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Operating Agent
and Management
Boulevard Poincaré 79
B-1060 Brussels – Belgium
inive@bbri.be - www.inive.org

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Air Infiltration and Ventilation Centre

Ventilative Cooling

State-of-the-art review executive summary

Per Heiselberg &
Maria Kolokotroni

1 Introduction

Overheating in buildings is emerging as a challenge both at the design stage and during operation. This is due to a number of reasons:

- high performance standards to reduce heating demand by high insulation levels;
- restriction of infiltration in heating dominated climatic regions;
- the occurrence of higher external temperatures during the cooling season due to changing climate and urban climate not usually considered at design stage;
- changes in internal heat gains during operation not factored in the design.

Such factors have resulted in significant deviations in energy use during operation which is usually termed the energy 'performance gap'. In most energy performance comparative studies, energy use is higher than predictions and post-occupancy studies frequently report overheating problems. Ventilative cooling can be a solution.

Ventilative cooling refers to the use of natural or mechanical ventilation strategies to cool indoor spaces. This effective use of outside air reduces the energy consumption of cooling systems while maintaining thermal comfort. The most common technique is the use of increased ventilation airflow rates and night ventilation, but other technologies may be considered. Ventilative cooling is only working in case the outside temperature is lower than the inside temperature and/or in case there is sufficient thermal mass available to cool down. Ventilative cooling is relevant in a wide range of buildings and may even be critical to realise renovated or new nearly Zero Energy Buildings (NZEB)[1].

Ventilation is designed for and is present in buildings through mechanical and/or natural systems for Indoor Air Quality (IAQ) purposes and it can be used additionally to remove both excess heat gains as well as increase air velocities and thereby widen the thermal comfort range. However, to realise this potential, it is important that the technology is covered in regulations and it must be supported by appropriate technical solutions (distinct from IAQ ventilation) which are compatible and accounted for in standards and regulations.

This executive summary summarises the outcome of a state-of-the-art review carried out in IEA EBC Annex 62[2] and gives a brief overview of the state-of-the-art in ventilative cooling. The state-of-the-art report covers topics as follows:

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[1] Venticool: http://venticool.eu/

[2] Ventilative Cooling – State-of-the-art Review. Edited by Maria Kolokotroni and Per Heiselberg. Aalborg University 2015, ISBN 87-91606-25-X.

- Potentials and limitations
- Ventilative cooling in existing energy performance regulations
- Exemplary existing buildings
- Available building components and control strategies
- Existing analysis and design methods and tools

2 Potentials and Limitations to Ventilative Cooling

The ventilative cooling potential is favourable in most European countries, especially during night. Possible cooling energy savings range from about 30% to 50% for office buildings. Although limited in number, studies in the residential sector also suggest significant, yet lower, potential**.**

According to the definition, ventilative cooling is dependent on the availability of suitable external conditions to provide cooling. It also depends on the building type and its thermal characteristics which determine its cooling demand and the acceptability of internal environment by its users.

The review presents existing methods suitable to estimate the cooling potential of climatic conditions considering (a) the type of building, (b) time of cooling (day or night); (c) availability of natural driving forces; and (d) the impact of the urban environment[1,2,3].

As an example the review provides definition and worked examples of the 'climate cooling potential' (CCP) index. The CCP index is suitable for all ventilative cooling estimations and is based on (a) degree-day calculations and (b) on a building temperature variable within a temperature band determined by summertime thermal comfort. CCP can be used to calculate the ventilative cooling potential of regions and an example for Europe is presented in figure 1.

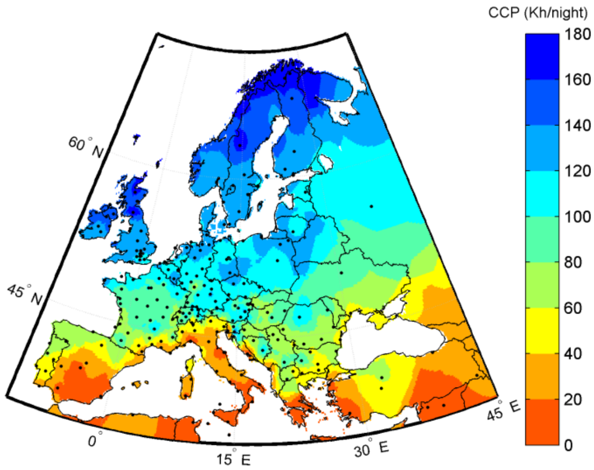

Figure 1: Map of mean climatic cooling potential (Kh/night) in July based on Meteonorm data[4].

For a daytime heat load of about 50W/m^2 a climatic cooling potential of about 80Kh/night is required to cool down the building thermal mass[5]. Therefore, it is concluded that in the whole of Northern Europe (including the British Isles) the climatic cooling potential is favorable, and therefore passive cooling of buildings by night-time ventilation seems to be applicable in most cases. In Central, Eastern and even in some regions of Southern Europe, the climatic cooling potential is still significant, but due to the inherent stochastic properties of weather patterns, series of warmer nights may occur at some locations, where passive cooling by night-time ventilation might not be sufficient to guarantee thermal comfort. If lower thermal comfort levels are not accepted during short periods of time, additional cooling systems are required. In regions such as southern Spain, Italy and Greece climatic cooling potential is limited and night cooling alone might not be sufficient to provide good thermal comfort during the

[1] Steven J. Emmerich, Brian Polidoro, James W. Axley. 2011. Impact of adaptive thermal comfort on climatic suitability of natural ventilation in office buildings. Energy and Buildings 43 (2011) 2101-2107.

[2] Cristian Ghiaus, Francis Allard. Potential for free-cooling by ventilation. Solar Energy 80 (2006) 402–413.

[3] Yao, R., Li, B., Steemers, K., Short, A. Assessing the natural ventilation cooling potential of office buildings in different climate zones in China. Renewable Energy 34 (2009) 2697-2705.

[4] Artmann N, H.Manz, P. Heiselberg P, 2007. Climatic potential for passive cooling of buildings by night-time ventilation in Europe. *Applied Energy*, 84(2), pp. 187-201.

[5] Artmann N, H.Manz, P. Heiselberg P, 2007. Climatic potential for passive cooling of buildings by night-time ventilation in Europe. *Applied Energy*, 84(2), pp. 187-201

whole year. Nevertheless, night-time ventilation can be used in hybrid cooling systems during spring and fall.

In many cases ventilative cooling is based partly or fully on natural driving forces for air transport. In such cases it is very important to be able to assess the availability and strength of the natural driving forces in the early design phases in a simplified way. Several methods have been developed for this purpose that are based on available climatic data and simplified assumptions on building location and design. These methods can estimate the ventilative cooling potential, when air transport is based on natural driving forces. In the review a method is presented[1], which integrates the British Standard natural ventilation calculation method[2] for a single zone within a thermal resistance network model[3], called the Thermal Resistance Ventilation (TRV) model.

The review continues by outlining current research on possible reduction of cooling energy use and/or decrease of the indoor temperature. Current studies mainly focus on office buildings for which simulations indicate that ventilative night cooling has the potential of eliminating or reducing cooling demand by approximately 30-50%.

Studies on residential buildings are limited but available studies indicate that there is potential. The application of ventilative cooling may be limited by a number of critical barriers, specifically outdoor noise and air pollution. The review provides indicative ranges for design possibilities.

The review also presents a number of thermal comfort indices used to evaluate the internal environment cumulatively and also considering their distribution within the building[4]. It discusses the Percentage outside the Range method introduced by ISO 7730 and EN 15251 and the percentage of occupied hours above a reference temperature. Cumulative indices are presented such as Predicted Percentage of Dissatisfied (PPD)-weighted criterion and exceedance$_M$ as well as risk indices such as overheating criteria. Finally, averaging indices such as average PPD are presented. The suitability and challenges in application of the different thermal comfort indices are highlighted and it is concluded that although suitable for mechanically conditioned buildings several indices might be misleading in the cases of naturally ventilated buildings.

3 Ventilative Cooling in Existing Energy Performance Regulations

It is complex to include ventilative cooling requirements in regulations as it includes aspects related both to ventilation, energy, building construction and comfort. Energy performance calculations in many countries do not explicitly consider ventilative cooling and most available tools used for energy performance calculations are not well suited to model its impact.

The review presents important results of surveys through questionnaires on the treatment of ventilative cooling in national codes and standards completed by participants of Annex 62. Three questionnaires were designed and completed by Annex 62 participants focussing on ventilative cooling aspects in (a) building codes, (b) national energy demand calculations and (c) implementation of ventilative cooling in current national building regulations. Results of these questionnaires are presented in detail in the review report.

It was concluded from the surveys that ventilative cooling requirements in regulations are complex and five categories of parameters

[1] Yao, R., Li, B., Steemers, K., Short, A. Assessing the natural ventilation cooling potential of office buildings in different climate zones in China. Renewable Energy 34 (2009) 2697-2705.
[2] CIBSE applied manual AM10: natural ventilation in non-domestic buildings. CIBSE, ISBN 0 900953772; 1997
[3] Yao R, Steemers K, Baker N. Strategic design and analysis method of natural ventilation for summer cooling. Build Serv Eng Res Technol 2005;26 (No. 4).

[4] S. Carlucci, L. Pagliano, A review of indices for the long-term evaluation of the general thermal comfort conditions in buildings, Energ Buildings, 53, (2012) 194-205

were identified; these are: (a) energy consumption for cooling, (b) building parameters influencing ventilative cooling, (c) ventilation requirements - both ventilation amounts and ventilation openings and positions, (d) safety, and (e) temperature, air velocity and humidity requirements. It is proposed that these need clarification in the national codes to facilitate ventilative cooling.

In the USA every state has its own regulations. In the review report, only the California building codes are discussed in detail. Compared to the European codes, the California building code has no fixed value for the energy demand, or equivalent coefficient, for a building, but a comparison to an energy calculation of a standard building which is described in the code is necessary.

Table 1*: Consideration of energy use for cooling in selected countries.*

	IT	NL	UK	DK	IR	CN	NO	JP	CH	BE	US-CA
Is energy consumption for cooling considered?	No	Yes	Yes	Yes	No	No	No[1]	Yes	Yes	Yes	Yes
Is energy consumption for cooling considered separately?	No	No	Yes	No	No	No	No	Yes	Yes[2]	No	No
Is auxiliary and parasitic consumption from mechanical ventilation considered separately?	No	No	Yes	No	Yes	No	No	Yes	--	No	No[3]
Is the energy consumption for (de-) humidifying considered separately?	No	No	Yes	No	No	No	No	No	Yes	No	?

Table 1 illustrates the outcome of the survey in relation to category (a) Energy consumption for cooling in residential buildings.

Countries in the European Union are required to implement the Energy Performance of Buildings Directive (EPBD). However, for some countries, such as Italy, national implementation is expected but not yet realised. And even if an energy performance level is required, energy demand for cooling is not necessarily considered. This leads to the unwanted situation that a calculation of energy demand for cooling is not required for all countries, thus rendering the energy benefit of ventilative cooling invisible in national regulations.

For several countries, The Netherlands, Belgium, Denmark, and Norway, the energy performance certificate requires a total energy demand calculation over a year, not separated in heating and cooling. If energy demand for cooling is not considered separately, the energy demand for cooling can be compensated by other means (reduced heating, sustainable energy production) diminishing the usefulness of ventilative cooling in the regulations.

Several countries include the energy demand from mechanical ventilation and de-humidification in the energy demand calculation. These aspects have an influence on ventilative cooling by influencing the choice for mechanical or natural ventilation if auxiliary and parasitic consumption from mechanical ventilation is considered separately. If de-humidification is considered, this might pose extra demands on the type of ventilative cooling that can be installed, being with or without de-humidification.

In Switzerland, there is a minimum requirement on electricity use in buildings, i.e., electric energy use of buildings estimated at

[1] Although energy demand for cooling is not explicitly mentioned in the Building Code, it is included in the total energy budget or energy measures required in the Building code.
[2] Electricity is separated from heat and hot water consumption. Cooling is part of electricity (1. lighting, 2. ventilation, 3. cooling, 4. auxiliary installations)
[3] But taken into account in the entire calculation

design cannot exceed a given value. Active cooling, lighting, ventilation and use of auxiliary installations are considered in the electric energy use. In other words, if you want to apply active cooling, it poses limits on lighting, ventilation and the use of auxiliary installations. However, according to dynamic calculations based on ISO 15 591, ventilative cooling may reduce cooling needs in Switzerland down to zero.

It was also revealed that energy performance calculations in many countries do not explicitly consider ventilative cooling. Therefore, available tools used for energy performance calculations might not be well suited to model the impact of ventilative cooling, especially in annual and monthly calculations. There might be need for the development of an international standard on ventilative cooling, which should also address calculation methods.

4 Exemplary Existing Building using Ventilative Cooling

A large number of buildings using ventilative cooling have already been built around the world. The review presents twenty-six existing and operational buildings from fourteen different countries using principles of ventilative cooling, recommended by the participants in the project and in this sense they provide significant examples of how ventilative cooling is currently exploited, developed and studied around the world. All buildings were built after 2000 and are located in different climates to include hot summer/cold winter (9), mild summer/cold winter (4) and mild summer/mild winter (5). The type of the buildings range from residential (6) to office (10), educational (8) and exhibition (2). Most buildings are newly built with one retrofit (CDdl Arfrisol Ceder). Table 2 provides an overview of all buildings included in the review.

Figure 2: C-DdI ARFRISOL CEDER, Altos de Lubia, Soria, Spain. Retrofit of office building using cross ventilation and intake chimneys, evaporative pads on top of windows, ventilated pergola on roof with solar thermal collectors and direct evaporative systems inside the Air Handling.

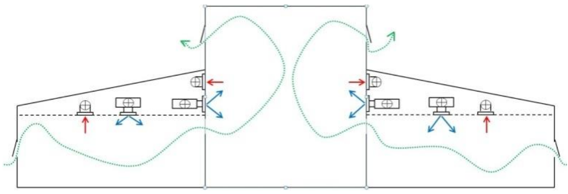

Figure 3: Solstad, Larvik, Norway. Kindergarten in Norway with hybrid ventilation combining motor controlled operable windows with balanced mechanical ventilation.

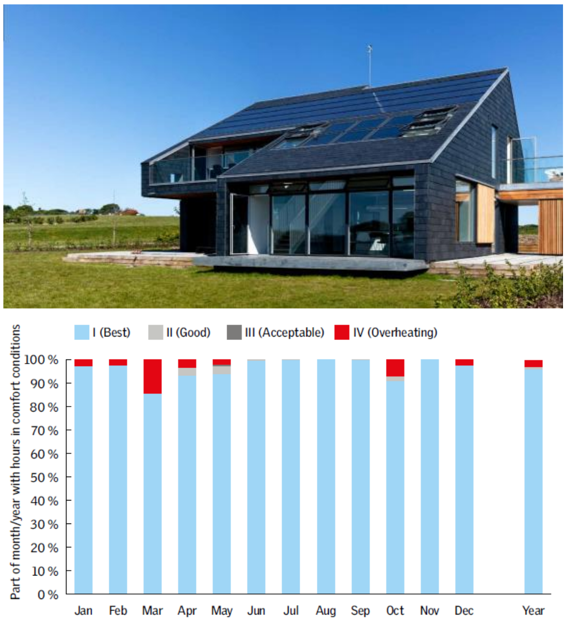

Figure 4: Home for Life – Denmark. Operable windows are distributed on all facades and the roof giving potential of utilising both cross ventilation and stack effect as well as single sided ventilation. Solar shading and natural

ventilative cooling is controlled by a building management system opening and closing windows according to indoor temperature and outdoor climate. Lower graph shows measured comfort conditions.

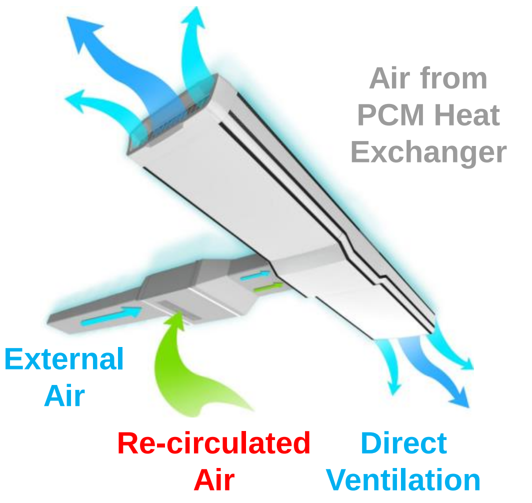

Figure 5: Bournemouth University, Bournemouth, UK. Cooling through night ventilation using Phase Change Materials (PCM) and a low energy fan.

Figure 6: CIT Zero 2020 Building, Cork, Ireland. Retrofit of office building using bespoke windows providing single sided ventilation. Annex 62 participants in front of the building.

Figure 7: Franshion Exhibition Centre, Changsha, Hunan Province, China. The building uses concave balconies defined by an electric sunshade glass louvre so that the building shape coefficient can be changed in different.

Figure 8: M-smart city Kumagaya, Kumagaya-shi, Japan. Exhibition House, Japan. Openings' orientation to prevailing wind, shape of balconies and monitored roof openings facilitate cross and stack ventilation.

Table 2 : Overview of the 26 case studies included in the review report

Building Name	Country(City)	Building Type	Year of Completion	Net Floor Area(m^2)	Climate Zone
C-DdI ARFRISOL PSA	Tabernas, Almería, Spain	Office building	2007	1007.40	Dry hot summer /cold winter
C-DdI ARFRISOL CEDER	Altos de Lubia, Soria, Spain	Refurbishment Office building	2009	1088	Hot summer/ cold winter
GRUPO LINCE HEADQUARTERS	Valladolid, Spain	Office building	2011	1000	Hot summer/ cold winter
Police office Schoten	Schoten, Belgium	Office building	2009	2514	Moderate
Mellomhagen	Larvik, Norway	School	2010	3500	Cold
Solstad	Larvik, Norway	kindergarten	2011	788	Cold
Home for Life	Lystrup, Denmark	Residential	2009	190	Temperate coastal climate
Maison Air et Lumière	Verrières-le-Buisson, France	Residential	2012	130	Warm summer /cool winter
CHH – Christop-horushaus	Miva, Stadl Paura, Austria	Multifunctional	2001	1215	High heating load
Edifício Solar XXI	Lisbon, Portugal	Office and Laboratory	2006	1500	High cooling loads
Frederick Lanchester Library	Coventry, UK	Library	2000	9100	Moderate heating and cooling loads
Poikkilaakso School	Helsinki, Finland	School	2001	3132	High heating load
Bournemouth University	Bournemouth, UK	Education building	2012	--	Moderate
CIT Zero 2020 Building	Cork, Ireland	Office Building	2012	222.5	Warm summer/ mild winter
Energy Flex House	Taastrup , Denmark	Residential	2009	216	Temperate
Spirehuset	Denmark	Kindergarten	2005	500	Temperate
Rijkswaterstaat building	Terneuzen, Netherlands	Office	2000	1750	Moderate heating and cooling loads
Shandong Jiaotong Univ.	Jinan, Shandong Province, China	Library Building	2003	22 666.76	Cold
Franshion Exhibition Centre	Changsha ,Hunan Province, China	Exhibition building	2014	12125.15	Hot summer/ cold winter
Vanke Center Shenzhen	Shenzhen, Guangdong, China	Multifunctional	2009	12130	Hot summer/ warm winter
Shanghai Eco-Housing	Shanghai, China	Residential Building	2010	3147	Hot summer/ cold winter
Cork Country Hall	Carrigrohane Rd, Cork, Ireland	Office Building	2006	16000	Warm summer/ mild winter

CasaClima in Bernate	Bernate Ticino, Milano, Italy	Family house	2013	305	Hot summer/ cold winter
Basisschool KA Etterbeek	Etterbeek, Belgium	School building	2012	924.7	Moderate
LIXILPassive first Pavilion (Gallery)	Toyota city, Aichi, 471-0024 Japan	Exhibition house	2014	150.91	Hot, humid summer/ cold, dry winter
M-smart city Kumagaya	Kumagaya-shi, Japan	Housing	2014	12125.15	Hot summer/ cold winter

The review report includes a 2-page description of each building, where they are described by providing details of type, year of completion, location, climatic zone, size, orientation, the design team and an external photograph. Site data in the form of heating and cooling degree days, location within the urban environment, and indications of potential barriers to ventilative cooling such as air pollution, external noise, external humidity, prevailing wind direction and altitude are indicated. The architectural design philosophy for the reduction or possible removal of cooling demand and risk of overheating is described. The description also includes specific information on ventilative cooling; the principle is described together with the components and control strategies used. The descriptions highlight the commonality of components used in various building types and climatic regions; these are thermal mass, grills, fans, CO_2 and temperature sensors, manually operated windows, motorised windows, special ventilation openings -in many cases in the form of wind towers, solar chimneys and atria. In most cases control strategies focus on guaranteeing thermal comfort, indoor air quality and minimise energy use. The final part for each building presents a description of the overall performance of the building including lessons learned.

A particular topic of interest in the investigation of the existing buildings was the overall design philosophy used for the reduction/removal of cooling demand and risk of overheating. It was clear from the survey that a successful ventilative cooling design depended on an integrated design approach being applied, in which optimal use is made of one or more ventilative cooling technologies such as night ventilation (including Phase Change Materials -PCM), evaporative cooling (particularly effective for dry climates), cross ventilation, air cooling by ambient woods or water surface (lake, driver, sea), buoyancy driven flow, cooling by soil, cooling through underground, natural or mechanical driving forces, increased air velocity, wind inducing external wall, etc. A common feature in the design of the presented buildings is that first passive energy strategies are used; when passive strategies are not enough to achieve comfort, active strategies are applied. In most cases for the summer period, automatically controlled natural ventilation is used to provide good indoor air quality and natural ventilative cooling. During the heating season, mechanical ventilation with heat recovery is used for indoor air quality and natural ventilative cooling is used in case of overheating.

Some common components were used in most buildings. These include thermal mass, grills, fans, CO_2 and temperature sensors, manually operated and/or motorised windows, external solar shading, or special ventilation openings, and wind towers, solar chimneys or atria for exhaust.

The review presents an overview on typical available building components and control strategies. The information presented is a first step for the classification of building components suitable for ventilative cooling and highlight the lack of specific information on control strategies.

Building components for ventilative cooling are classified and presented in the following way:

- **Airflow Guiding Ventilation Components:**
  - Windows, Rooflights, Doors | Dampers, Flaps, Louvres | Special Effect Vents

- **Airflow Enhancing Ventilation Building Components:**
    - Chimneys | Atria | Venturi Ventilators | Wind Towers, Wind Scoops
- **Passive Cooling Components:**
    - Convective Cooling Comp. | Evaporative Cooling Comp.| Phase Change Cooling Comp.
- **Actuators:**
    - Chain Actuators | Linear Actuators | Rotary Actuators
- **Sensors**
    - Temperature | Air flow | Solar radiation | Humidity | CO_2 | Rain | Wind

The description of building components is loosely structured in the following way:

- the component's physical principle, background and possible application;
- its capacity and limitations, fields of possible improvement and innovation;
- figures of exemplary products in the market and/or as installed in operational buildings including integrated building elements;
- outlook on fields of further development;
- relevant literature and link to manufacturers.

It was identified that control strategies is one of the important parameters to guarantee indoor comfort levels, indoor air quality and minimise energy consumption. These should include temperature and CO_2 to ensure that the ventilation not only reduces energy consumption but also ensures thermal comfort and sufficient supply of fresh air.

It was also identified that user behaviour has shown to be a crucial element for successful performance. In many buildings it was reported that when occupants had learned how to operate the system, energy use reduction was achieved for satisfactory comfort level and indoor air quality.

5 Existing Analysis and Design Methods and Tools

Design and analysis of ventilative cooling requires combined modelling of air flow and building thermal performance and at different level of detail in each design phase. Designers need clearer guidance regarding the uncertainty in ventilative cooling performance predictions and ways to improve the reliability and robustness.

The review presents existing analysis and design methods and tools suitable for designing and evaluating ventilative cooling aspects during building design including assessment of their capabilities, gaps, needs and limitations in the context of ventilative cooling performance prediction.

The review starts with early stage design tools using widely accepted first principle and empirical equations to calculate air flow rates based on available driving forces. These are useful for two reasons; firstly they can be referred to in the calculation of climatic potentials of ventilative cooling and secondly are useful when interpreting building codes and regulations.

The review also includes a useful listing of detailed modelling tools used for ventilation calculations such as network models, empirical /mathematical models, Computational Fluid Dynamics (CFD) models and coupled models. A table with commonly used public domain and commercial models together with some details of inputs and outputs required is given at the end of the chapter.

The review identified the following aspects to be important for further model and software improvement:

- Airflow network models coupled with the most commonly used building energy simulation tools allow to predict natural ventilation strategies performance. Although the coupling allows to consider interactions between airflows and building thermal behaviour, the convection heat transfer modelling is still too simplified for night cooling effect predictions. Furthermore, new features/types to model new solutions and technologies like wind catchers and solar chimneys are needed.

- Airflow predictions are obviously highly sensitive to window opening controls. In case of manual controls, it is necessary to include more detailed occupant comfort based stochastic window control algorithms. In case of automatic controls, the integration of predefined control strategies would support designers in choosing the most effective control for a particular climate and/or design.
- The recent developments in Building Energy Simulation (BES)-CFD- Zonal airflow network (AFN) coupling are very promising and revealed the advantages of the integrated building simulation over the separated building energy and CFD applications, which are:
  - CFD receives more precise and real-time thermal boundary conditions and can predict the dynamic indoor environment conditions that are important for the assessment of indoor air quality and thermal comfort.
  - BES obtains more accurate convection heat from enclosures and can provide more accurate estimation of building energy consumption and dynamic thermal behaviours of building envelopes.

The review also looked into the choice of design method/tool depending on the level of resolution needed to be able to predict the performance indicators required, the resources available (computing capacity, manpower and time) and the ventilative cooling solution to be modelled.

Table 3 illustrates the generally required targets and performance indicators to be assessed within the three main design steps of building.

During the schematic design phase, the architect typically works with the client and other design team members to explore alternative concepts for addressing the client's needs. The design phase typically ends with a presentation of the proposed design including a description of the energy concept and how the design meets the client's project program and goals. Depending on the defined targets, alternative design concepts can be compared in terms of cooling demand reduction, achievable ventilation rates and thermal comfort improvement.

Design development phase aims at proving standard and building regulation compliance. Therefore, simulation tools are used to efficiently size building components in order to guarantee the standard requirements typically identified as minimum required air change rate (ACR) to guarantee indoor air quality or maximum number of overheating hours.

Construction documents describe in detail the components of a project that need to be fabricated and assembled in order for it to be built. Building components specification has to be guided and proven by relating simulations parameter settings to product characteristics.

The review concluded that designers need clearer guidance regarding sources of uncertainty in natural ventilation performance predictions and ways to improve the reliability of these predictions and the model robustness.

Table 3 Design stages and generally required performance indicators.

Design stage	Schematic design	Design development	Constructive documents
Target	To explore design solutions	To size building components for standard accomplishment	To detail the description of building components
Performance indicators	Cooling demand reduction Thermal comfort improvement Achievable ventilation rates Fan electricity Primary energy	Min required ACR guaranteed Max number of overheating hours Max heating/cooling load Max/min temperature in the zone PPD Contaminant distribution	Conformity of building components to simulation components Local discomfort

6 Conclusion

The state-of-the-art review reveals that ventilative cooling is an attractive option for the reduction of energy use in residential and non-domestic buildings with materialised examples in a variety of climates. As a cooling strategy has, thus, the potential to contribute significantly to the reduction (even elimination for certain buildings and climates) of the end use cooling energy demand.

The state-of-the-art has also revealed that in many national building codes and energy performance regulations ventilative cooling is not explicitly referred to as a cooling option for achieving energy performance. Therefore the treatment of ventilation (air flow rate) requirements for ventilative cooling and its effect on cooling demand reduction are not clear. This has an impact on the architectural design of the building as well as the specification of components and controls facilitating ventilative cooling.

The report identified that the selection of proper control strategies is one of the most important issues to guarantee indoor comfort levels, indoor air quality and minimise energy consumption and that user behaviour is a crucial element for successful performance. However, research results in this field are too scarce to develop solid recommendations.

Furthermore, the risk of overheating in buildings is not linked to the potential of ventilative cooling to eliminate it for certain climatic areas, especially those heating dominated.

IEA EBC Annex 62 on ventilative cooling

The Executive Committee of the IEA Energy in Buildings and Communities programme (IEA EBC) approved the IEA EBC Annex 62 on Ventilative Cooling in November 2013 with a four year working and reporting phase from 2014 – 2017.
In order to address the cooling challenges of buildings the research focus of the annex has been the development of design methods and compliance tools related to predicting, evaluating and eliminating the cooling need and the risk of overheating in buildings, and new attractive energy efficient ventilative cooling solutions.

This information paper summarises the outcome of the work of the initial working phase of IEA EBC Annex 62 Ventilative Cooling and is based on the findings in the participating countries. It presents a summary of the first official Annex 62 report that describes the state-of-the-art of ventilative cooling potentials and limitations, its consideration in current energy performance regulations, available building components and control strategies and analysis methods and tools. In addition, the report provides twenty six examples of operational buildings using ventilative cooling ranging from domestic to offices and other non-domestic buildings such as schools and exhibition spaces and located in different outdoor climates.

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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, Germany, Italy, Japan, Netherlands, New Zealand, Norway, Republic of Korea, Spain, Sweden, United Kingdom and United States of America.

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