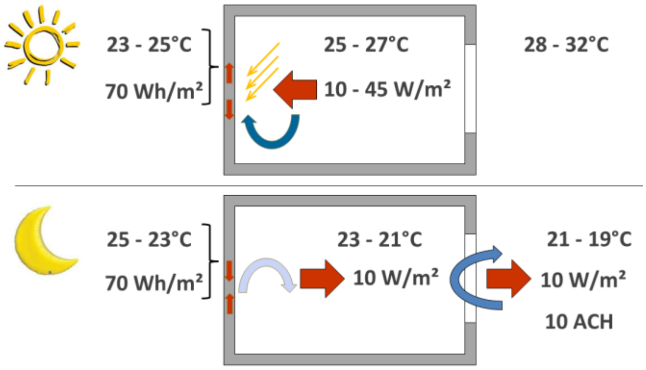

# Feedback from the 39th AIVC & 5th venticool conference: Summary of the ventilative cooling track

More than 200 participants attended the joint 39th AIVC – 7th TightVent – 5th venticool conference held in Juan-Les-Pins, France on September 18-19, 2018. The programme consisted of 3 parallel sessions with contributions from 27 countries and international organisations. Around 150 presentations were given covering the main conference topics namely: Smart Ventilation, Indoor Air Quality (IAQ) and Health relationships; Ventilation and (building) Airtightness; Ventilative cooling - Resilient cooling.
It has also been a major discussion place for on-going or recently launched projects and initiatives such as the Indoor Environmental Quality – Global Alliance (http://ieq-ga.net/), the IEA EBC annex 80 "Resilient Cooling" (http://annex80.iea-ebc.org/) and the IEA EBC annex 78 "Supplementing Ventilation with Gas-phase Air Cleaning, Implementation and Energy Implications"( http://annex78.iea-ebc.org/).
The "Ventilative Cooling-Resilient Cooling" track at the AIVC 2018 conference consisted of 14 presentations organised in 3 sessions:

1. Ventilative cooling
2. Improving the efficiency of ventilative cooling
3. IEA EBC Annex 80 on Resilient Cooling (topical session)

The article available here provides a summary of the main trends and conclusions addressed during the presentations and discussions on the topic of ventilative & resilient cooling.

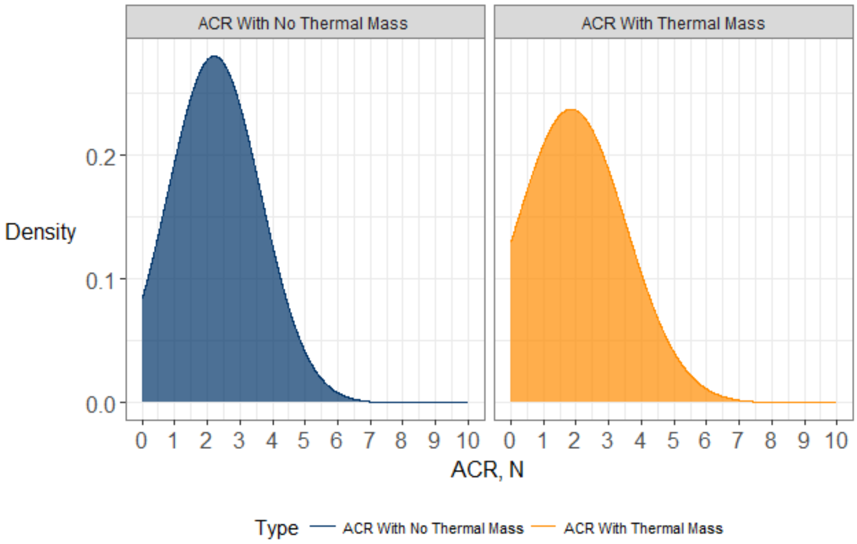
In the framework of *IEA EBC Annex 62 Ventilative Cooling* project, Stern presented a list of key performance-indicators derived from successful ventilative cooling solutions as well as a list of major challenges and examples of successful practical solutions (Holzer & Stern, 2018). According to the authors, airflow, temperature, usability & reliability are crucial for ventilative cooling (VC) systems. The successful implementation of ventilative cooling entails: favouring airflow through architectural apertures; enhancing airflow by powerless ventilators; designing for very low pressure drop in the VC-system; making the most of available temperature differences while limiting VC to periods which physically make sense; strictly emphasising operability and reliability of VC components; and recognizing the importance of post occupancy optimisation.




Scheme of typical VC temperatures, loads and air change rates (Holzer & Stern, 2018)

Plesner & Pomianowski evaluated how well ventilative cooling is currently integrated into Danish national standards, legislation and compliance tools (Plesner & Pomianowski, 2018). Results showed that ventilative cooling is not explicitly addressed in Danish building legislation nor national standards while there is lack of information on how to use windows, night cooling possibilities, window control and automation. However, while most European compliance tools use monthly average models that could underestimate the cooling potential of ventilative cooling, Denmark has implemented a “summer comfort” module (additional feature to the official compliance tool) that performs hourly calculations of thermal comfort in summer in residential buildings. The authors recommended that the full effects of ventilative cooling are evaluated reflecting the real conditions for the building, control, use and climate. Moreover, legislation should include or refer to guidelines, standards or compliance tools on how to calculate the cooling effect, resulting temperatures and the energy performance. Compliance tools should also reflect what is stated in the legislation.
Pomianowski et al validated a BSim dynamic model- according to the procedure proposed in EN 15255 standard “Thermal performance of buildings – Sensible room cooling load calculation – General criteria and validation procedures”. The validation was followed by a comparison between simulated and measured operative temperatures in order to predict the performance of ventilative cooling in a single sided ventilated room (Pomianowski, Smal, Florentzou, & Heiselberg, 2018). The results of their study suggest that a good understanding of indoor air distribution and the software used is important. The reliability of simulation results of natural ventilation were comparable to results for mechanical ventilation strategy, and a good estimation of natural ventilation performance was obtained. Validation against EN 15255 was recommended taking into account that non-compliance in some cases can be reasoned by discrepancies between the standard’s and software’s input possibilities. The robustness of the model needs to be checked for one parameter at a time as well as their combination.
Breesch et al. evaluated the thermal comfort and measured performances of a ventilative cooling system of a nearly Zero Energy Building (nZEB) school building of KU Leuven Ghent Technology Campus (Breesch, Merema, & Versele, 2018). They carried out long term measurements of internal temperatures, occupancy, opening of windows, operation of indirect evaporative cooling (IEC), airflow of air handling unit (AHU), etc. from May to September 2017. Their measurements showed an overall good thermal summer comfort (excluding heat waves and/or periods with high occupancy rates where high indoor temperatures were monitored), while night-time ventilation and indirect evaporative cooling operated very well. They also found that IEC can lower the supply temperature by day significantly compared to the outdoor temperature and that the air change rate (ACR) of the night ventilation depends a lot on wind direction and velocity. Two key lessons learned from the operation phase were: 1) the data monitoring system was essential to optimize the performance of the ventilative cooling; and 2) the users have to be informed about the operation of automated systems.
O’ Sullivan et al. looked into the effect of incorporating energy storage on the assessment of climate cooling potential for low energy buildings (O’ Sullivan, O’ Donovan, & Murphy, 2018). They

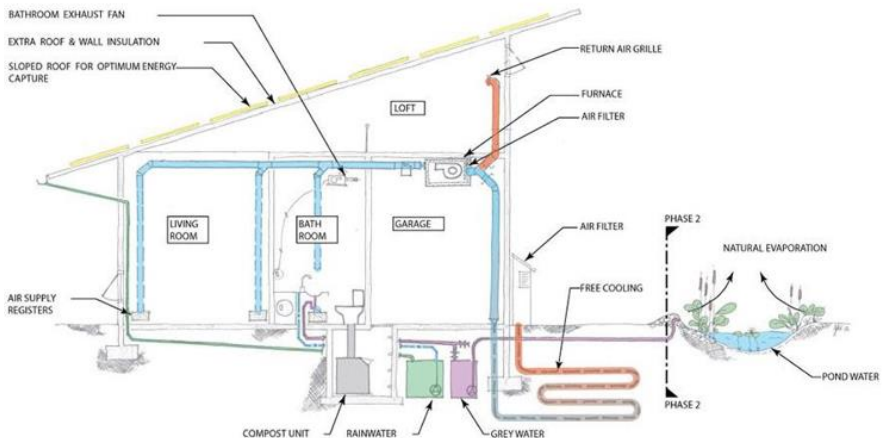
proposed a method to include the energy accumulation in the steady state energy balance equation for predicting the balance point temperature used to assess the ventilative cooling state. Based on their results, a modest energy accumulation significantly influences the prediction of ventilative cooling hours in winter months. Required cooling airflow rates are also modified significantly. Simplified approaches to incorporating thermal mass in early stage assessment of climate cooling potential should be considered further and can influence whether or not a passive strategy may be adopted for a building design.




Change in range of ACR values when an energy accumulation term is used in the energy balance equation (O' Sullivan, O' Donovan, & Murphy, 2018)

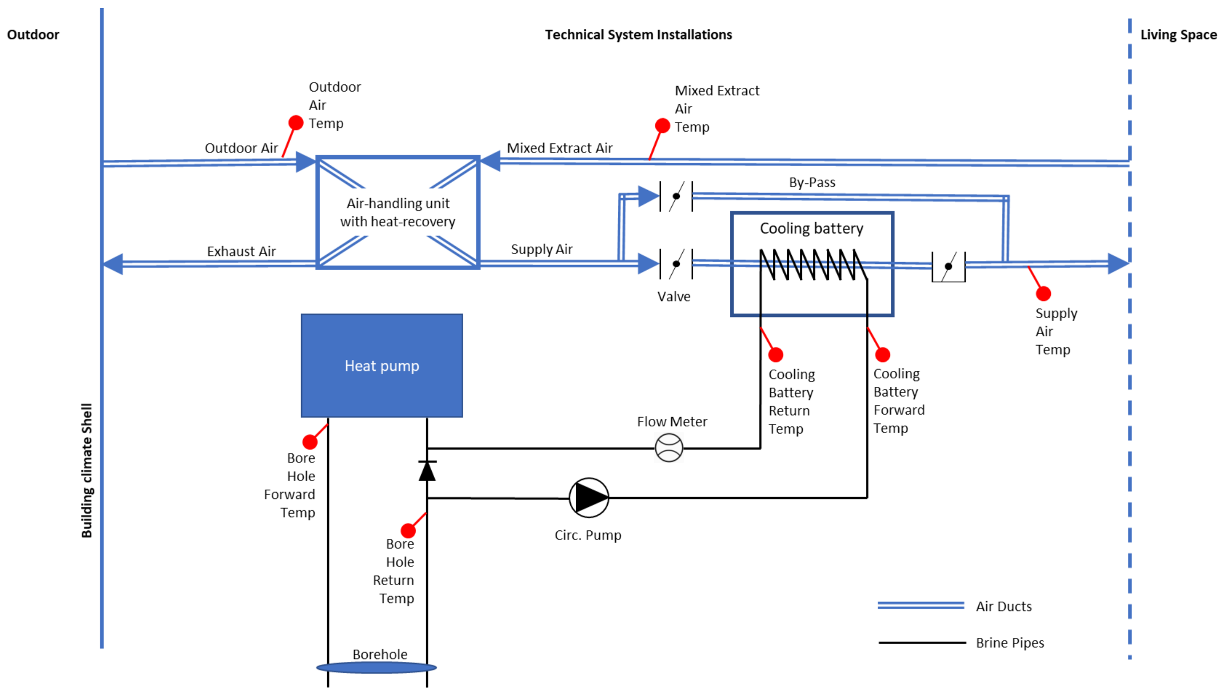
Litvak presented the results (state of the art and onsite measurement campaigns) of FREEVENT, a research project which mainly deals with field measurement evaluations of summer comfort and evaluates the efficiency of ventilative cooling in French residential and office buildings (Litvak, Bernard, Piot, & Labaume, 2018). Onsite conditions, buildings' architecture characteristics, thermal inertia, solar shadings and various constraints were discussed as main designing choices for efficient ventilative cooling systems. They showed how performance is linked to good sizing, design, correct use of thermal destocking, and correct fit in and correct take over, checking airflows as well as controls of the system. Recommendations & guidelines for designers were summarized. Key points for success highlighted by the presenter included: Upstream bioclimatic design: ventilative cooling will not compensate a poor design of internal and external loads; adequate sizing that accounts for all comfort criteria; involvement of owners / maintainer and occupants in the first years for fine-tuning operation and; development of devices specifically dedicated to over-ventilation.

Butler presented the context and application of earth tube systems for the provision of ventilative cooling and general make-up air in the heating, ventilation and air conditioning (HVAC) sector of the built environment focusing on case studies in Canada (Butler, Littlewood, & Millward, 2018). The earth tubes appear to be a proven technology to provide free cooling, but also the factors of improving indoor air quality in winter – as well as summer – are further benefits, with no operational costs. The factors such as passive survivability are enhanced through less reliance on complex mechanical equipment. The earth tubes are a simple technology that can assist the passive operation.



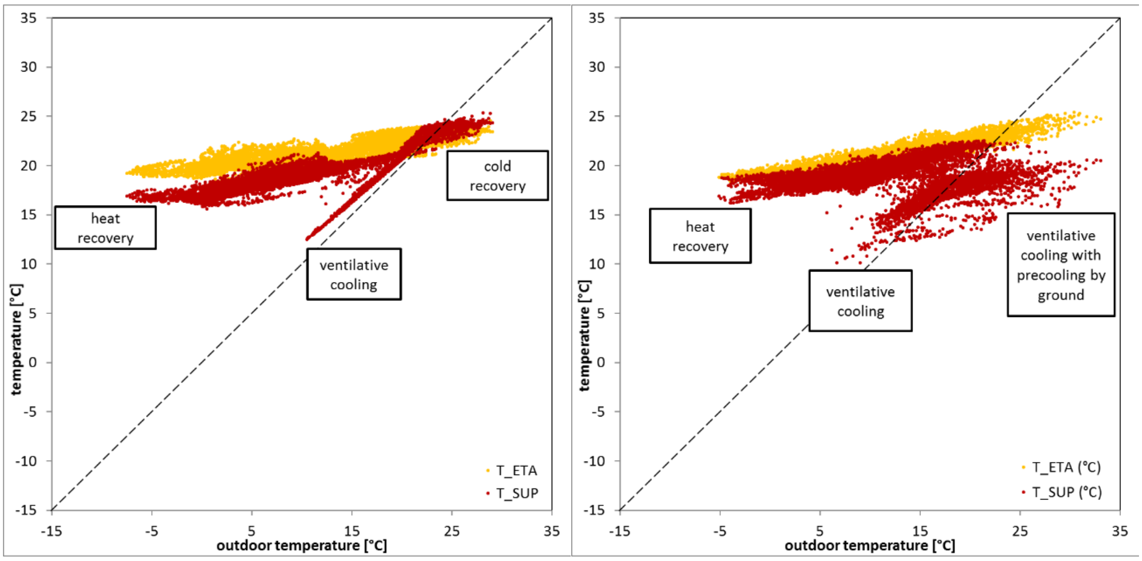

Ethel Lane House - Zero Air-Conditioned – 100% passive cooling by earth tubes (Butler, Littlewood, & Millward, 2018)

Gustafson et al. investigated the integration of a ground source heat pump system with a bidirectional ventilation system with heat recovery to enable free cooling in a single family nZEB. This was done by simulation of the building and the building services engineering systems in IDA Indoor Climate and Energy (IDA ICE) and by follow-up field measurements in a research villa (Gustafsson, Haglund Stignor, Chen, Ruud, & Persson, 2018). The measurements confirmed that it is possible to lower the indoor temperature considerably by free cooling by use of the borehole and supply the air system, even though the cooling capacity is limited due to restrictions on ventilation rates and supply air temperature. Moreover, control of the free cooling system was found crucial to achieve the full cooling potential and for high system energy performance.



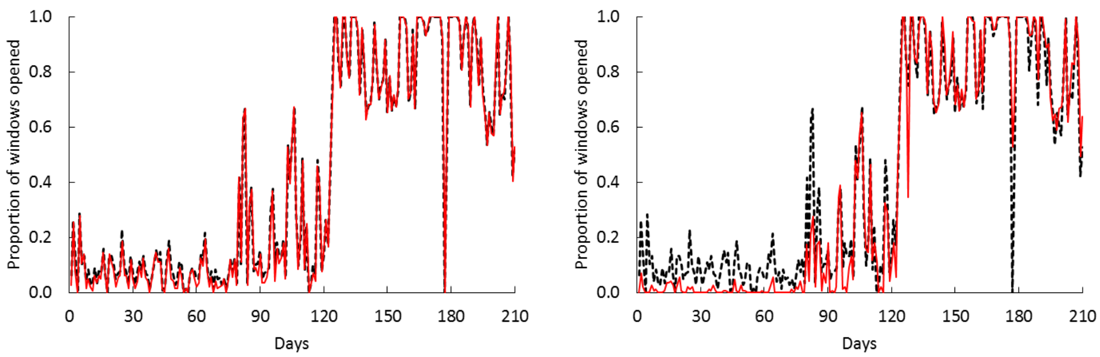

The system setup of the installation of the cooling battery in the Research Villa (Gustafsson, Haglund Stignor, Chen, Ruud, & Persson, 2018).

Cremers conducted an energy analysis of a balanced ventilation system during a full year (Cremers, 2018). Balanced ventilation units were monitored in six field studies, located in The Netherlands, Germany and Austria, and two of these units were combined with ground heat exchange. For an entire year, relevant parameters were recorded in each project, and hourly average values were analysed. The heat recovered, the ventilative cooling, and the cold recovered have been evaluated and given as a function of outdoor air temperature. The values were summed into annual heating recovered, annual ventilative cooling and annual cold recovered. The sums were compared to the electrical consumption in the respective period. Values for the ventilative cooling indicate efficient performance of cooling with the mechanical supply of fresh air. Using ground heat exchange, the period where ventilative cooling is used is extended from only during cool summer nights to the entire summer period. When outdoor is warmer than extract air, ventilative cooling by natural means is not preferable. The cold recovery by a balanced ventilation system reduces the cooling load of a dwelling to some extent, besides the comfort increase by reduction of the supply temperature.

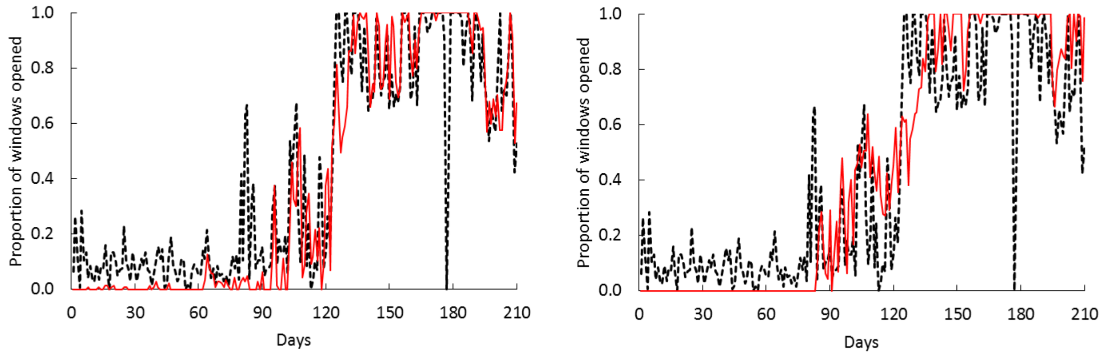



Extract temperature (yellow) and supply temperature (red) as a function of outdoor temperature for field test DE03 (left) and field test “Nulwoning” (right) (Cremers, 2018).

Jeong et al. aimed to identify an appropriate algorithm and primary parameters for predicting window opening behaviour in residential buildings (Jeong, Choi, Yoo, & Park, 2018). They compared the predictive accuracy of a logistic regression model and three machine learning algorithms (k-Nearest Neighbours (KNN), Random Forest (RF) and Artificial Neural Networks (ANN)). The tested machine learning algorithms outperformed the logistic regression model. KNN showed the best performance but requires to consider its computational cost. Temperature-related variables are the major predictors to be used for window opening prediction. The results showed improvement of predictive accuracy with the use of machine learning-based control system.




(a) KNN (b) RF




(a) ANN (b) LR

Comparison of KNN's RF's ANN's and LR's predicted proportion of windows opened with observed data. The dashed line represents observed data and the solid red line represents predicted data (Jeong, Choi, Yoo, & Park, 2018).

Bejat et al. performed an experimental and numerical study of a building retrofitting solution combining Phase Change Material (PCM) wallboards and night ventilation (Béjat, Fulcheri , & Therme, 2018). They developed a modular, reversible, lightweight retrofitting system and integrated it in a real size experimental test cell aiming to develop a retrofitting solution for office buildings which can be rapidly and reversibly installed as an inside layer on the existing structure, like a "box in a box" to replace air-conditioning by night cooling. According to the authors the "box in the box" concept was able to replace air-condition by free cooling in temperate climates. Nevertheless, combining with space ventilation is crucial to obtain competitive results for hot periods. The simulations showed that a PCM changing phase at 27°C can decrease the "integrated thermal discomfort level over 26°C" (ITDL26) by 65% compared to a PCM changing phase at 23°C.

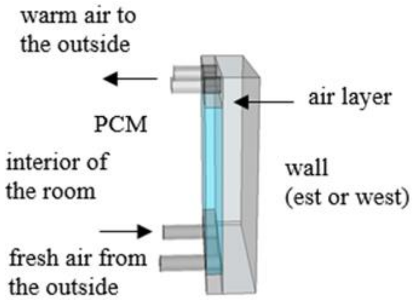
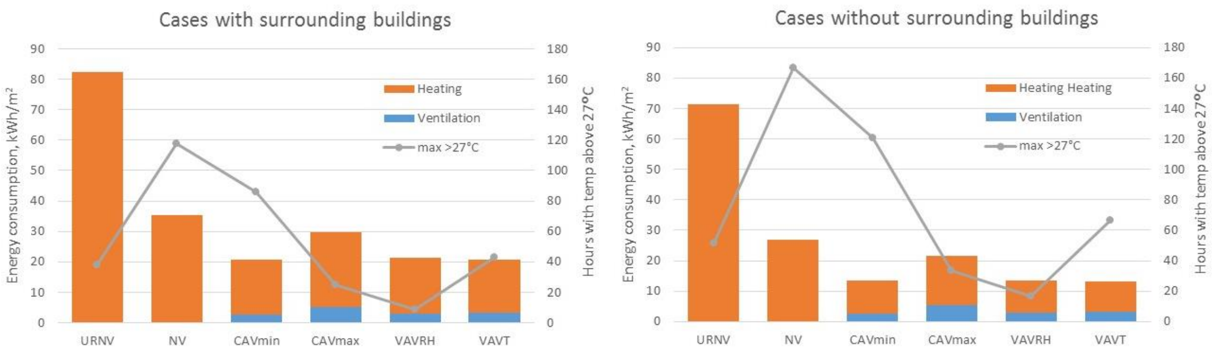



Illustration of the PCM panel (Béjat, Fulcheri , & Therme, 2018)


Illustration of the test cell at CEA INES with the photo of the built system. (Béjat, Fulcheri , & Therme, 2018)

Zukowska et al. carried out a simulation based study to investigate the potential of mechanical ventilation for reducing overheating risks in retrofitted Danish apartment buildings from the period 1850-1890 (Zukowska, Kolarik, Ananida, Sarey Khanie, & Rammer Nielsen, 2018). The study showed that energy renovation in this type of buildings, including adding insulation and exchanging windows, yielded energy saving of approx. 60%, but resulted in an increase of overheating hours when no mechanical ventilation system was added. All studied mechanical ventilation systems with heat recovery were able to decrease the overheating hours below the limit specified by the Danish building code in the case of a building situated in a narrow street canyon. In the absence of shading from surrounding buildings, the constant air volume (CAV) ventilation operating with minimum airflow required by the Danish building code reduced overheating hours insufficiently.




Energy consumption and a number of hours with indoor temperature over 27 °C in the zone with maximum overheating hours (kitchen) for the investigated ventilation strategies for cases with surrounding buildings (left) and without (right) (Zukowska, Kolarik, Ananida, Sarey Khanie, & Rammer Nielsen, 2018)

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