INTERNATIONAL ENERGY AGENCY
Energy conservation in buildings and community systems programme

28th AIVC Conference

Building Low Energy Cooling and Advanced Ventilation Technologies in the 21st Century

Conference Report

Air Infiltration and Ventilation Centre
Operating Agent and Management
INIVE EEIG
Boulevard Poincaré 79
B-1060 Brussels
Belgium

Written by Willem de Gids
December 2007

0 Introduction

From September 27 to September 29, the 28th AIVC Conference was held at the Aldemar Knossos Royal Village Conference Centre located in the outskirts of Hersonissos village in Crete, Greece. An excellent ambiance to inspire the ventilation research society.

The 28th AIVC conference was organized in conjunction with the 2nd Palenc conference. Palenc stands for Passive and Low Energy Cooling. So the main theme of the conference was **Ventilation and Cooling**.

This overview set its focus mainly on the ventilation aspects.

The foreword in the proceedings from Peter Wouters and Mat Santamouris starts with:
"Increase of the living standards, deterioration of the thermal conditions in the urban environment and non-appropriate architectural design have caused a huge penetration of air conditioning in Europe, mainly but not only in the Southern Countries. Such a trend has a very serious impact on the peak electricity demand of these countries and the corresponding energy consumption. Intensive research carried out during the last years has permitted to develop new concepts, technologies and components that permit to decrease drastically or even eliminate the cooling demand of buildings. In parallel, very low energy consumption for cooling new generation buildings have been realized and monitored.

Intelligent ventilation permit to decrease the cooling demand, improve the comfort conditions and decrease indoor pollution levels. A wide range of activities by the research community and industry has permitted to develop advanced ventilation systems that highly satisfies the above requirements."

This present situation in the world is really a challenge for the researchers to show the possibilities of alternative cooling and ventilation strategies.

There were plenary sessions consisting of Key Note lectures as well as sessions with 3 parallel tracks.

The overview of the normal or standard sessions who all started also with a keynote speaker are done per session but per headline of topic. Going through all the session the choice was on four topics:

- Measurements
- CFD Modelling
- Schools
- Miscellaneous

It is always difficult to characterize a paper on its content and from that to put it under a certain topic. The choice is in most cases arbitrarily.

1 Plenary session 1

In the first Plenary Session there were three keynotes speaker.

Olli Sepannen from Helsinki University held an inspiring summary about the role of the indoor environment on peoples performance mainly in the working situation. He did not only talk about absenteeism, due to sickness leave but rather about the better performance due to a good or increased quality of the indoor environment. A discussion on the basis for ventilation requirements was integrated in his lecture: only ventilation for humans or also for emissions of building and furniture. Comparisons between natural and mechanical ventilated building and symptoms of people were presented and commented.

The second Key Note was from Mr H.Akbari from Lawrence Berkeley National Laboratory USA. He started to look more globally to the problem of global warming and its effect on the climate. He showed the result of new technologies for estimating the average annual surface temperature of the earth using satellites. He pointed out that coatings on roofs and roads may influence the global warming. This lecture was more focusing on the political choices which should be made to protect the world from to big changes in climate. Some attention was paid on the behavioural aspect as well as the perception of people on indoor climate.

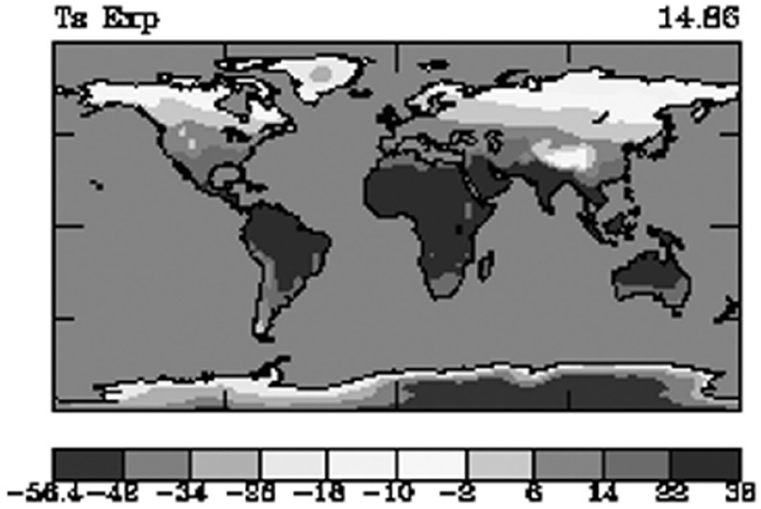

Figure 1 : Preliminary simulations of surface temperature (Ts) using the NASA GISS GCM. Global annual averages are listed on r.h.s. of the figure. (H. Akbari, S. Menon, A. Rosenfeld. Global cooling: effect of urban albedo on global temperature)

The third Key Note was from an architect: Mrs Sue Roaf from the UK. She started to point out that most people in architecture and building services think too traditional and are not creative enough. Her main topic was about poor hospital architecture. Without using the word “hybrid ventilation” she was more or less promoting the hybrid approach. People should start to think more about the application of natural ventilation with open windows for cooling as well as indoor air quality in hospital wards. But she also remind us to think about cross infection in hospitals. So mechanical ventilation is required in those parts of hospital where flow direction control is required. Areas such as operating theatres, intensive care and laboratories must be mechanically ventilated. Her main message “start to think of the application of natural ventilation in low rise buildings” was clear.

2 Measurements

To be honest the papers about measurements and measurement techniques were not amongst the majority of papers. Modelling seems nowadays the way of studying problems or solutions for buildings. Nevertheless there were quite interesting papers on measurements. In the first AIVC track session there were two papers both from Asia. One paper about multi zone air flow from H. Yoshino and one paper from T. Kim. H. Yoshino presented a paper with an interesting comparison between results from tracer gas measurements and results based on human CO_2 production.

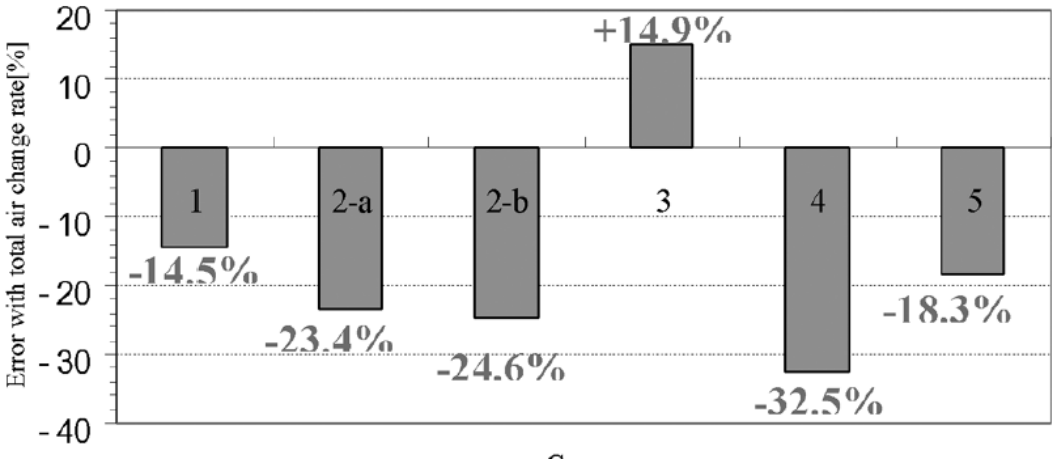

Figure 2 : Comparison of total air change rate of each case (H. Yoshino, M. Fujikawa, R. Takaki, H. Okuyama, M. Hayashi, M. Sugawara. Measurement method of multi-zone air flow rate using human expiration)

T. Kim from Korea was investigation the spread of odours in high residential buildings.He used SF6 as tracer. His conclusions was overcome spreading totally was almost impossible but a good kitchen ventilation system reduces the annoyance considerable.

Air tightness measurements of buildings were reported in an number of papers. Ms Sfakianaki from Greece reported about measurements in 40 Greek houses. She found a wide range of n_{50} values varying from reasonably tight, n_{50} of around 2 ACH to leak houses with an n_{50} of around 13 ACH. The relative importance of air tightness for the energy balance has of course a strong relation with the outdoor temperature and hence the heat demands of the dwelling. She proposed a classification in three groups:

- n_{50} 1-5 h^{-1} high level
- n_{50} 5-10 h^{-1} medium level
- n_{50} > 10 h^{-1} low level

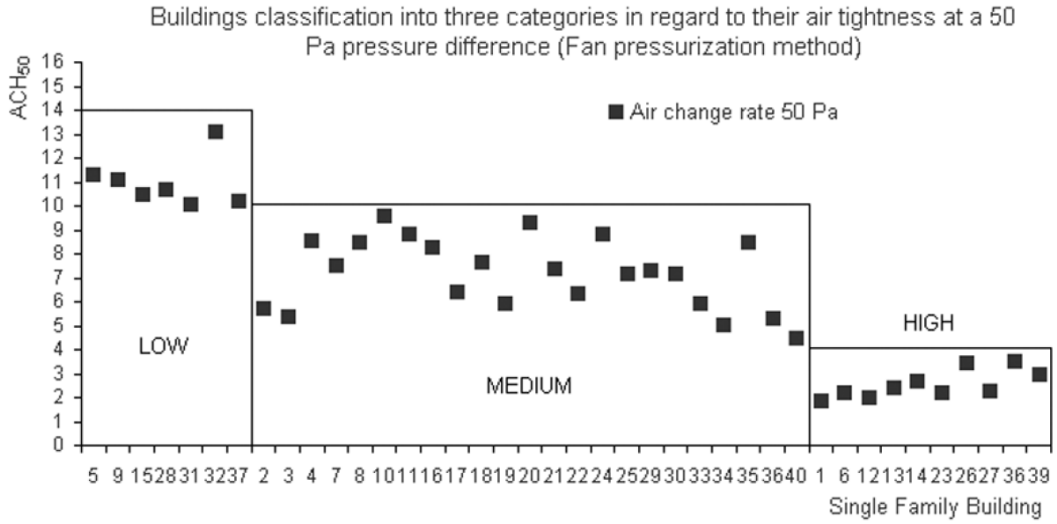

Figure 3 : Proposal for Greek building classification into three categories in regard to their air tightness at a 50 Pa pressure difference (Fan pressurization method) (K. Sfakianaki & others).

Mat Santamouris from Greece gave an interesting talk about urban aspects and indoor air quality. CO_2, CO, TVOC, PM2,5 and PM10 were measured in fifty houses. The ventilation rate was calculated from the CO_2 concentrations. Although he was especially looking to indoor/ outdoor effects, he found that pollutants produced by the people themselves play an important role in the concentrations measured. Especially smoking was, not surprisingly though, a dominant factor. Most pollutants were above the required or advised levels in homes.

C. Kittas from Greece did a study on pesticide distribution in greenhouses using N_20 as a tracer. He also carried out simulations with a numerical model. He found good correlations between measurements and prediction.

Microorganisms in the air in swimming pools were measured in a program of qualifying swimming pools by H Kokotti (Finland). He found adverse effects on health and recommend adequate ventilations provisions in swimming pools. The same author had a paper on microbiological growth in crawlspaces and the influence on the indoor air quality in homes.

3 Computational Fluid Dynamic (CFD) models

Computational fluid dynamic models are more and more used as a tool to evaluate and predict air flow in and around buildings. It application is not always obvious because the input data of these models and the algorithms used to predict the friction are not easy to chose. Reliable use of CFD models always requires a measured reference set of data to fit or check some of the results.

In this conference CFD applications were reported very frequently and applications vary from the air flow distribution in greenhouses to the air flow in solar chimneys.

The most interesting study was from A. Pitts from the UK. He carried out a study on the effect of roof angle on wind induced cooling. Pitts put al data together and give guidelines for the design in his paper.

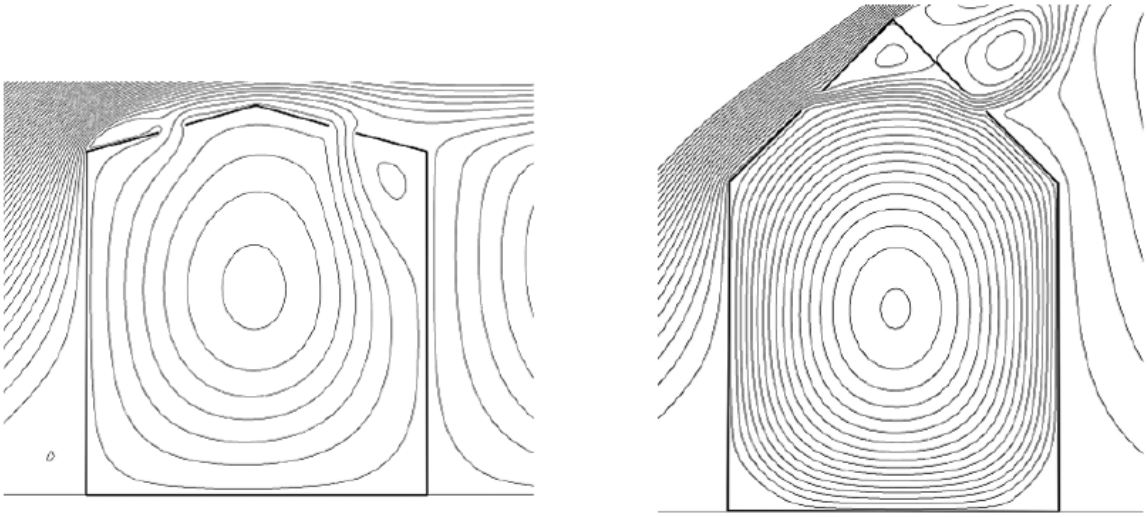

Figure 4 : Airflow pattern of wind-induce natural ventilation for atrium spaces with a roof angle of 15°(left) and 45°(right) (R. Li, A. Pitts, M. Niu . The effects of roof angle and width of adjacent buildings on wind-induced cooling ventilation of atrium spaces)

Another interesting presentation was from P.R. Drach from Brazil. This paper describes in depth the modelling approach and choices of algorithms He modelled an old building from north Africa. He found a reasonable agreement between what was reported in very early literature. The passive cooling was applied centuries ago and we are reinventing it.

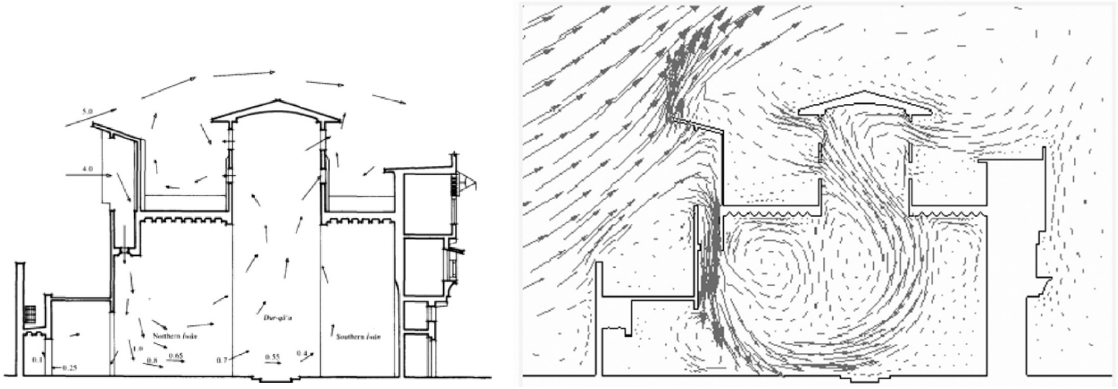

Figure 5: Left - Section throught the Q˜a'a ofMuhib AdDin Ash-Shf'i Al-Muwaqqi - mesurements were made by students from the Architectural Association School, London in 1973 (Fathy 1986). Right - Steady state – wind field .
(P. R. Drach, F. J. Karam. Computational analysis of indoor air circulation and heat transfer in a house ventilated by wind-catch)

T.Endo from Japan did a study on wind pressures effects on buildings. Quite interesting results were be obtained. Prediction and experimental results show a reasonable agreement.

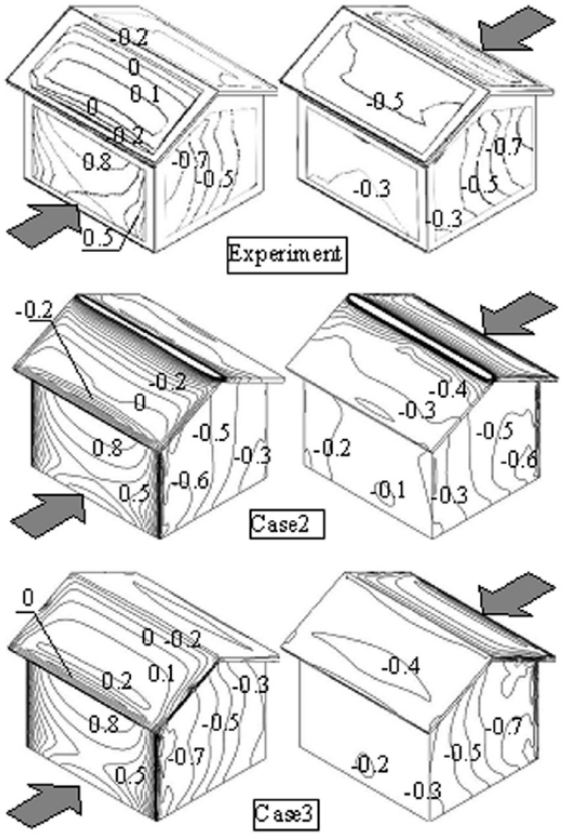

Figure 6 : Wind pressure distribution (Y. Kadowaki, T. Kurabuchi,T. Nonaka, T. Endo. Enhancement of cross-ventilation of a detached house using roof surfaces in densely populated urban areas Part 2 Numerical investigations about the effects of the roof surface use by CFD)

The last paper on CFD modelling which is given attention in this overview is from T Bartzanas from Greece, who studied the air flow in greenhouses due to different roof vents. He found that not only the roof vents but also wall vents could improve the ventilation of the greenhouses.

Reading through the two volumes with the papers of the conference a lot of papers on CFD were also presented in the Palenc track of the conference. They are certainly also worth to be read and to be studied.

4 Schools

School buildings were very popular in this conference. About ten papers dealt with schools buildings. Several topics were touched on during the conference. Such as:

- Learning skills
- Comfort
- Indoor Air Quality
- Window opening behaviour
- Passive cooling
- Design

G. Iwashita (Japan) presented a good paper on natural ventilation in schools without heating. Not only the ventilation was not always sufficient as can be seen from the figure below, but also the temperatures in winter were sometimes around 17 ^{o}C during school hours.

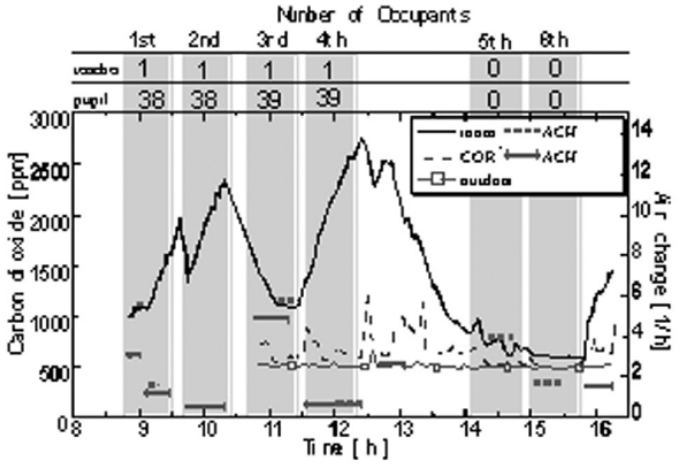

Figure 7 : CO2 and airchange rate on February 9th (G. Iwashita, H. Yoshino. The effect of natural ventilation on the indoor air quality in classroom of the elementary school without heating equipments during winter season)

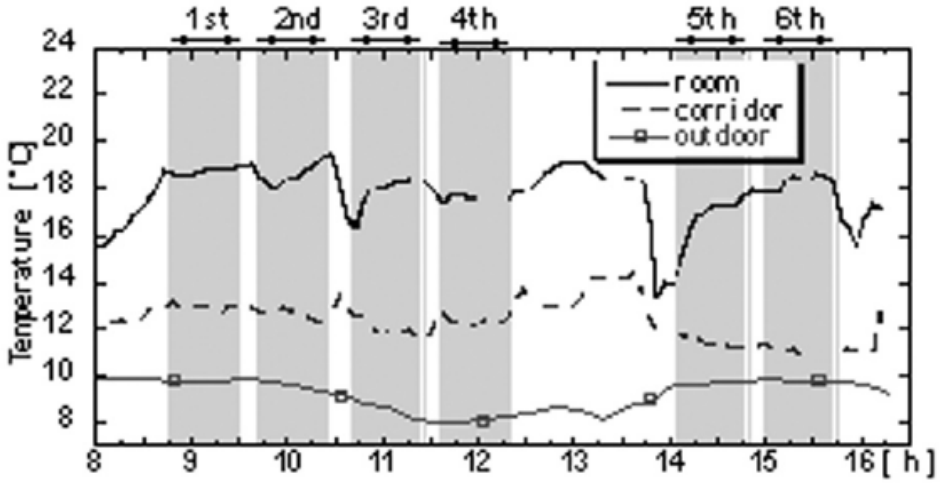

Figure 8 : Temperature on February 10th(G. Iwashita, H. Yoshino. The effect of natural ventilation on the indoor air quality in classroom of the elementary school without heating equipments during winter season)

From the Netherlands there were several studies by different authors about perceived comfort and learning skills of pupils in classrooms. A double blind study was carried out in two classrooms with each around 25 pupils. At the beginning of the lessons they were asked to carry out 4 type of tests. In one classroom the ventilation was controlled in the other the ventilation was only through infiltration so all ventilation provisions closed. No one in the school knew in what classroom the ventilation was controlled. The effect of CO_2 as an indicator for the indoor air quality on the performance of pupils was about 10 % less mistakes in the ventilation controlled classroom.

5 Miscellaneous

Pressure coefficients (Cp) on buildings are very important input data for ventilation studies where multi zone modelling is used. A complete new approach was presented by M. Tajima from Japan. He made a relation with an earlier presented paper in an AIVC conference about the Cp generator which was based on wind tunnel data. His neural network approach is innovative and looks promising at the same time looking to the results he obtained.
Cp data predictions from a neural net work

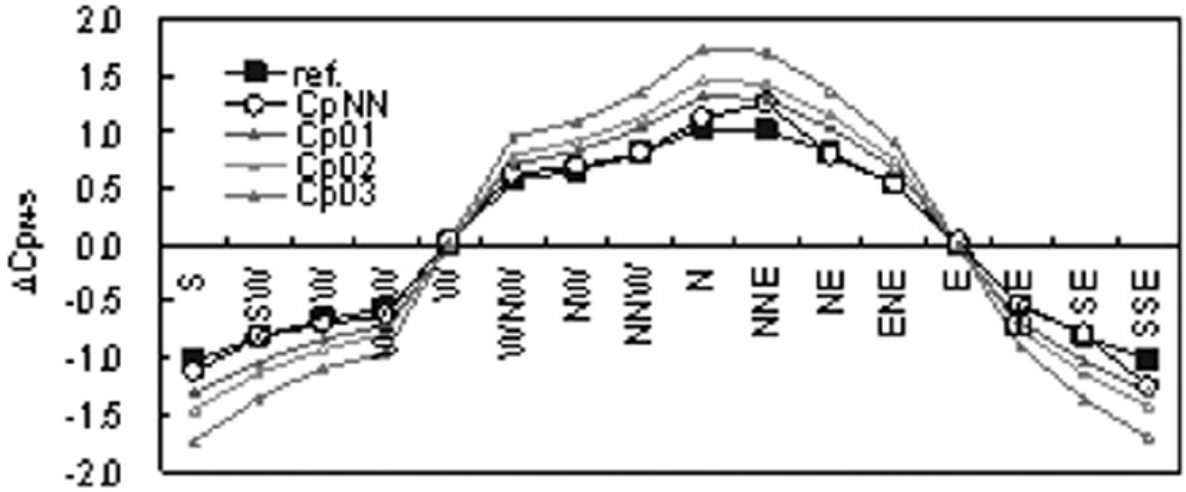

Figure 9 : ΔCp values used for the ventilation calculations (M. Tajima, T. Sawachi. Accuracy of a neural network for the prediction of wind pressure coefficient)

Apart from the above described papers there were a lot of very interesting papers from different authors which has not yet been described in this overview. Aspects as air flow and contaminants in street canyons, adaptive comfort, air flow in single sided openings, air distribution effectiveness, the application of heat recovery and sustainable heating with mine water it is all in the proceedings and worth reading.

The Air Infiltration and Ventilation Centre was inaugurated through the International Energy Agency and is funded by the following countries:

Belgium, Czech Republic, Denmark, France, Greece, Japan, Republic of Korea, Netherlands, Norway and United States of America.

The Centre provides technical support in air infiltration and ventilation research and application. The aim is to provide an understanding of the complex behaviour of the air flow in buildings and to advance the effective application of associated energy saving measures in both the design of new buildings and the improvement of the existing building stock.

Air Infiltration and Ventilation Centre
Operating Agent and Management
INIVE EEIG
Boulevard Poincaré 79
B -1060 Brussels - Belgium

www.aivc.org

Tel: +32 2 655 77 11
Fax: +32 2 653 07 29
inive@bbri.be
www.inive.org