension: The Energy Concept Adviser (*)
Working Group - HVAC Energy Calculation Methodologies for Non-residential Buildings (*)
Working Group - Cities and Communities
Working Group – Building Energy Codes

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1. Introduction

As the AIVC was created in 1979, the 40th anniversary of the AIVC was celebrated in October 2019 at the 40th AIVC conference in Ghent. In the context of this celebration, it was decided to publish 2 overview publications:

- An AIVC technote, focusing on the main technical areas of AIVC involvement during the past 40 years
- This publication, which focuses on the overall history of the AIVC and those involved in the organisation

This report provides information about the history of AIVC, its events and publications, its member countries and board members and collaborations with other organisations.

2. AIVC as an IEA EBC information centre on energy efficient ventilation

2.1. The International Energy Agency IEA

The International Energy Agency (IEA) was established in 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme. A basic aim of the IEA is to foster international co-operation among the 30 IEA member countries and 8 association countries and to increase energy security through energy research, development and demonstration in the fields of technologies for energy efficiency and renewable energy sources.

2.2. The IEA Energy in Buildings and Communities Programme (IEA EBC)

The IEA co-ordinates international energy research and development (R&D) activities through a comprehensive portfolio of Technology Collaboration Programmes. The mission of the Energy in Buildings and Communities (EBC) Programme is to develop and facilitate the integration of technologies and processes for energy efficiency and conservation into healthy, low emission, and sustainable buildings and communities, through innovation and research. (Until March 2013, the IEA-EBC Programme was known as the Energy in Buildings and Community Systems Programme, ECBCS.) The research and development strategies of the IEA-EBC Programme are derived from research drivers, national programmes within IEA countries, and the IEA Future Buildings Forum Think Tank Workshops.

The research and development (R&D) strategies of IEA-EBC aim to exploit technological opportunities to save energy in the buildings sector, and to remove technical obstacles to market penetration of new energy efficient technologies.

The current R&D strategies apply to residential, commercial, office buildings and community systems, and will impact the building industry in five focus areas for R&D activities:

1. Integrated planning and building design
2. Building energy systems
3. Building envelope
4. Community scale methods
5. Real building energy use

2.3. AIVC as one of the annexes of IEA EBC

Since its creation in 1974 until 2021, the executive committee of IEA EBC has approved 86 projects (called annexes). Each project has a typical duration of 3 to 4 years. The only exception is the AIVC, which was the 5th approved project and which has been running since 1979.

3. Context for setting up annex 5

The IEA implementing programme on energy conservation in buildings and community systems (IEA ECBCS) started in 1977 with its first project being “Annex 1 Load/Energy Determination of Buildings”. The operating agents were Energy Research and Development Administration USA and Oscar Faber UK (1977-1980).

In this project, representatives from eight countries, working with 19 different computer programs, assessed the ability of computer models to simulate the thermal load and energy requirements of commercial buildings. One of their findings was that mechanical ventilation could be implemented easily in these models air infiltration energy loss was a significant and the most uncertain variable.

For that reason, Energy Research and Development Administration USA made an urgent request to the International Energy Agency (IEA) Energy Conservation in Buildings and Community Systems (ECBCS) to organize a workshop to find solutions for the problems of the models used in Annex 1.

- This workshop took place in Paris in 1978.
- Prior to the workshop there was a small seminar in Switzerland (Rapperswill) (Editor Howard Ross, DOE USA and P. Hartmann EMPA Switzerland.
- after the Paris workshop was held over 3 days and was attended by 25 researchers from countries all over the world. Many actions were formulated, one of which was the need for international cooperation in the field of understanding air infiltration into buildings since this parameter was a significant unknown.
- From the outcome of this workshop a very unique IEA Draft Program Plan "Air infiltration in buildings" was published. This was Edited by Howard Ross, DOE US with contributions by Willem de Gids, D. Grimsrud, C.M. Hunt, L. Nevander, George Tamura and U.U. Wanner).

From this action evolved the 5th project of the IEA ECBCS known as “Annex 5 - Air infiltration Centre” (AIC). The main goals were to:

- Disseminate existing knowledge on air infiltration
- To co-ordinate international research in the field
- To improve the knowledge on air infiltration
- To investigate and compare numerical models of air infiltration using a compiled database of measurement data.
- To establish an international bibliographic database of air infiltration

The preparation phase in 1978 resulted in the willingness of 8 countries to form the Air Infiltration Centre as a cost sharing [1] annex, whereby each participating country contributed financially towards a central staff working in the AIC.

Oscar Faber Consulting Engineers in the UK (David Curtis) was appointed operating agent and the Centre was hosted at the Building Services Research and Information Association (BSRIA) in the UK. The aim was to appoint 3 to 5 staff at the AIC to carry out the work.

[1] Cost sharing means that all countries pay a certain amount of money in a fund and together they try to spend that money as efficient as possible. Cost sharing is the counter part of task sharing, where each country promise at the start of the project to deliver a certain man month of work.

4. Evolutions in AIVC scope between 1979-2020

One of the Centre's first activities was to organise an international conference. This, the first the Centres's annual conferences, was held in Windsor Park Berkshire UK October 1980, with the theme "Air Infiltration Instrumentation and Measuring Techniques". In total, there were 30 participants representing all 8 participating countries.

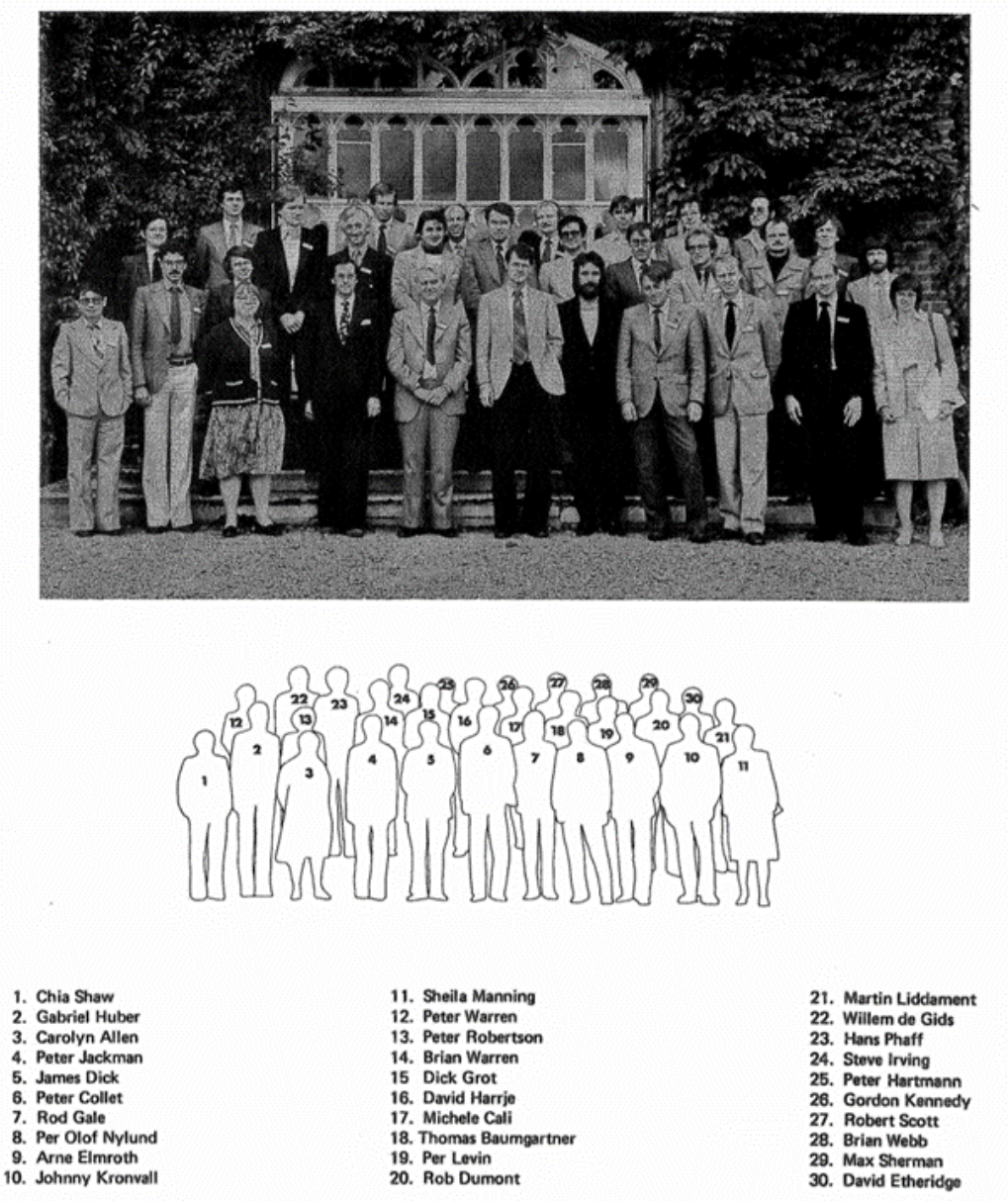


Figure 1. Participants of the 1st AIVC conference - Windsor Park Berkshire UK, October 1980.

Many old faces can be recognised but just two are still active in AIVC in 2021.

A primary output of the AIC was the production technical notes. Important Technical Notes included:

- TN 1: Air Infiltration Instrumentation and Measuring Techniques, Proceedings of the 1st AIC conference

- TN 2: Building Design for Minimum Air Infiltration, Proceedings of the 2nd AIC Conference

The focus on minimising energy consumption for the heating of air in relation to airtight construction methods was the most important item in the AIC's program during its first ten years. Securing building airtight to control air infiltration was seen as a cornerstone in achieving building energy efficiency. The second AIC conference "Building Design for Minimum Infiltration" in Stockholm, Sweden was hence a logical step. A subsequent step was the production of a Guide which soon became the 'Bible' of building airtightness construction techniques and was published as:

- TN 3: Air Infiltration Control in Housing – A guide to International Practice This publication was compiled and written by the Swedish delegation who had already much experience in the airtight construction of houses.

An early requirement, identified within the Centre, was needed to produce an agreed glossary of terms and definitions. A common language and vocabulary were a necessity to understand each other during meetings and to understand the ins and outs of each other's reports and publications. This resulted in the publication of two Technical Notes:

- TN5: Air Infiltration Glossary. The main glossary of terminology was published in English, as TN 5, with subsequent translation supplements **in** German, French, Italian & Dutch.
- TN 6: Reporting format for the measurement of air infiltration in buildings. This publication, as with TN 5, resulted in better communication and understanding between AIC partners.

The research community discovered that good mathematical models for air infiltration were a necessity. Initially, effort was associated with identifying and assessing the performance of models. It was also necessary to identify sources of measurement data that could be used in the assessment of mathematical models. Resultant publications included:

- TN 4: Instrumentation for the measurement of air infiltration- An annotated bibliography. Identifying the measurements needed for model evaluation and the techniques used in making measurements marked the start of the assessment activity. This report outlines some of the sources.
- TN 9: Mathematical models of air infiltration - a brief review and bibliography. This report provided the foundation for model assessment.
- TN 11: The Validation and Comparison of Mathematical Models of Air Infiltration . This Technical note introduced the AIC's model validation study in which selected mathematical air infiltration computer model results were compared with measurement data. This showed that many had good correlation (within 20% of measurement). It also identified a need to improve the assessment of wind pressure acting on buildings and emphasized the need for a good understanding of total building airtightness.
- TN 13: Wind Pressure Data Requirements for Air Infiltration Calculations. Following on from TN 11, wind pressure data was identified as a significant but uncertain parameter. Most wind pressure data, in existing literature, were for constructional strength of buildings focussing on extremes. To understand infiltration and ventilation, average wind pressure data and the distribution over the envelope were needed. A basic database of approximate wind coefficients was developed based on data published in the literature.
- TN13.1 Wind Pressure Workshop – Proceedings. The AIC analysis on wind pressure was supported by an international wind pressure workshop held in Wellington, New Zealand.

In 1984 on the Centre undertook a review of related building airtightness, air infiltration and ventilation standards. This marked the beginning of the AIC's interest in standards. Relevant Technical Notes included:

- TN 14: "A Review of Building Airtightness and Ventilation Standards" (1984)
- TN 30: "A Review of Building Airtightness and Ventilation Standards" (1990)

By 1986, awareness that ventilation and infiltration could no longer be seen as separate phenomenon resulted, in the change of the name of Annex 5 from the Air Infiltration Centre (AIC) to the Air Infiltration and Ventilation Centre (AIVC).

1988 marked the start the Centre's first formal cooperation with associated IEA Annexes and International projects. Joint technical notes included:

- TN 23: IEA Annex VIII 'Inhabitants Behaviour with respect to Ventilation . This report addressed the way that occupants interacted with ventilation systems.
- TN 26: "IEA Annex 1X Minimum Ventilation Rates and Measures for Controlling Indoor Air Quality"
- TN 29: "Fundamentals of the Multizone Air Flow Model -COMIS" was published in 1990. This publication was the result of co-operation between a number of AIVC countries to develop a new innovative multizone air infiltration and ventilation model. The idea came from Max Sherman who during a workshop in Wellington (New Zealand) in 1987 launched a proposal to bring leading infiltration specialists for one year together in

his lab in Berkeley to develop a new ventilation model code and led to Annex 23. Ten specialists from around the world worked for more than one year on this code.

Throughout the 1990's the AIVC invited several visiting specialists from other AIVC countries to work at the Centre in Warwick on certain areas of interest. Participants and resultant publications included:

- TN 27: Infiltration and Leakage Paths In Single Family Houses - A Multizone Infiltration Case Study (Mark Bassett, BRANZ, New Zealand).
- TN 28: A guide to air change efficiency (Helen Sutcliffe, Coventry University, UK)
- TN 32: Reporting guidelines for the measurement of airflows and related factors in buildings (David Harrje, Princeton University, USA).
- TN 35: Advanced Ventilation Systems-State of the Art and Trends (Bas Knoll, TNO, The Netherlands).
- TN 41: Infiltration data from the Alberta Home Heating Research Facility (David Wilson and Iain Walker University of Alberta, Canada).
- TN 47: Energy requirements for conditioning of ventilating air (Don Colliver, University of Kentucky, USA).
- TN 50: Ventilation technology in large non-domestic buildings (Donald Dickson, UK).

By the late 1980s, broader areas of ventilation heat and heat transfer mechanisms were considered, including ventilation heat recovery and ventilative cooling methods. Another issue covered the impact of ventilation on overheating especially in relation to insulation, airtightness and poor solar control. Associated publications included:

- TN 35: Advanced Ventilation Systems-State of the Art and Trends.
- TN 40: An overview of combined modelling of heat transport and air movement.
- TN 45: Air-to-Air Heat Recovery in Ventilation (1988).
- TN 48: The Role of Ventilation in Cooling Non-Domestic Buildings was published in (1996). This Publication was written by Steve Irving, using his knowledge of the consulting work on this topic, taking place at Oscar Faber Consulting Engineers where he was a director. Steve was also a former Operating Agent of the AIVC.

In the 1980s and 90s The AIVC became an international reference portal for ventilation and airtightness related data. These data were used to assist in the production of a number of guides including:

- **1986** Air Infiltration and Calculation Techniques: An Applications Guide
- **1988** Air exchange rate and airtightness measurement techniques - An application guide
- **1996** A Guide to Energy Efficient Ventilation
- **1990** A Guide to Air Change Efficiency, published as **TN 28**
- **1991** A Guide to Contaminant Removal Effectiveness, published as **TN 28.2**

These Guides drew attention to the relationship between ventilation and indoor air quality. No longer could ventilation and air infiltration be considered solely as an energy concern, energy efficient ventilation also had to address indoor air quality. Even in 2020 the Guide to Energy Efficient Ventilation is still a very valuable document. It shows how AI(V)C became more and more involved in understanding the process of infiltration, ventilation and air quality issues.

Since 2000, new topics have received specific interest in the context of the AIVC activities, e.g.:

- Indoor air quality and IAQ metrics
- Increase importance of building regulations with respect to ventilation and airtightness performances. In particular in Europe, the Energy Performance of Buildings directive has been a major driver.
- Quality aspects related to ventilation systems
- Quality aspects of building and ductwork airtightness, including durability issues
- Optimisation of energy efficiency of ventilation systems
- Smart control of ventilation

Since 2010, the concept of AIVC projects has been implemented, whereby the AIVC board agrees on specific projects resulting in a range of outcomes, e.g.:

- Publications (Technotes, Ventilation Information Papers)
- Topical sessions at conferences
- Webinars
- Workshops
- Newsletters & Newsletters special issues

The following AIVC projects can be mentioned:

- Testing, reporting and quality schemes for building airtightness (2011-2013)
- Ventilative cooling (2012-2013)
- Improving the quality of residential ventilation systems (2012-2013)
- Ventilation and health (2012-2016)
- Competent tester schemes for building airtightness (2012-today)
- Quality of methods for measuring ventilation and infiltration in buildings (2013-2014)
- Cooker hoods in residential buildings (2014-today)
- Utilization of heat recovery in residential ventilation systems (2016-2020)
- Rationale behind ventilation requirements and regulations (2016-today)
- Smart Ventilation (2017-2018)
- Integrating uncertainties due to wind and stack effect in declared airtightness results (2017-today)
- Indoor Air Quality-IAQ metrics (2017-today)
- 40 Years of AIVC (2018-today)
- Ventilation, airtightness and COVID-19 (2021-2021)
- Temperature take-back effect in the context of energy efficient ventilation strategies (2020-today)

Strengthening of collaboration with other networks and projects has become more and more a key priority for the AIVC. See §6 and §7.

In terms of communication and dissemination, there has been a permanent attention to increase outreach while optimising the cost. Examples are:

- The first AIVC website was launched in 1995. The website has been regularly updated, with a major update in the spring of 2021.
- Printed publications have been replaced by distribution of publications on a CD-ROM (2001 – 2010) and later replaced by full internet access.
- AIRBASE has been fully digitalised and is since 2020 accessible free of charge
- The role of social media is becoming more and more important
- Webinars are frequently organised.
- Regular AIVC newsletter

5. Evolutions in AIVC operation mode between 1979-2019

5.1. 1979-2000

The Air Infiltration Centre started in 1979 at the Building Services Research and Information Association (BSRIA) in Bracknell, Berkshire UK with Peter Jackman as head of centre and quickly followed by Martin Liddament as senior scientist. The operating agent for Annex 5 was Oscar and Faber consultants UK where David Curtis led this project. By 1980 the Centre had 5 members of staff. All participating countries paid on the basis of their brut national product (BNP) a financial contribution.

The number of participating countries at the start-up was 8, Canada, Denmark, Italy, Netherlands, Sweden, Switzerland United Kingdom and United States of America. All the participating countries had a representative in the Steering Group, which met twice yearly. The ambition of the Steering Group was to have a yearly conference in autumn and, if possible, a workshop in spring.

In 1986 the name was changed in the Air Infiltration and Ventilation Centre. Shortly after, in 1988, the centre relocated under the same operating agent from BSRIA Bracknell to the University of Warwick Science Park in Coventry UK, Martin Liddament became Head of Centre. In the meantime, a number of countries joining the centre increased with the addition of five further countries: Belgium, Germany, Finland, New Zealand and Norway. In 1990 France joined the AIVC and Greece joined in 1997.

5.2. 2001-2020

The approach of having a central staff of 5…6 persons paid by the AIVC member countries appeared in 1998…2000 to become too expensive for most member countries. The member contribution fees were function of the GDP of the country and ranged from 6 to 54 k£/year. It was clear that a continuation on this basis was not evident.

In 1999-2000, several organisations discussed the possibility for setting up a new organisation which had as first objective to run the AIVC activities, with the following boundary conditions:

- Substantially lower membership fees for the participating countries
- Financial contributions from the members of the new organisations
- More active involvement of member countries in the creation of deliverables.

This approach was adopted by the AIVC steering committee and formally approved by the IEA EBC ExCo meeting in November 2000.

As a result, the new organisation INIVE EEIG was set up and has been operating agent since 2001 until now.

There have been evolutions in the membership of INIVE. The present members are:

1. BBRI
2. CETIAT
3. CSTB
4. IBP Fraunhofer
5. NKUA
6. Sintef
7. TNO
8. PoLiMi (associated member)

INIVE EEIG has been running various platforms and projects, including the following projects:

- The European BUILDUP platform was operated on behalf of the European Commission by INIVE EEIG from 2006 till 2017. (www.buildup.eu)
- TightVent (www.tightvent.eu)

- Venticool (www.venticool.eu)
- Dynastee www.dynastee.info
- Several European projects:
  - ASIEPI
  - QualichEck
  - EPBD 19a contract for DG Energy
- INIVE EEIG is also, on behalf of AIVC, the legal representative in IEQ-GA.

6. Collaborations with other organisations and projects

Collaborations with organisations and projects is a key element in the AIVC strategy, as this allows to increase the impact and outreach of the AIVC activities and the activities of the others.

6.1. TightVent Europe 'Building and Ductwork Airtightness Platform'

The TightVent Europe 'Building and Ductwork Airtightness Platform' (https://tightvent.eu/) was launched in January 2011. It aims at facilitating exchanges and progress on building and ductwork airtightness issues, including the production and dissemination of policy oriented reference documents and the organization of conferences, workshops, webinars, etc.

TightVent Europe has been initiated by INIVE EEIG (International Network for Information on Ventilation and Energy Performance) with the technical and financial support of the following partners: Lindab, MEZ-TECHNIK, Retrotec, BlowerDoor GmbH, Eurima, Soudal, Gonal, SIGA, ACIN Instrumenten, Buildings Performance Institute Europe, the European Climate Foundation, Tremco illbruck, Wienerberger and the Covenant of Mayors for Climate & Energy.

The collaboration between the TightVent Europe platform and AIVC is at various levels:

- Joint organisation of the annual conference
- Organisation of topical sessions at the conference
- Co-organisation of webinars
- TightVent has a particular focus on market implementation aspects of building and ductwork airtightness, whereas AIVC has a strong focus on the more scientific aspects.

6.2. Venticool platform

Venticool is the international ventilative cooling platform (https://venticool.eu/) 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. In 2020, venticool decided to broaden its scope towards resilient ventilative cooling. The platform supports better guidance for the appropriate implementation of resilient 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. Venticool joins forces with international projects (in particular IEA EBC annexes 62 (ventilative cooling) and, more recently, annex 80 (Resilient cooling for buildings)) and organizations with significant experience and/or well identified in the field of ventilation and thermal comfort like AIVC (www.aivc.org) and REHVA (www.rehva.eu).

The platform has been initiated by INIVE EEIG with (International Network for Information on Ventilation and Energy Performance) with the financial and/or technical support of its partners: Agoria-NAVENTA, Velux, WindowMaster, Reynaers, CIBSE, ES-SO, the Covenant of Mayors for Climate & Energy and REHVA.

The collaboration between the venticool platform and AIVC is at various levels:

- Joint organisation of the annual conference
- Organisation of topical sessions at the conference
- Co-organisation of webinars

6.3. ASHRAE

ASHRAE (https://www.ashrae.org/) , founded in 1894, is a global society, advancing human well-being through sustainable technology for the built environment. The Society 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. ASHRAE was formed as the American Society of Heating, Refrigerating and Air-Conditioning Engineers by the merger in 1959 of American Society of Heating and Air-Conditioning Engineers (ASHAE) founded in 1894 and The American Society of Refrigerating Engineers (ASRE) founded in 1904.

In 2012, as part of a rebranding, ASHRAE began doing business as "ASHRAE" vs. using its full legal name of the American Society of Heating, Refrigerating and Air-Conditioning Engineers. Use of ASHRAE reflects the Society's worldwide membership and that services will continue evolving globally.

AIVC and ASHRAE were co-organiser of the 2016 conference in Alexandria (USA). It was also planned to co-organise the 2020 AIVC conference in Athens (Greece), but due to the pandemic, the conference was first postponed to October 2021 and then to May 2022.

6.4. REHVA

REHVA (https://www.rehva.eu/), The Federation of European Heating, Ventilation and Air Conditioning associations founded in 1963, is an umbrella organization that represents over 120,000 HVAC designers, building services engineers, technicians and experts across 27 European Countries.

REHVA is dedicated to the improvement of the health, comfort and energy efficiency in all buildings and communities. The association provides its members with a strong platform for international professional networking, and knowledge exchange pursuing the vision of improving health, comfort, safety and energy efficiency in all buildings and communities. It follows EU policy developments and represents the interests of its members in Europe and worldwide.

This is achieved through the exchange of technical information, practical experience and research results by REHVA's working groups, seminars, publications and journal.

AIVC and REHVA have signed a Memo of Understanding, whereby both organisations have agreed on various collaborative activities.

REHVA has produced several editions of the REHVA journal with a special focus on outcomes of the AIVC conferences.

6.5. EPIC

The European Conferences on Energy Performance and Indoor Climate were organised in 1994, 1998, 2002 and 2006 and held in Lyon, France.

The 2002 and 2006 editions were combined with the 23rd and 27th AIVC conference.

6.6. International Journal on Ventilation

The International Journal on Ventilation (IJV) is a peer reviewed journal aimed at providing the latest information on research and application. It focuses on the development and application of ventilation, including measurement techniques, driving forces, energy issues, performance and strategies.

Topics include:

- New ideas concerned with the development or application of ventilation;
- Validated case studies demonstrating the performance of ventilation strategies;
- Information on needs and solutions for specific building types including: offices, dwellings, schools, hospitals, parking garages, urban buildings and recreational buildings etc;
- Developments in numerical methods;
- Measurement techniques;
- Related issues in which the impact of ventilation plays an important role (e.g. the interaction of ventilation with air quality, health and comfort);
- Energy issues related to ventilation (e.g. low energy systems, ventilation heating and cooling loss);
- Driving forces (weather data, fan performance etc.).

Special editions covering specific topics, collaborative research projects and conferences are also produced.

IJV has produced several editions of the IJV journal with a special focus on outcomes of the AIVC conferences.

6.7. IEQ-GA

The Indoor Environmental Quality – Global Alliance (IEQ-GA) was initiated by six (6) member organizations (AIHA, AIVC, ASHRAE, AWMA, IAQA & REHVA) in 2014 with the signing of a Memorandum of Understanding (MOU).

The member organizations now include: the American Conference of Governmental Industrial Hygienists (ACGIH®), AiCARR (Associazione Italiana Condizionemento dell'Aria, Riscaldamento e Refrigerazione), the American Industrial Hygiene Association (AIHA), the Air Infiltration and Ventilation Centre (AIVC), the Acoustical Society of America (ASA), the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), the Federation of Ibero-American Air Conditioning and Refrigeration Associations (FAIAR), the Federation and Association of the Interior Environment throughout Spain and Andorra (FEDECAI), the Institute of Inspection Cleaning and Restoration Certification (IICRC), the Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE), the Federation of European Heating, Ventilation and Air Conditioning Associations (REHVA), The Maine Indoor Air Quality Council & the Society for Indoor Environment (SIE). The mission of IEQ-GA is to provide a scientific and technical basis for an acceptable indoor environmental quality (thermal environment; indoor air quality; lighting; acoustic; etc.) to occupants in buildings and places of work around the world, and to make sure the knowledge from research on IEQ is implemented in practice by engineers and practitioners.

The objective of the IEQ-GA is to get the member organizations to think together, work together and speak with the same voice. Our emphasis is on communications, coordination, cooperation and collaboration between the member organizations on indoor environmental quality issues. The alliance is formed as an interdisciplinary, international working group of member organizations interested in indoor air quality, thermal comfort, lighting and acoustic science, technology, and applications to stimulate activities that will help in a significant way to improve the actual delivered indoor environmental quality in buildings.

The AIVC secretariat is in charge of the website www.ieq-ga.net.

7. Interaction with IEA EBC annexes

Since the establishment of AIC Annex 5, the AIVC had interactions with a whole range of annexes in IEA EBC. The most important annexes with interaction are the following:

– Inhabitant behaviour with regard to ventilation	Annex 8
– Minimum ventilation rates	Annex 9
– Condensation and Energy	Annex 14
– Demand Controlled Ventilation Systems	Annex 18
– Air Flow Patterns within Buildings	Annex 20
– Multizone air flow modelling	Annex 23
– Energy Efficient Ventilation of Large Enclosures	Annex 26
– Evaluation of Domestic Ventilation Systems	Annex 27
– Hybrid Ventilation	Annex 35
– Whole Building Heat, Air and Moisture Response	Annex 41
– Integrating Environmentally Responsive Elements in Buildings	Annex 44
– Ventilative Cooling	Annex 62
– Design and Operational Strategies for High IAQ in Low Energy Buildings	Annex 68
– Strategy and Practice of Adaptive Thermal Comfort in Low Energy Buildings	Annex 69
– Competition and living lab Platform	Annex 74
– Supplementing Ventilation with Gas-phase Air Cleaning, Implementation and Energy Implications	Annex 78
– Resilient cooling of buildings	Annex 80
– Energy Efficient Indoor Air Quality Management in Residential Buildings	Annex 86

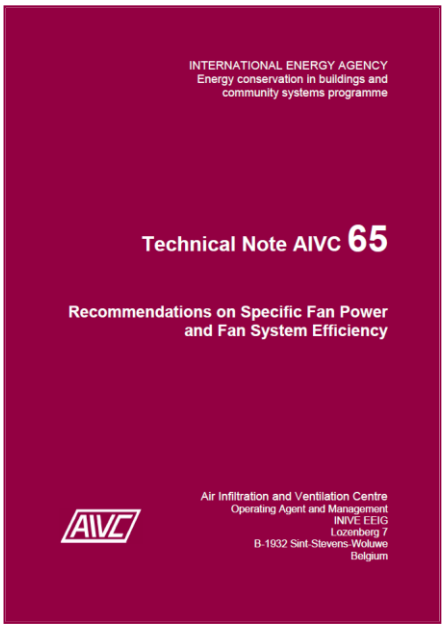
8. AIVC publications

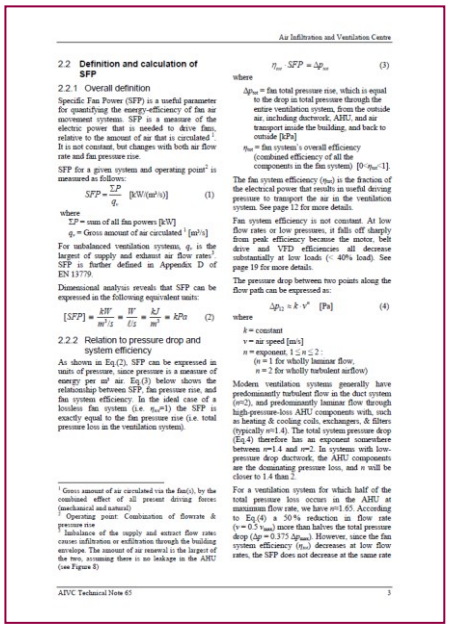
The AIVC publications include:

1. Technical notes
2. Ventilation Information papers (VIP)
3. Annotated bibliographies
4. Guides and handbooks
5. Contributed reports
6. Literature lists
7. Conference proceedings
8. AIRBASE – bibliographic database
9. Newsletters

8.1. AIVC technical notes

The AIVC's collection of technical notes deals with various subjects including ventilation, infiltration, indoor air movement, and measurement techniques.

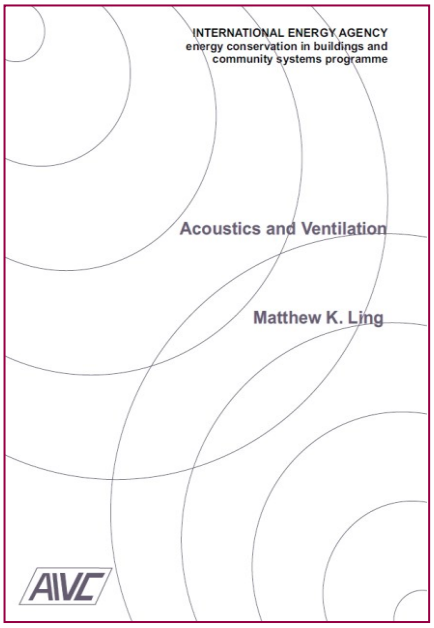


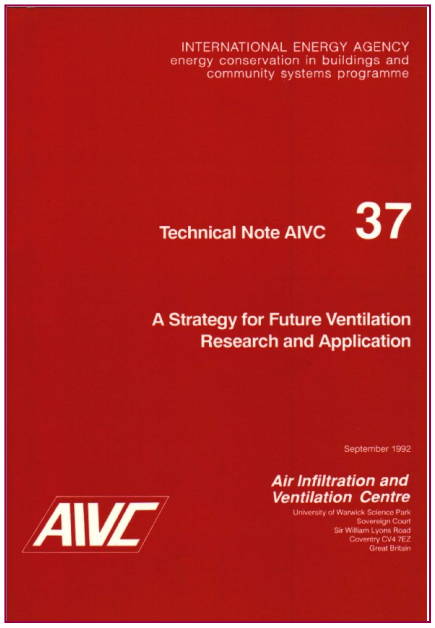


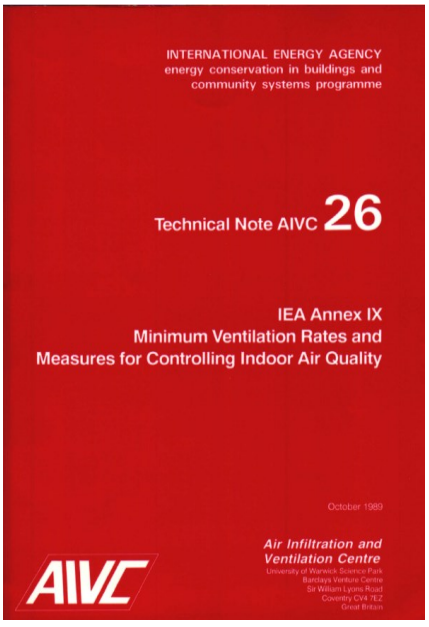
2016	TN 68	Residential Ventilation and Health
2012	TN 67	Building airtightness: a critical review of testing, reporting and quality schemes in 10 countries
2012	TN 66	Building air leakage databases in energy conservation policies: analysis of selected initiatives in 4 European countries and the USA
2009	TN 65	Recommendations on Specific Fan Power and Fan System Efficiency
2007	TN 64	Ventilation in Korea
2008	TN 63	Ventilation in the Czech Republic
2007	TN 62	Energy and Indoor Environmental Quality of Low Income Households
2007	TN 61	Natural and Hybrid Ventilation in the Urban Environment

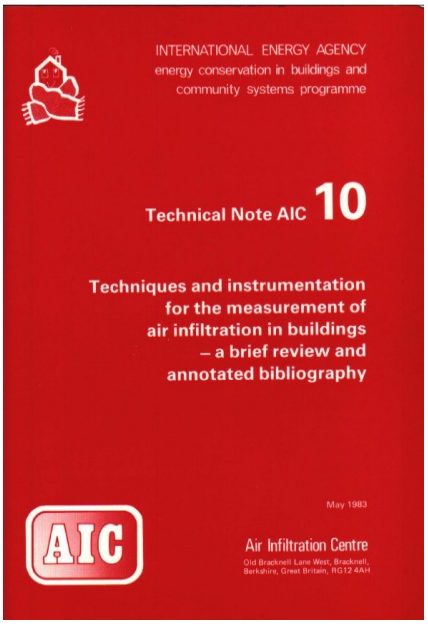
2006	TN 60	Efficacy of Intermittent Ventilation for Providing Acceptable Indoor Air Quality
2005	TN 59	Parameters for the design of demand controlled hybrid ventilation systems for residential buildings
2003	TN 58	Reducing Indoor Residential Exposures to Outdoor Pollutants
2002	TN 57	Residential ventilation
2002	TN 56	A Review of International Literature Related to Ductwork for Ventilation Systems
2001	TN 55	A review of international ventilation, airtightness, thermal insulation and in door air quality criteria
2001	TN 54	Residential passive ventilation systems: Evaluation and design
2001	TN 53	Occupant impact on ventilation
2001	TN 52	Acoustics and ventilation
1999	TN 51	Applicable Models for Air Infiltration and Ventilation Calculations
1998	TN 50	Ventilation technology in large non-domestic buildings
1998	TN 49	Energy impact of ventilation: estimates for the service and residential sectors
1997	TN 48	The role of ventilation in cooling non-domestic buildings
1995	TN 47	Energy requirements for conditioning of ventilating air
1995	TN 46	Survey of current research into air infiltration and related air quality problems in buildings
1994	TN 45	Air to air heat recovery in ventilation
1994	TN 44	Numerical Data for Air Infiltration and Natural Ventilation Calculations (replaced by Guide GU05)
1994	TN 43	Ventilation and building airtightness: an international comparison of standards, codes of practice and regulations. (replaced by TN55)
1994	TN 42	Current ventilation and air conditioning systems and strategies
1993	TN 41	Infiltration data from the Alberta Home Heating Research Facility
1993	TN 40	An overview of combined modelling of heat transport and air movement
1993	TN 39	A review of ventilation efficiency
1992	TN 38	AIRGUIDE - Guide to the AIVC's Bibliographic Database
1992	TN 37	A Strategy for Future Ventilation Research and Application
1992	TN 36	Air Infiltration and Ventilation Glossary
1992	TN 35	Advanced Ventilation Systems - State of the Art and Trends
1991	TN 34	Air flow patterns within buildings: measurement techniques
1991	TN 33	A Review of Building Air Flow Simulation
1991	TN 32	Reporting guidelines for the measurement of airflows and related factors in buildings
1990	TN 31	1990 Survey of Current Research into Air Infiltration and Related Air Quality Problems in Buildings
1990	TN 30	A Review of Building Airtightness and Ventilation Standards
1990	TN 29	Fundamentals of the multizone air flow model - COMIS
1991	TN 28.2	A guide to contaminant removal effectiveness

1990	TN 28	A guide to air change efficiency
1990	TN 27	Infiltration and Leakage Paths In Single Family Houses - A Multizone Infiltration Case Study
1989	TN 26	IEA Annex IX: Minimum ventilation rates and measures for controlling indoor air quality
1989	TN 25	A subject analysis of the AIVC's bibliographic database - AIRBASE (6th edition)
1988	TN 24	AIVC measurement techniques workshop: proceedings and bibliography
1988	TN 23	Inhabitant Behaviour with Respect to Ventilation - A Summary Report of IEA Annex VIII
1987	TN 21	A Review and Bibliography of Ventilation Effectiveness - Definitions, Measurements, Design and Calculation
1987	TN 20	Airborne moisture transfer: New Zealand workshop proceedings and bibliographic review









1986	TN 19	TN 19: 1986 Survey of Current Research into Air Infiltration and Related Air Quality Problems in Buildings

1986	TN 18	TN 18: A subject analysis of the AIC's bibliographic database - AIRBASE (4th edition)
1985	TN 17	Ventilation Strategy - A Selected Bibliography
1985	TN 16	Leakage Distribution in Buildings
1984	TN 15	A subject analysis of the AIC's bibliographic database - AIRBASE (3rd edition)
1984	TN 14	A review of building airtightness and ventilation standards
1984	TN 13.1	Wind Pressure Workshop - Proceedings
1984	TN 13	Wind Pressure Data Requirements for Air Infiltration Calculations
1983	TN 12	1983 Survey of Current Research into Air Infiltration and Related Air Quality Problems in Buildings
1983	TN 11	The Validation and Comparison of Mathematical Models of Air Infiltration
1983	TN 10	Techniques and instrumentation for the measurement of air infiltration in buildings
1982	TN 09	Mathematical models of air infiltration - a brief review and bibliography
1982	TN 08	A subject analysis of the AIC's bibliographic database - AIRBASE (2nd edition)
1981	TN 06	Reporting format for the measurement of air infiltration in buildings
1988	TN 05.4	Air Infiltration Glossary - Dutch
1984	TN 05.3	Air Infiltration Glossary - Italian
1984	TN 05.2	Air Infiltration Glossary - French
1983	TN 05.1	Air Infiltration Glossary - German
1981	TN 05	Air Infiltration Glossary (Replaced by TN 36)
1981	TN 04	Instrumentation for the measurement of air infiltration- An annotated bibliography
1983	TN03	Air infiltration Control in Housing - A Guide to International Practice
1981	TN02	Building Design for Minimum Air Infiltration Proceedings of the 2nd AIC Conference
1980	TN 01	Air Infiltration Instrumentation and Measuring Techniques, Proceedings of the 1st AIC conference

8.2. Ventilation information papers

Ventilation Information Papers (VIP) are a series of short AIVC publications (6 to 8 pages) intended for giving a basic knowledge of some aspects related to the air infiltration and/or the ventilation.

2021	VIP 44	Residential Cooker Hoods
2021	VIP 43	Residential ventilation and health
2021	VIP 42	The Concept for Substituting Ventilation by Gas Phase Air Cleaning
2021	VIP 41	Impact of wind on the airtightness test results
2020	VIP 40	Ductwork airtightness - A review
2019	VIP 39	A review of performance-based approaches to residential smart ventilation
2018	VIP 38	What is smart ventilation?

2017	VIP 37	Impact of Energy Policies on Building and Ductwork Airtightness
2017	VIP 36	Metrics of Health Risks from Indoor Air
2017	VIP 35	Ventilative Cooling. State-of-the-art review executive summary
2010	VIP 34	Needs and methods for ductwork cleaning in France
2010	VIP 33	CO2 as indicator for the indoor air quality - General principles
2010	VIP 32	Hybrid Ventilation
2009	VIP 31	Humidity Controlled Exhaust Ventilation in Moderate Climate
2008	VIP 30	An overview of national trends related to innovative ventilation systems
2008	VIP 29	An overview of national trends in envelope and ductwork airtightness
2008	VIP 28	IAQ and Ventilation Efficiency with Respect to Pollutants Inside Automobiles
2008	VIP 27	Trends in the Czech building ventilation market and drivers for change
2008	VIP 26	Trends in the Korean building ventilation market and drivers for change
2008	VIP 25	Trends in the Japanese building ventilation market and drivers for changes
2008	VIP 24	Trends in the Polish building ventilation market and drivers for changes
2008	VIP 23	Trends in the Brazilian building ventilation market and drivers for changes
2008	VIP 22	Trends in the US building ventilation market and drivers for changes
2008	VIP 21	Trends in the Norwegian building ventilation market and drivers for changes
2008	VIP 20	Trends and drivers in the Finnish ventilation and AC market
2008	VIP 19	Trends in the French building ventilation market and drivers for change
2008	VIP 18	Trends in the Belgian building ventilation market and drivers for change
2008	VIP 17	Trends in the building ventilation market in England and drivers for change


Ventilation Information Paper n° 18
May 2008
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International Energy Agency
Energy Conservation in Buildings and Community Systems Programme
Air Infiltration and Ventilation Centre
Trends in the Belgian building ventilation market and drivers for change
P. Wouters, N. Heijmans, C. Delmotte, P. Van den Bossche, D. Wuyts
BBRI, Belgium
1 Introduction
This paper presents the evolutions during the last 20..30 years as well as the latest changes in the Belgian[1] building ventilation market, with an attention not only for IAQ and energy issues, but also for airtightness and the assessment of innovative systems issues. Not only the trends but also the (lack of) drivers for change are discussed.
[1] It must be noticed that Belgium is a Federal State composed of three Regions: the Flemish Region, the Walloon Region and the Region of Brussels-Capital. Energy use in buildings and ventilation are under the responsibility of the Regions. The Flemish Region has introduced an EPBD related regulation in January 2006. The Region of Brussels-Capital introduces its own Energy Performance of Buildings (EPB) regulation in July 2008. At the time this paper was written, the regulation of the Walloon Region was still under preparation. The regulations are similar. However, in this paper, if the Region is not clearly mentioned, we always refer to the Flemish situation, including for what concerns the E-level described below.
2 National trends in IAQ requirements and market characteristics
2.1 Requirements on ventilation of dwellings
Historically, ventilation in Belgian buildings became a point of concern only after the first oil crisis and then even primarily because of the interest in reducing the energy consumption for ventilation. It was in that context that Belgium joined in 1983 the Air Infiltration Centre (AIC), which was set up by the International Energy Agency in 1979 with the major objective to improve the building airtightness (as reflected by the name AIC). As a large number of moisture problems occurred in the first insulated buildings, it appeared clearly that ventilation was more or less forgotten. In 1991, a Belgian standard about ventilation of dwellings was published [1]; this standard was largely inspired by a similar Dutch standard [2].
The application of the standard was made compulsory in 1996 in the Walloon Region (at the same time as a strengthening of the requirements on building insulation). The Flemish Region imposed the application of
1


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International Energy Agency
Energy Conservation in Buildings and Community Systems Programme
Air Infiltration and Ventilation Centre
Trends in the Japanese building ventilation market and drivers for change
Takao Sawachi, Dr. Eng., NILIM
Masaki Tajima, Ph.D., NILIM
1 Introduction
The technology in building physics and mechanical engineering for building ventilation may not be totally new area and must have rather long history and much knowledge accumulation of their own. Nowadays, the distance between the engineering field and society looks becoming shorter, since there are stronger needs from the society than before to reduce the environmental impact of the buildings and to enhance the indoor environmental quality with cost effectiveness, at the same time. The technological solutions by the engineering filed should have been cost effective so far as they can satisfy the contemporary needs, and resultantly they always must have contained compromises. That must be a reason why there is still many problems to be solved in the field of building physics and mechanical engineering for building ventilation. In this paper, such re-emerging or new problems, which are being struggled by experts in Japan will be reviewed and introduced. The authors wish that it should be fruitful for experts in different countries to be able to share some of the problems and the strategies to solve them.
2 National trends in IAQ requirements and market characteristics
2.1 Requirements on ventilation of dwellings
When buildings are to be built or to be repaired in a large scale, it is mandatory to apply for building confirmation according to the Building Standard Law. Without complying with the law, any buildings can not be built nor repaired in a large scale. As for the building ventilation, there are three kinds of regulations.
Firstly, there is a minimum requirement for the supply of outdoor air for habitable rooms, which can be satisfied either of mechanical ventilation or natural ventilation by window opening. For the mechanical ventilation, a minimum ventilation requirement is set at 20 m^3/h per person, and for the natural ventilation the minimum ratio of the openings is set at 1/20 of the room floor area.
Secondly, for rooms in which fire is used, the minimum ventilation requirement is set in proportion to the quantity of gas products generated during combustion.
1

2008	VIP 16	Air quality in passenger aircraft

2008	VIP 15	Report of the 2nd European BlowerDoor Symposium - 2007
2007	VIP 14	European ventilation standards supporting the EPBD
2007	VIP 13	Ceiling fans
2006	VIP 12	Adaptive thermal comfort and ventilation
2006	VIP 11	Use of Earth to Air Heat Exchangers for Cooling
2004	VIP 10	Sheltering in Buildings from Large-Scale Outdoor Releases
2004	VIP 09	Energy Performance Regulations: Which impact can be expected from the European Energy Performance Directive?
2004	VIP 08	Airtightness of buildings
2004	VIP 07	Indoor Air Pollutants – Part 2: Description of sources and control/mitigation measures
2004	VIP 06	Air-to-Air Heat Recovery in Ventilation Systems
2004	VIP 05	Displacement Ventilation
2004	VIP 04	Night ventilation strategies
2004	VIP 03	Natural ventilation in urban areas
2003	VIP 02	Indoor Air Pollutants – Part 1: General description of pollutants, levels and standards
2003	VIP 01	Airtightness of ventilation ducts

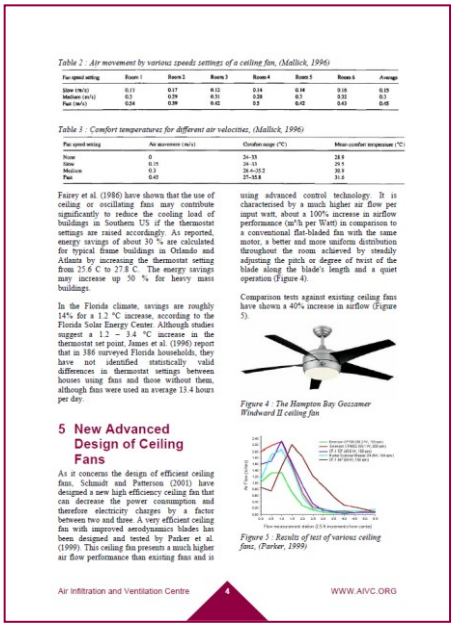

Table 2 : Air movement by various speeds settings of a ceiling fan, (Mallick, 1996)

Fan speed setting	Room 1	Room 2	Room 3	Room 4	Room 5	Room 6	Average
Slow (m/s)	0.13	0.17	0.12	0.14	0.14	0.16	0.15
Medium (m/s)	0.3	0.39	0.31	0.38	0.3	0.35	0.3
Fast (m/s)	0.54	0.39	0.42	0.5	0.42	0.43	0.45

Table 3 : Comfort temperatures for different air velocities, (Mallick, 1996)

Fan speed setting	Air movement (m/s)	Comfort range (°C)	Mean comfort temperature (°C)
None	0	24-33	28.9
Slow	0.15	24-33	29.5
Medium	0.3	26.4-35.2	30.9
Fast	0.45	27-35.8	31.6

Fairey et al. (1986) have shown that the use of ceiling or oscillating fans may contribute significantly to reduce the cooling load of buildings in Southern US if the thermostat settings are raised accordingly. As reported, energy savings of about 30 % are calculated for typical frame buildings in Orlando and Atlanta by increasing the thermostat setting from 25.6 C to 27.8 C. The energy savings may increase up 50 % for heavy mass buildings.

In the Florida climate, savings are roughly 14% for a 1.2 °C increase, according to the Florida Solar Energy Center. Although studies suggest a 1.2 – 3.4 °C increase in the thermostat set point. James et al. (1996) report that in 386 surveyed Florida households, they have not identified statistically valid differences in thermostat settings between houses using fans and those without them, although fans were used an average 13.4 hours per day.

5 New Advanced Design of Ceiling Fans

As it concerns the design of efficient ceiling fans, Schmidt and Patterson (2001) have designed a new high efficiency ceiling fan that can decrease the power consumption and therefore electricity charges by a factor between two and three. A very efficient ceiling fan with improved aerodynamics blades has been designed and tested by Parker et al. (1999). This ceiling fan presents a much higher air flow performance than existing fans and is using advanced control technology. It is characterised by a much higher air flow per input watt, about a 100% increase in airflow performance (m³/h per Watt) in comparison to a conventional flat-bladed fan with the same motor, a better and more uniform distribution throughout the room achieved by steadily adjusting the pitch or degree of twist of the blade along the blade's length and a quiet operation (Figure 4).

Comparison tests against existing ceiling fans have shown a 40% increase in airflow (Figure 5).

Figure 4 : The Hampton Bay Gossamer Windward II ceiling fan

Figure 5 : Results of test of various ceiling fans, (Parker, 1999)

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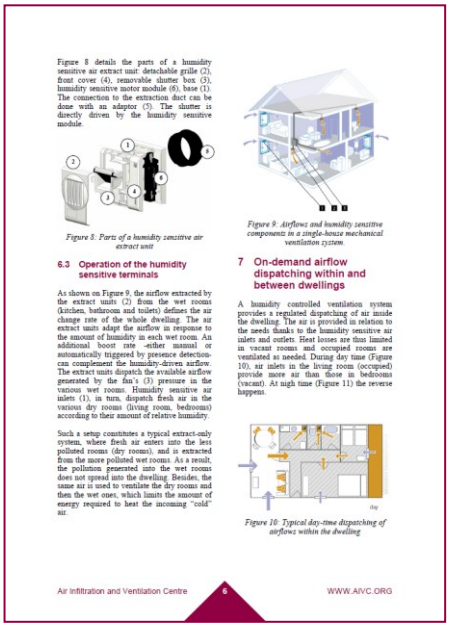

Figure 8 details the parts of a humidity sensitive air extract unit: detachable grille (2), front cover (4), removable shutter box (3), humidity sensitive motor module (6), base (1). The connection to the extraction duct can be done with an adaptor (5). The shutter is directly driven by the humidity sensitive module.

Figure 8: Parts of a humidity sensitive air extract unit

6.3 Operation of the humidity sensitive terminals

As shown on Figure 9, the airflow extracted by the extract units (2) from the wet rooms (kitchen, bathroom and toilets) defines the air change rate of the whole dwelling. The air extract units adapt the airflow in response to the amount of humidity in each wet room. An additional boost rate -either manual or automatically triggered by presence detection- can complement the humidity-driven airflow. The extract units dispatch the available airflow generated by the fan's (3) pressure in the various wet rooms. Humidity sensitive air inlets (1), in turn, dispatch fresh air in the various dry rooms (living room, bedrooms) according to their amount of relative humidity.

Such a setup constitutes a typical extract-only system, where fresh air enters into the less polluted rooms (dry rooms), and is extracted from the more polluted wet rooms. As a result, the pollution generated into the wet rooms does not spread into the dwelling. Besides, the same air is used to ventilate the dry rooms and then the wet ones, which limits the amount of energy required to heat the incoming "cold" air.

Figure 9: Airflows and humidity sensitive components in a single-house mechanical ventilation system.

7 On-demand airflow dispatching within and between dwellings

A humidity controlled ventilation system provides a regulated dispatching of air inside the dwelling. The air is provided in relation to the needs thanks to the humidity sensitive air inlets and outlets. Heat losses are thus limited in vacant rooms and occupied rooms are ventilated as needed. During day time (Figure 10), air inlets in the living room (occupied) provide more air than those in bedrooms (vacant). At nigh time (Figure 11) the reverse happens.

Figure 10: Typical day-time dispatching of airflows within the dwelling

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8.3. Annotated bibliographies

The AIVC's collection of bibliographies is listed below.

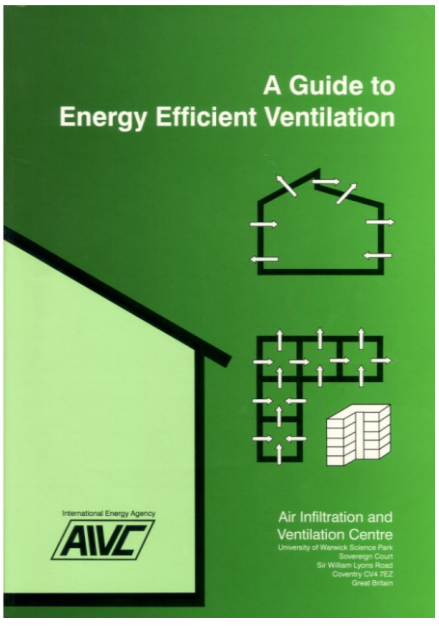
2007	BIB 13	Review of Literature Related to Residential Ventilation Requirements
2003	BIB 12	Review of Airflow Measurement Techniques
2001	BIB 11	Balancing Ventilation systems - An Annotated Bibliography

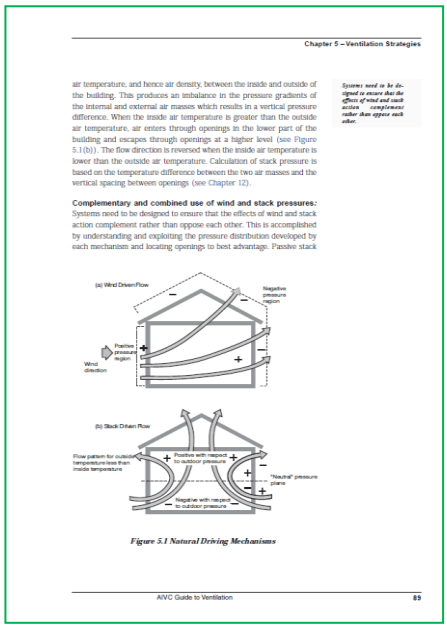
2000	BIB 10	Annotated Bibliography: Ventilation System Duct Cleaning
1999	BIB 09	An Annotated Bibliography: Impact of Urban Air Pollution on the Indoor Environment
1998	BIB 08	Passive Cooling Technology for Office Buildings: An Annotated Bibliography
1997	BIB 07	Ventilation and acoustics in buildings: an annotated bibliography
1997	BIB 06	Ventilation in schools: an annotated bibliography
1996	BIB 05	An annotated bibliography: heat pumps for ventilation exhaust air heat recovery
1995	BIB 04	Ventilation and infiltration characteristics of Ventilation and Infiltration Characteristics of Lift Shafts and Stair Wells - A Selected Bibliography
1994	BIB 03	An annotated bibliography: air intake positioning to avoid contamination of ventilation air
1994	BIB 02	An annotated bibliography: natural ventilation
1993	BIB 01	An annotated bibliography: garage ventilation

8.4. Guides and handbooks

A series of carefully researched and readily accessible publications giving detailed coverage on a range of important topics.

2002	GU 5	Ventilation modelling data guide
1999	TP 1999:4	Improving ductwork: a time for tighter air distribution systems
1996	GV	A guide to energy efficiency ventilation
1988	AG	Air exchange rate and airtightness measurement techniques - An application guide
1986	CT	Air Infiltration Calculation Techniques: An Applications Guide
1983	HNBK	Air Infiltration Control in Housing. A Guide to International practice




Chapter 5 – Ventilation Strategies

air temperature, and hence air density, between the inside and outside of the building. This produces an imbalance in the pressure gradients of the internal and external air masses which results in a vertical pressure difference. When the inside air temperature is greater than the outside air temperature, air enters through openings in the lower part of the building and escapes through openings at a higher level (see Figure 5.1(b)). The flow direction is reversed when the inside air temperature is lower than the outside air temperature. Calculation of stack pressure is based on the temperature difference between the two air masses and the vertical spacing between openings (see Chapter 12).

Systems need to be designed to ensure that the effects of wind and stack action complement rather than oppose each other.

Complementary and combined use of wind and stack pressures:
Systems need to be designed to ensure that the effects of wind and stack action complement rather than oppose each other. This is accomplished by understanding and exploiting the pressure distribution developed by each mechanism and locating openings to best advantage. Passive stack

Figure 5.1 Natural Driving Mechanisms

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8.5. Contributed reports

A series of republished documents which are of interest to the field but have not been created and reviewed by the AIVC for errors or omissions.

2020	CR19	Indoor Air Quality Design and Control in Low-Energy Residential Buildings - EBC Annex 68 | Subtask 4: Current challenges, selected case studies and innovative solutions covering indoor air quality, ventilation design and control in residences
2019	CR18	Ventilation and Indoor Air Quality in New California Homes with Gas Appliances and Mechanical Ventilation
2017	CR 17	Indoor Air Quality Design and Control in Low-energy Residential Buildings- Annex 68 | Subtask 1: Defining the metrics | In the search of indices to evaluate the Indoor Air Quality of low-energy residential buildings
2017	CR 16	Towards compliant building airtightness and ventilation systems
2012	CR15	Development and evaluation of a new test method for portable air cleaners
2012	CR14	Methods and techniques for airtight buildings
2010	CR13	Reduction of tobacco smoke in the hospitality business
2009	CR 12	Indoor air quality in French dwellings
2008	CR 11	Air Leakage of U.S. Homes: Model Prediction
2008	CR 10	Ventilation Behavior and Household Characteristics in New California Houses
2007	CR 09	Source Book for Residential Hybrid Ventilation Development
2007	CR 08	Occupant behaviour and attitudes with respect to ventilation of dwellings
2007	CR 07	State-of-the-art of low-energy residential ventilation
2007	CR 06	Low-pressure-drop HVAC design for laboratories
2005	CR 05	Considerations concerning costs and benefits with application to ventilation
2006	CR 04	Contrasting the capabilities of building energy performance simulation programs
2005	CR 03	Ventilated Double Skin Façades - Classification & illustration of façade concepts
2005	CR 02	Flow-Generated Noise in Ventilation Systems
2005	CR 01	Aerodynamic Noise of Fans

8.6. Literature Lists

The AIVC's collection of Literature Lists from 2001 to 2020 follows:

2020	LL35	Building & Ductwork Airtightness
2020	LL34	Ventilative Cooling
2005	LL33	Overview of reports from the EU-RESHYVENT project on residential hybrid ventilation
2001	LL32	Hospitals
2001	LL31	Air cleaning
2001	LL30	Use of vegetation to clean indoor air

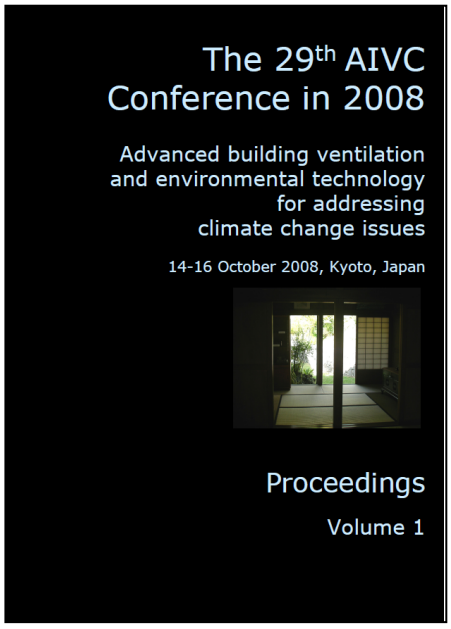
2001	LL29	Design for fire/smoke movement
2001	LL28	Ventilation problems in crawlspaces
2001	LL27	Kitchen ventilation
2001	LL26	Effects of outdoor air pollution on indoor air
2001	LL25	Passive Solar Design
2001	LL24	Passive Cooling
2001	LL23	Sustainability
2001	LL22	Moisture and Condensation Problems in Buildings
2001	LL21	Displacement Ventilation Strategies
2001	LL20	Computational fluid dynamics for analysis of room air flow
2001	LL19	Location of Exhausts and Inlets
2001	LL18	Control of Cross Contamination from Smokers
2001	LL17	Flow through Large Openings
2001	LL16	Sick Buildings
2001	LL15	Identification of air leakage paths
2001	LL14	Roofs and Attics
2001	LL13	Air Infiltration Measurement Techniques
2001	LL12	Windbreaks and Shelterbelts
2001	LL11	Occupancy Effects on Air Infiltration
2001	LL10	Carbon Dioxide Controlled Ventilation
2001	LL09	Air Infiltration in Public Buildings
2001	LL08	Air Infiltration and Ventilation in Commercial Buildings
2001	LL07	Air Flow Through Building Entrances
2001	LL06	Air Infiltration and Ventilation in Industrial Buildings
2001	LL05	Domestic air-to-air heat exchangers
2001	LL04	Caulks and Sealants
2001	LL03	Weatherstripping Windows and Doors
2001	LL02	Pressurisation - Infiltration Correlation: Measurements
2001	LL01	Pressurisation - Infiltration Correlation: Models

8.7. Conference proceedings

Since 1980 the AIVC holds a conference each year in September/October in one of the AIVC participating countries, presenting around 50 to 100 papers on a variety of topics in air infiltration or ventilation fields.

2019	Belgium, Ghent	From energy crisis to sustainable indoor climate 40 years of AIVC

2018	France, Juan-Les-Pins	Smart ventilation for buildings
2017	UK, Nottingham	Ventilating healthy low-energy buildings
2016	USA, Alexandria	ASHRAE- AIVC IAQ 2016 joint Conference
2015	Spain, Madrid	Effective ventilation in high performance buildings
2014	Poland, Poznan	Ventilation and airtightness in transforming the building stock to high performance
2013	Greece, Athens	Energy conservation technologies for mitigation and adaptation in the built environment: the role of ventilation strategies and smart materials
2012	Denmark, Copenhagen	Optimising Ventilative Cooling and Airtightness for [Nearly] Zero-Energy Buildings, IAQ and Comfort
2011	Belgium, Brussels	Towards Optimal Airtightness Performance
2010	Korea, Seoul	Low Energy and Sustainable Ventilation Technologies for Green Building
2009	Germany, Berlin	Trends in High Performance Buildings and the role of Ventilation
2008	Japan, Kyoto	Advanced building ventilation and environmental technology for addressing climate change issues
2007	Greece, Crete Island	Building Low Energy Cooling and Advanced Ventilation Technologies in the 21st Century
2006	France, Lyon	Technologies & Sustainable Policies for a Radical Decrease of the Energy Consumption in Buildings (Volume 3)
2005	Belgium, Brussels	Ventilation in Relation to the Energy Performance of Buildings
2004	Czech Republic, Prague	Ventilation and Retrofitting
2003	USA, Washington	Ventilation, humidity control and energy
2002	France, Lyon	Energy efficient and healthy buildings in sustainable cities
2001	UK, Bath	Market opportunities for advanced ventilation technology
2000	Netherlands, The Hague	Innovations in ventilation technology



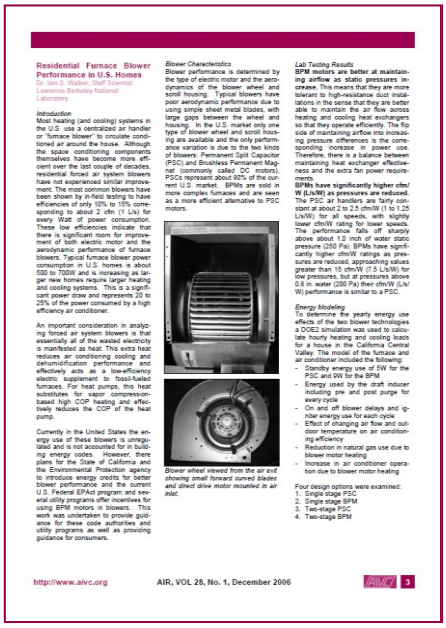
1999	Scotland, Edinburgh	Ventilation and indoor air quality in buildings
1998	Norway, Oslo	Ventilation Technologies in Urban Areas
1997	Greece, Athens	Ventilation and Cooling
1996	Sweden, Gothenburg	Optimum ventilation and air flow control in buildings
1995	USA, Palm Springs	Implementing the results of ventilation research
1994	UK, Buxton	The role of ventilation
1993	Denmark, Copenhagen	Energy impact of ventilation and air infiltration
1992	France, Nice	Ventilation for energy efficiency and optimum indoor air quality
1991	Canada, Ottawa	Air movement and ventilation control within buildings
1990	Italy, Belgirate	Ventilation system performance
1989	Finland, Espoo	Progress and trends in air infiltration and ventilation research
1988	Belgium, Gent	Effective ventilation
1987	West Germany, Ueberlingen	Ventilation technology research and application
1986	UK, Stratford-upon-Avon	Occupant interaction with ventilation systems
1985	Netherlands	Ventilation strategies and measurement techniques
1984	USA, Nevada, Reno	The implementation and effectiveness of air infiltration standards in buildings
1983	Switzerland	Air infiltration reduction in existing buildings
1982	UK, London	Energy efficient domestic ventilation systems for achieving acceptable indoor air quality
1981	Sweden	TN 02 Building design for minimum air infiltration
1980	UK	TN 01 Instrumentation and measuring techniques

8.8. Bibliographic database - AIRBASE

Contains references and abstracts of more than 22 700 articles and publications related to energy efficient ventilation. Where possible, sufficient detail is supplied in the bibliographic details for users to trace and order the material via their own libraries. More than 16.200 documents can be downloaded by pdf.

8.9. Air information review and AIVC newsletter

The Air Information Review (AIR) was published from 1979 till 2010. This quarterly newsletter of the AIVC contained topical and informative articles on air infiltration and ventilation research and application. Starting in 2001, most of the articles were linked to a more detailed feature on the AIVC website (www.aivc.org)



From 2001 till 2010, the AIR newsletter had at the back a CD-ROM will all information.

Since 2011, AIR has been replaced by the AIVC newsletter, which is published twice a year.

9. AIVC events

9.1. AIVC conferences

Figure 2 and Figure 3 show the locations of the AIVC conferences.

Figure 2. Locations of AIVC conferences (see Figure 3 for details about conferences in Europe)

Figure 3: Locations of AIVC conferences in Europe

Conference	Date	Location	# participants	# papers
41st AIVC –ASHRAE-IAQ– 9th TightVent – 7th venticool conference	4-6 May 2022 [Postponed due to COVID-19]	Athens, Greece		
40th AIVC – 8th TightVent – 6th venticool conference	15-16 October 2019	Ghent, Belgium	204	126
39th AIVC - 7th TightVent - 5th venticool conference	18-19 September 2018	Juan-les-Pins, France	207	140
38th AIVC - 6th TightVent - 4th venticool conference	13-14 September 2017	Nottingham, UK	185	107
37th AIVC - ASHRAE- IAQ joint Conference	12-14 September 2016	Alexandria VA, USA	176	-
36th AIVC - 5th TightVent – 3rd venticool conference	23-24 September 2015	Madrid, Spain	160	119
35th AIVC - 4th TightVent – 2nd venticool conference	24-25 September 2014	Poznan, Poland	143	86
34th AIVC – 3rd TightVent – 2nd Cool Roofs - 1st venticool Conference	25-26 September 2013	Athens, Greece	167	130
33rd AIVC – 2nd TightVent Conference	10-11 October 2012	Copenhagen, Denmark	165	61
32nd AIVC – 1st TightVent Conference	12-13 October 2011	Brussels	160	60
31st AIVC Conference	26-28 October 2010	Seoul, Korea	-	80
30th AIVC Conference	1-2 October 2009	Berlin, Germany	-	48
29th AIVC Conference	14-16 October 2008	Kyoto, Japan	-	165

28th AIVC – 2nd Palenc Conference	27-29 September 2007	Crete, Greece	-	247
27th AIVC – 4th Epic Conference	20-22 November 2006	Lyon, France	-	153
26th AIVC Conference	21-23 September 2005	Brussels, Belgium	-	52
25th AIVC Conference	15-17 September 2004	Prague, Czech Republic	-	51
24th AIVC & BETEC Conference	12-14 October 2003	Washington D.C., USA	-	56
23rd AIVC & Epic Conference	23-26 October 2002	Lyon, France	-	149
22nd AIVC Conference	11-14 September 2001	Bath, UK	-	42
21st AIVC Conference	26-29 September 2000	Hague, Netherlands	-	60
20th AIVC and Indoor Air 99 Conference	9-13 September 1999	Edinburgh, Scotland	-	141
19th AIVC Conference	28-30 September 1998	Oslo, Norway	-	55
18th AIVC Conference	23-24 September 1997	Athens, Greece	-	70
17th AIVC Conference	17-20 September 1996	Gothenburg, Sweden	-	62
16th AIVC Conference	18-22 September 1995	Palm Springs, USA	-	51
15th AIVC Conference	27-30 September 1994	Buxton, UK	-	75
14th AIVC Conference	21-23 September 1993	Copenhagen, Denmark	-	63
13th AIVC Conference	14-18 September 1992	Nice, France	-	56
12th AIVC Conference	24-27 September 1991	Ottawa, Canada	-	88
11th AIVC Conference	18-21 September 1990	Belgirate, Italy	-	46
10th AIVC Conference	25-28 September 1989	Espoo, Finland	-	52
9th AIVC Conference	12-15 September 1988	Ghent, Belgium	-	44
8th AIVC Conference	21-24 September 1987	Ueberlingen, West Germany	-	40
7th AIVC Conference	29 September - 2 October 1986	Stratford-upon-Avon, UK	-	27
6th AIVC Conference	16-19 September 1985	Southern Netherlands	-	32
5th AIVC Conference	1-4 October 1984	Reno, USA	-	24
4th AIVC Conference	26-28 September 1983	Elm, Switzerland	-	12
3rd AIVC Conference	20-23 September 1982	London, UK	-	29
2nd AIVC Conference	21-23 September 1981	Stockholm, Sweden	-	12
1st AIVC Conference	6-8 October 1980	Windsor, UK	-	12

9.2. AIVC workshops

Figure 4: Locations of AIVC workshops

Workshops	Date	Location	# participants
Quality ventilation is the key to achieving low energy healthy buildings	27-28 March 2019	Dublin, Ireland	80
Ventilation for Indoor Air Quality and Cooling	23 March 2018	Sydney, Australia	80
Towards higher-performing buildings: The role of airtightness and ventilation	19-20 March 2018	Wellington, New Zealand	129
Is ventilation the answer to indoor air quality control in buildings? Do we need performance-based approaches?	14-15 March 2017	Brussels, Belgium	70
Voluntary and Regulatory Frameworks to Improve Quality and Compliance of ventilation and airtightness	16-17 March 2015	Lund, Sweden	55
Quality of Methods for Measuring Ventilation and Air Infiltration in Buildings	18-19 March 2014	Brussels, Belgium	71
Building and Ductwork Airtightness: Design, Implementation, Control and Durability: Feedback from Practice and Perspectives	18-19 April 2013	Washington DC, USA	58
Ventilative Cooling Need, Challenges and Solution Examples	19-20 March 2013	Brussels, Belgium	55
Securing the quality of ventilation systems in residential buildings: status and perspectives	18-19 March 2013	Brussels, Belgium	75
Achieving relevant and durable airtightness levels: status, options and progress needed	28-29 March 2012	Brussels, Belgium	80
Large scale national implementation plans for building airtightness assessment: a must for 2020	14-15 June 2010	Brussels, Belgium	N/A
Innovative products and systems for energy efficient building	3-4 March 2010	Amsterdam, Netherlands	N/A
Compliance and control on regulation	1-2 September 2009	Brussels, Belgium	N/A
Summer comfort and cooling	31 March- 1 April 2009	Barcelona, Spain	N/A
Trends in national building ventilation markets and drivers for change	18-19 March 2008	Ghent, Belgium	N/A
Innovative ventilation systems workshop	21-22 March 2002	Brussels, Belgium	N/A
Intelligent natural ventilation devices for IAQ control	19-20 May 1999	Brussels, Belgium	N/A

Air distribution in buildings: Airtightness aspects	10-11 June 1998	Brussels, Belgium	N/A
AIVC Database Workshop	19-20 March 1990	Warwick UK	N/A
Measurement Techniques Workshop	21-23 March 1988	Køge, Denmark	N/A
Moisture Workshop	23-27 March 1987	Wellington, New Zealand	N/A
Wind Pressure Workshop	21-22 March 1984	Brussels, Belgium	N/A

9.3. AIVC Webinars

Webinar	Date	# participants
Inspection of ventilation systems in new regulations in European countries	30 November 2021	180
Emerging smart ventilation strategies for energy efficient IAQ management	23 November 2021	194
Impact of wind on airtightness test results	8 November 2021	153
Smart materials for energy efficient IAQ management	12 October 2021	146
Resilient Ventilative Cooling in practice	1 June 2021	180
Big data, IAQ and ventilation – part 2	21 April 2021	166
Big data, IAQ and ventilation – part 1	13 April 2021	271
IAQ and Ventilation Metrics	8 April 2021	267
Building ventilation: How does it affect SARS-CoV-2 transmission?	1 April 2021	438
Building airtightness improvements of the building stock- Analysis of European databases	19 January 2021	184
Resilient Ventilative Cooling in practice	9 December 2020	194
Better Quantifying and Locating Building Leakages	30 November 2020	145
COVID-19 Ventilation related guidance by ASHRAE and REHVA	20 November 2020	406
Moisture Control	19 May 2020	240
Ventilation requirements, trends and thermal comfort	13 May 2020	324
Kitchen Ventilation	6 May 2020	231
Ventilative Cooling – design and examples	26 March 2020	277
Durability of building airtightness: Assessment through laboratory testing	21 February 2020	66
Durability of building airtightness: Assessment through field measurements	30 January 2020	94
New Perspectives on Kitchen Ventilation	23 May 2019	126
Ductwork airtightness measurements: protocols	25 April 2019	81
Using Metal Oxide Semiconductor (MOS) sensors to measure Volatile Organic Compounds (VOC) for ventilation control	4 September 2018	89
Ventilative cooling and summer comfort: Freevent project in France	25 April 2018	79
IAQ sensors for smart ventilation of buildings	6 March 2018	180
Ductwork airtightness: Standardisation's ongoing work and an overview of status and trends in Sweden, Japan, Spain and Portugal	25 January 2018	60
On The Quest For Indices Defining Indoor Air Quality. What Is A Reasonable Approach?	13 January 2017	93
Building airtightness and initiatives to improve the quality of the works	12 January 2016	79
Ventilative cooling potential and compliance in Energy Performance regulations Status and perspectives in Belgium, Estonia, Greece	17 December, 2015	30
Assessing ventilative cooling potential in Energy Performance regulations Status and perspectives in Austria, Denmark, France	8 December, 2015	91
Airtightness testing part 3: Status and trends in competent tester schemes in Denmark, Ireland and Sweden	20 November 2014	35
Airtightness testing part 2: Status and trends in competent tester schemes in Germany, the Czech Republic and France	22 November 2013	31

Airtightness Testing part 1: Status and trends in competent tester schemes in the UK and Belgium	14 November 2013	60
Building Airtightness Solutions: System approach and characterisation of air barrier and moisture management systems	8 October 2013	99
Building Airtightness Solutions: Recent Research and Characterisation of Sealants and Tapes	4 June 2013	112
Demand-Controlled Ventilation in the European context Approaches in 4 countries and at EU level	26 November 2012	-
The need for structured air leakage databases in energy conservation in buildings policies	25 May 2012	-
Achieving better envelope airtightness in practice – Norway	9 November 2011	-

10.AIVC overall info

10.1. AIVC member countries

	Australia	Belgium	Canada	China	Czech Republic	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Japan	Korea	Netherlands	New Zealand	Norway	Poland	Portugal	Spain	Sweden	Switzerland	UK	USA
1979			•		•	•						•			•						•	•	•	•
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1986		•	•			•	•		•						•	•	•				•	•	•	•
1987		•	•			•	•		•						•	•	•				•	•	•	•
1988		•	•			•	•		•			•			•	•	•				•	•	•	•
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1990		•	•			•	•		•			•			•	•	•				•	•	•	•
1991		•	•			•	•	•	•			•			•	•	•				•	•	•	•
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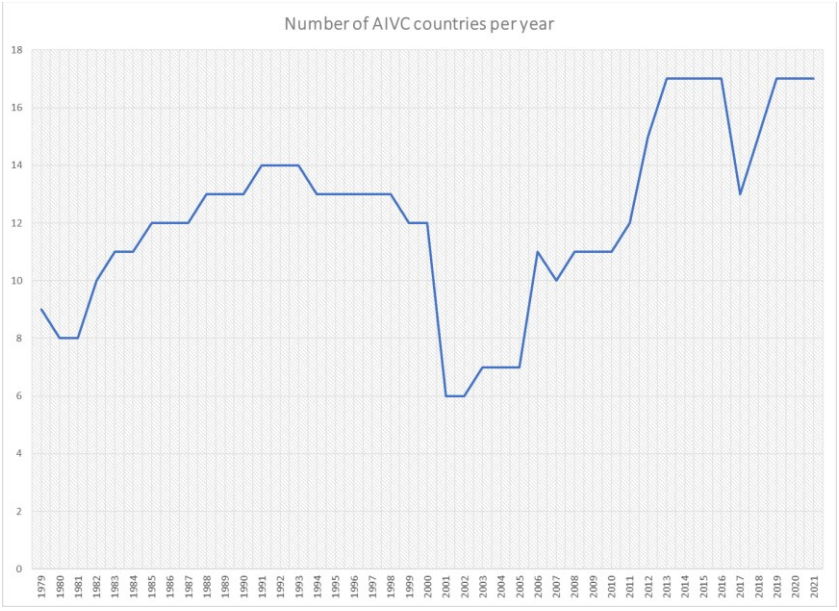
2012		•			•	•		•	•	•		•	•	•	•	•	•		•		•			•
2013		•			•	•	•	•	•	•		•	•	•	•	•	•	•	•		•			•
2014		•			•	•	•	•	•	•		•	•	•	•	•	•	•		•	•			•
2015		•			•	•	•	•	•			•	•	•	•	•	•	•		•	•		•	•
2016		•			•	•	•	•	•			•	•	•	•	•	•	•		•	•		•	•
2017		•				•		•				•	•	•	•	•	•			•	•		•	•
2018	•	•		•		•		•				•	•	•	•	•	•			•	•		•	•
2019	•	•		•		•		•		•	•	•	•	•	•	•	•			•	•		•	•
2020	•	•		•		•		•		•	•	•	•	•	•	•	•			•	•		•	•
2021	•	•		•		•		•		•	•	•	•	•	•	•	•			•	•		•	•



10.2. AIVC steering group and board members (1979 – 2021)

The table that follows lists the AIVC country representatives who were active in the steering and/or board.

Country	Last Name	Name	Affiliation	Duration
Australia	Santamouris	Mat	University of New South Wales	2018-2021
Australia	Miller	Wendy	Queensland University of Technology	2018-2020
Belgium	Caluwaerts	Paul	CSTC	1983-1983
Belgium	Nusgens	Pierre	University of Liège	1983-2000
Belgium	Wouters	Peter	BBRI	1984-2010
Belgium	Delmotte	Christophe	BBRI	2001-2010
Belgium	Janssens	Arnold	University of Ghent	2011-2020
Belgium	Lebrun	Jean	University of Liège	2011-2017
Belgium	Caillou	Samuel	BBRI	2017-2021
Canada	Dumont	R.	National Research Council	1979-1987
Canada	Shaw	John	National Research Council	1979-1998
Canada	Riley	Mark	Ministry of Energy, Mines, and Resources	1987-1998
Canada	Favot	P.	Canada Mortgate and Housing Corporation	1981
Canada	White	J.H	Canada Mortgate and Housing Corporation	1982-1992
Canada	Hamlin	T.	Canada Mortgate and Housing Corporation	1992-1994
Canada	Hill	Duncan	Canada Mortgate and Housing Corporation	1994-1998
Canada	Atif	Morad	Institute of Research in Construction - National Research Council	2009-2010
China	Zhang	Guoqiang	Hunan University	2018-2021
China	Chen	Weijun	Hunan Shinilion Energy Saving Sci. and Tech. Corp. Ltd	2018-2021
China	Ai	Zhengtao	Hunan University	2020
Czech Republic	Jicha	Miroslav	Brno University of Technology	2003-2017

Czech Republic	Plockova	Irena	Ministry of Industry & Trade	2003-2008
Czech Republic	Kabele	Karel	Czech Technical University	2011-2017
Denmark	Collet	Peter	Danish Institute of Technology	1979-2000
Denmark	Jensen	Ole	Danish Institute of Technology	1986-1998
Denmark	Heiselberg	Per	Aalborg University	1999-2000/2007-2010
Denmark	Hafstrom	Bjorn	Danish Energy Agency	2000
Denmark	Olesen	Bjarne	Technical University of Denmark - DTU	2007-2010/2013-2021
Denmark	Afshari	Alireza	Aalborg University	2013-2021
Finland	Ahvenainen	S.	Technical Research Centre	1984-1985
Finland	Kohonen	Reijo	Technical Research Centre	1984-1991
Finland	Korkala	T.	Technical Research Centre	1985-1986
Finland	Luoma	M.	Technical Research Centre	1991-1993
Finland	Heikkinen	Jorma	Technical Research Centre	1993-1994
Finland	Sateri	Jorma	Helsinki University of Technology	1994-2000
Finland	Koskela	Hannu	Finnish Institute of Occupational Health	2013-2016
Finland	Kosonen	Risto	Halton	2013-2016
France	Plazy	Jean-Louis	AFME	1991-1992
France	Bienfait	Dominique	CSTB	1991-1992
France	Hérant	Pierre	ADEME	1992-1997/2011-2016
France	Duchêne-Marullaz	Philippe	CSTB	1992-2000
France	Lemaire	Marie-Claude	ADEME	1997-2006
France	Durier	François	CETIAT	2011-2021
France	Deroubaix	Pierre	ADEME	2006-2010
France	Doré	Nicolas	ADEME	2017-2021
Germany	Trepte	Lutz	Dornier System GmbH	1985-1990
Germany	Steimle	Fritz	Fachinstitut Gebaude-Klima	1990-2000
Germany	Le Marie	André	KFA Jülich GmbH	1985-1989
Germany	Gehlmann	Jurgen	KFA Jülich GmbH	1990-2000
Germany	Mertz	Günther	Fachinstitut Gebaude-Klima	1991-2000
Germany	Erhorn Kluttig	Heike	Fraunhofer Institute for Building Physics	2002/2009-2017
Germany	Erhorn	Hans	Fraunhofer Institute for Building Physics	2011-2017
Greece	Nomidis	Dimitrios	Ministry of Development	1997
Greece	Santamouris	Mat	NKUA	1998-2016
Greece	Charalambopoulos	Dimitris	ASHRAE Hellenic Chapter	2019-2021
Greece	Triantafyllopoulos	Alkis	ASHRAE Hellenic Chapter	2019-2021
Ireland	Jones	Simon	Aereco	2019-2021
Ireland	Coggins	Marie	NUI Galway	2020-2021
Italy	Cali	Michele	Politecnico di Torino	1979-1982
Italy	Zecchin	Roberto	Università degli Studi di Milano	1979-1983
Italy	Masoero	Marco	Politecnico di Torino	1983/1988-1993
Italy	Esposti	Walter	ICITE	1979-1983
Italy	Pagliano	Lorenzo	Politecnico di Milano	2011-2021

Japan	Sawachi	Takao	National Institute for Land and Infrastructure Management/ Building Research Institute (from 2011)	2006-2021
Japan	Osawa	Haruki	Building Research Institute	2007-2008
Japan	Nishizawa	Shigeki	NILIM	2011-2017
Japan	Akamine	Yoshikino	NILIM	2018-2021
Korea	Lee	Yun Gyu	Korea Institute of Construction Technology	2007-2021
Korea	Jeong	Jae-Weon	Sejong University	2011-2021
Netherlands	de Gids	Willem	TNO	1979-2007
Netherlands	Borsboom	Wouter	TNO	2008-2021
New Zealand	Trethowen	H.A.	BRANZ	1982-1986
New Zealand	Bassett	Mark	BRANZ	1986-2000
New Zealand	Plagmann	Manfred	BRANZ	2012-2021
Norway	Ramstad	T.Ø.	Norwegian Building Research Institute	1982-1983
Norway	Uvsløkk	S.	Norwegian Building Research Institute	1982-1987
Norway	Mathisen	Hans Martin	SINTEF	1988-2000
Norway	Vik	B.	Norwegian Building Research Institute	1984
Norway	Brunsell	Johnny	Norwegian Building Research Institute	1984-2004
Norway	Schild	Peter	Norwegian Building Research Institute	2004-2016
Norway	Thunshelle	Kari	SINTEF	2016-2021
Poland	Mróz	Tomasz	Poznan University of Technology	2013-2016
Poland	Górka	Andrzej	Poznan University of Technology	2013-2015
Poland	Gorzenski	Radek	Poznan University of Technology	2016
Portugal	Maldonado	Eduardo	University of Porto	2013
Portugal	Fragoso	Rui	ADENE	2013
Portugal	Santos	Paulo	ADENE	2013
Portugal	Pinto	Margarida	ADENE	2013
Spain	Linares Alemparte	Pilar	The Eduardo Torroja Institute for Construction Science - CSIC	2014-2021
Spain	Tenorio Ríos	José Antonio	The Eduardo Torroja Institute for Construction Science - CSIC	2014-2017
Spain	Garcia Ortega	Sonia	The Eduardo Torroja Institute for Construction Science - CSIC	2018-2021
Sweden	Sundbom	L.	Swedish Council for Building Research	1979-1982
Sweden	Elmroth	Ake.	Royal Institute of Technology	1979-1982
Sweden	Månsson	Lars-Goran.	Swedish Council for Building Research	1983-1987
Sweden	Peterson	P.	Royal Institute of Technology	1983-1989
Sweden	Kronvall	Johnny	Lund University	1987-2000
Sweden	Logdberg	A.	Swedish Council for Building Research	1990-1991
Sweden	Lagerström	J.	Swedish Council for Building Research	1991-1999
Sweden	Dawidowicz	Nina	Swedish Council for Building Research	1999-2000

Sweden	Hagentoft	Carl-Eric	Chalmers University of Technology	2011-2014
Sweden	Wahlgren	Paula	Chalmers University of Technology	2011-2020
Sweden	Johansson	Pär	Chalmers University of Technology	2019-2021
Switzerland	Hartmann	Peter	EMPA	1979-1992
Switzerland	Dorer	Victor	EMPA	1992-1996
UK	Curtis	David	The Oscar Faber Partnership	1979-1984
UK	Irving	Steve	The Oscar Faber Partnership	1984-1994
UK	Wilson	J.	ETSU	1979
UK	Kennedy	G. J.	ETSU	1980-1982
UK	Danskin	H.	BRESCU	1983-1987
UK	Trim	M.	BRESCU	1987-1994
UK	Perera	Earle	Building Research Establishment	1990-2000
UK	Liddament	Martin	The Oscar Faber Partnership	1997-2000
UK	Cockroft	J.	BSRU	1979
UK	Robertson	P.	BSRU	1980-1983
UK	Jackmann	Peter	BSRIA	1988-1994
UK	Jones	Benjamin	University of Nottingham	2016-2021
UK	Kolokotroni	Maria	Brunel University London	2016-2021
USA	Ross	H.	Department of Energy	1979-1983
USA	Hunt	C. M.	National Bureau of Standards	1979
USA	Grot	Richard	National Bureau of Standards	1979-1989
USA	Sherman	Max	Lawrence Berkeley National Laboratory	1983-2021
USA	Persily	Andrew	National Bureau of Standards/NIST (from 2011)	1990-2000/2011-2021
USA	Grimsrud	David	Lawrence Berkeley National Laboratory	1979-1982
USA	Smith	J.	Department of Energy	1984-1989
USA	Harrje	David	Princeton University	1980-1989
USA	Talbott	John	Department of Energy	1990-2000
USA	Walker	Iain	Lawrence Berkeley National Laboratory	2021

10.3. AIVC board guests

AIVC Board guests			
Last name	**First Name**	**Affiliation**	**Duration**
Atif	Morad	National Research Council of Canada (NRCC)	2012-2015
Campos	José Maria	Tecnalia Research and Innovation	2012-2015
de Gids	Willem	Ventguide	2008-2021
Engelund Thomsen	Kirsten	SBI, Denmark	2012
Kolokotroni	Maria	Brunel University London	2012-2015
Liddament	Martin	VEETECH Ltd	2012-2013
Maldonado	Eduardo	University of Porto	2012
Olesen	Bjarne	DTU	2012
Santos	Paulo	ADENE	2012

Yoshino	Hiroshi	Tohoku University	2012-2021
Eckmanns	Andreas	Swiss Federal Office of Energy	2013
Fulop	Laszlo	University of Pécs	2013-2021
Magyar	Zoltan	Budapest University of Technology	2013-2021
Wargocki	Pawel	ISIAQ	2016-2017
Walker	Iain	LBNL	2016-2020

10.4. Representatives or organizations in the Board

Representatives of organizations in the AIVC board			
Last Name	**First name**	**Affiliation**	**Duration**
Hensen	Jan	IBPSA	2012-2021
Eckmanns	Andreas	IEA-EBC	2014-2017
Sawachi	Takao	IEA-EBC	2018-2021
Rode	Carsten	IEA EBC Annex 68	2016-2020
Wargocki	Pawel	IEA EBC Annex 78	2018-2021
Holzer	Peter	IEA EBC Annex 80	2020-2021
Laverge	Jelle	IEA EBC Annex 86	2020-2021
Weekes	Donald	IEQ-GA	2018-2021
Liddament	Martin	IJV	2014-2017
Hughes	Ben	IJV	2018-2021
Allard	Francis	REHVA	2014-2015
Hogeling	Jaap	REHVA	2014-2021

10.5. AIVC board meetings and steering group meetings

Year	Meeting 1	Meeting 2
1979	St. Albans, UK	Delft NL
1980		Windsor, UK
1981		Stockholm, SE
1982	Venice, IT	London, UK
1983		Elm, CH
1984	Brussels, BE	Reno, Nevada, USA
1985	Oslo, NO	Meerdal park, NL
1986	Bonn, DE	Stratford-upon-Avon, UK
1987	Wellington, NZ	Ueberlingen, DE
1988	Koge, DK	Ghent, BE
1989	Berkeley, USA	Espoo, FI
1990	Warwick, UK	Belgirate, IT
1991		Ottawa, CA
1992	Lund, SE	Nice, FR
1993	Warwick, UK	Copenhagen, DK
1994	Zürich, CH	Buxton, UK
1995	Ghent, BE	Palm Springs, USA
1996	Stuttgart, DE	Gothenburg, SE

1997	Helsinki, FI	Athens, GR
1998		Oslo, NO
1999		Edinburgh, Scotland
2000	Athens, GR	Hague, NL
2001	Rio De Janeiro, BR	Bath, UK
2002	Brussels, BE	Lyon, FR
2003	Athens, GR	Washington D.C., USA
2004	Warsaw, PO	Prague, CZ
2005	Santorini, GR	Brussels, BE
2006	Ottawa, CA	Lyon, FR
2007	Copenhagen, DK	Crete, GR
2008	Ghent, BE	Kyoto, JP
2009	Barcelona, ES	Berlin, DE
2010	Amsterdam, NL	Seoul, KO
2011	Brussels, BE	Brussels, BE
2012	Brussels, BE	Copenhagen, DK
2013	Washington DC, USA	Athens, GR
2014	Brussels, BE	Poznan, PO
2015	Lund, SE	Madrid, ES
2016	Aalborg, DK	Alexandria, USA
2017	Brussels, BE	Nottingham, UK
2018	Wellington, NZ	Juan-les-Pins, FR
2019	Dublin, IE	Ghent, BE
2020	Virtual	Virtual
2021	Virtual	Virtual

ANNEX 5

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