webinar
2021.06.01

Resilient Ventilative Cooling in Practice


Hilde Breesch – KU Leuven, Belgium


Peter Holzer – Operating Agent EBC Annex 80


Ivan Pollet – Renson, Belgium


Nick Hopper – Monodraught, United Kingdom


Peter Foldbjerg – Velux, Denmark


Jannick Roth – WindowMaster, Denmark

Webinar management


Maria Kapsalaki (INIVE, BE)


Valérie Leprince (INIVE, BE)

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Resilient Ventilative Cooling in Practice

AGENDA

- 15:00 | **Introduction to resilient ventilative cooling and venticool**, Hilde Breesch – KU Leuven, Belgium
- 15:10 | **Ventilative cooling components: an overview**, Peter Holzer – Operating Agent EBC Annex 80, Institute of Building Research & Innovation, Austria
- 15:25 | **Application of louvres to support ventilative cooling**, Ivan Pollet – Renson, Belgium
- 15:40 | *Questions & Answers*
- 15:50 | **Examples of air flow enhancing and natural cooling components**, Nick Hopper – Monodraught, United Kingdom
- 16:05 | **Controlled windows for ventilative cooling**, Peter Foldbjerg – Velux, Denmark
- 16:20 | **Ventilative cooling integrated design**, Jannick Roth – WindowMaster, Denmark
- 16:35 | *Questions & Answers*
- 16:45 | End of webinar

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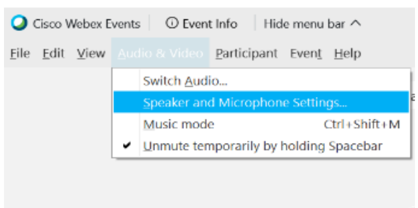

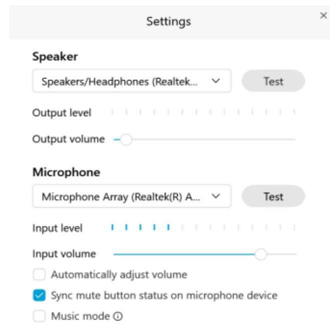

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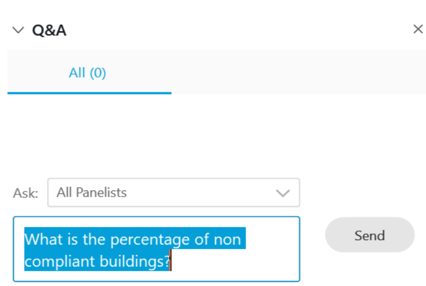

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With support from:
- venticool platform (www.venticool.eu)
- IEA EBC Annex 80 Resilient Cooling of Buildings (https://annex80.iea-ebc.org/)
- IEA-EBC Annex 62 Ventilative Cooling (https://venticool.eu/annex-62-home/)
- the Air Infiltration and Ventilation Centre (www.aivc.org)

NOTES:
- The webinar will be recorded and published at www.venticool.eu & www.aivc.org within a couple of days, along with the presentation slides.
- After the end of the webinar you will be redirected to our post event survey. Your feedback is valuable so take some minutes of your time to fill in.

Resilient ventilative cooling & venticool

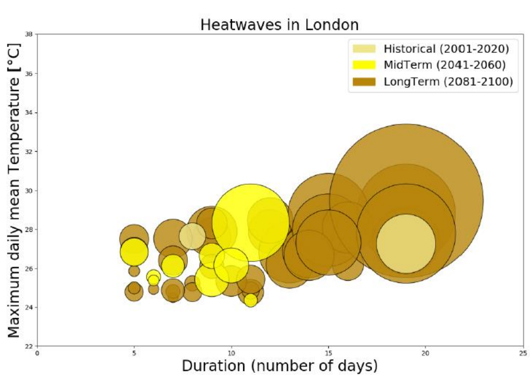
the platform for resilient ventilative cooling

Hilde Breesch, KU Leuven

Peter Wouters, INIVE

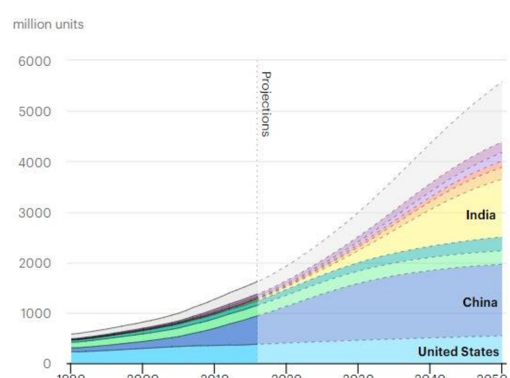
Context

- Heat waves: severity & duration



Source: IEA EBC Annex 80 preliminary results

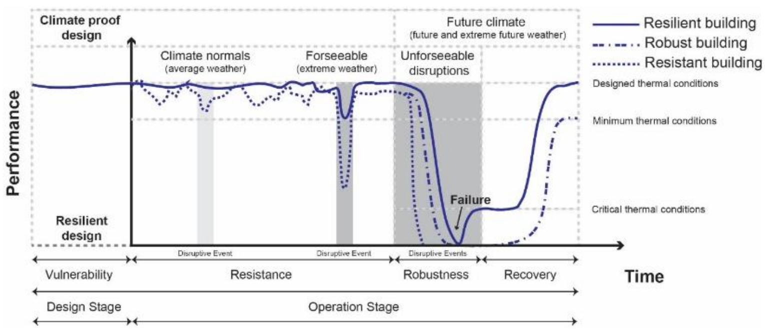
- Global energy demand cooling



Source: IEA (2018) The Future of Cooling

Ventilative cooling part of resilient cooling strategy

- Ventilative cooling performance
  - prevent overheating combined with building design & solar control
  - Satisfactory performance, but fail to function in extraordinary scenarios
- Resilience = ability of building/system
  - withstand disruptions
  - maintain capacity to adapt, learn, transform

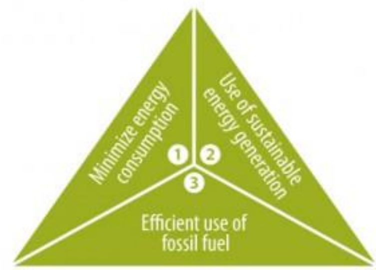


Source: Attia et al: Annex 80: Resilient cooling

Ventilative cooling in standards, legislation & energy performance calculations

- Energy performance regulations
  - key market drivers
  - Ventilative cooling: mature assessment thermal comfort & ventilation losses
- Standards, legislation & energy performance calculation need to include
  - Assessment of overheating
  - Assessment of resilient natural & mechanical ventilative cooling
  - Design calculation methods
- venticool’s concern = international (CEN, ISO) but also national

venticool's position



- Ventilative cooling -> reduce cooling energy need
- Implementation of ventilative cooling is limited
- venticool
  - Asks standards & legislation writers: fair & easy evaluation ventilative cooling performance
  - Provides knowledge & tools for designers to assess potential & limitations
- Focus on resilient cooling -> stimulate uptake of ventilative cooling

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Diamond partners:

NAVENTA NATURAL VENTILATION ASSOCIATION | Reynaers Aluminium | VELUX

Gold partners:

WindowMaster Fresh Air. Fresh People.

Associate partners:

activehouse | CIBSE | Covenant of Mayors for Climate & Energy

EuroWindoor | REHVA Federation of European Heating, Ventilation and Air-conditioning Associations

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Institute of Building Research & Innovation ZT-GmbH

Ventilative Cooling Components
An Overview

Dipl. Ing. Dr. Peter Holzer

Institute of Building Research
Subtask Leader in Annex 62 Ventilative Cooling (finished)
Operating Agent in Annex 80 Resilient Cooling (ongoing)

1

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Typologies of Ventialtive Cooling Components

A Airflow guiding ventilation components:
- Windows, doors and rooflights
- Flaps, grilles, louvres and dampers
- Terminals

2

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Typologies of Ventialtive Cooling Components

A Airflow guiding ventilation components

B Airflow enhancing ventilation components

- Powerless ventilators
- Chimneys
- Mechanical ventilators

3

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Typologies of Ventialtive Cooling Components

A Airflow guiding ventilation components

B Airflow enhancing ventilation components

C Passive Cooling ventilation components

- e.g. Comfort ventilators
- e.g. Evaporators
- e.g. Phase Change Materials

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Typologies of Ventialtive Cooling Components

A Airflow guiding ventilation components

B Airflow enhancing ventilation components

C Passive Cooling ventilation components

D Automation components

- Actuators
- Sensors
- Controllers

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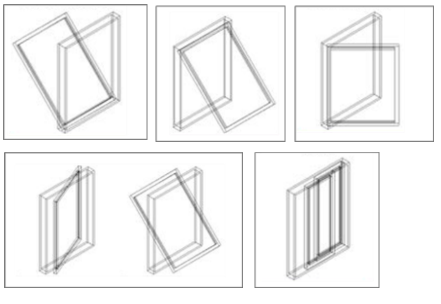
Airflow guiding ventilation components

Windows, Doors and Rooflights

bottom hung (transom), top hung, side hung, pivot hung, sliding (sash)



- Highly effective and cheap
- Manual use as well as automated
- Weak in case of driving rain, burglary, dust, insects and noise
- In case of uni-directional flow:

$$\dot{V} = C_d \sqrt{\frac{2}{\rho}} \sqrt{\Delta p} A = C_F \sqrt{\Delta p} \quad (m^3/s)$$

Discharge Coefficient: $C_d = 0{,}6 \div 0{,}7$
e.g.: $A=1\ m^2$, $\Delta p=1$ Pa → $V=3.000\ m^3/h$

See Ventilative Cooling Sourcebook (Annex 62)
Formula according to EN 16798

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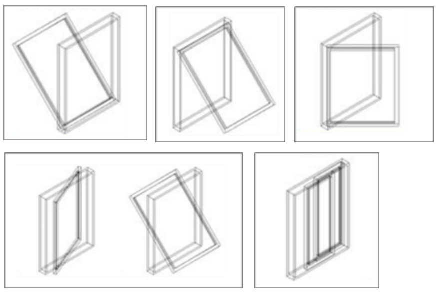
Airflow guiding ventilation components

Windows, Doors and Rooflights

bottom hung (transom), top hung, side hung, pivot hung, sliding (sash)



CONTROLLED WINDOWS FOR VENTILATIVE COOLING
Peter Foldbjerg, Velux, DK

- Highly effective and cheap
- Manual use as well as automated
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- In case of uni-directional flow:

$$\dot{V} = C_d \sqrt{\frac{2}{\rho}} \sqrt{\Delta p} A = C_F \sqrt{\Delta p} \quad (m^3/s)$$

Discharge Coefficient: C_d = 0,6 ÷ 0,7
e.g.: A=1 m², Δp=1 Pa → V=3.000 m³/h

See Ventilative Cooling Sourcebook (Annex 62)
Formula according to EN 16798

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Airflow guiding ventilation components

Dampers, Flaps, Louvres, Grilles

- Manual use as well as automated
- Partly protective against burglary, dust, insects and noise. Generally: the higher protective, the lower effective
- Range of C_d 0,2-0,7
  Net geometric free area ratio 40-60%
  Recommended design Δp 1-3 Pa

See Ventilative Cooling Sourcebook (Annex 62)
Pictures from Duco, Passivent, Gaugele
Values from merging design information from different manufacturers.

8

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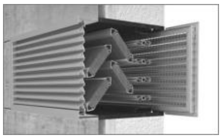
Airflow guiding ventilation components

Dampers, Flaps, Louvres, Grilles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APPLICATION OF LOUVRES TO SUPPORT VENTILATIVE COOLING
Ivan Pollet, Renson, BE

See Ventilative Cooling Sourcebook (Annex 62)
Pictures from Duco, Passivent, Gaugele
Values from merging design information from different manufacturers.

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Airflow guiding ventilation components

Terminals

Window ventilators (trickle vents or slots), discular diffusers (disc valves)


- Regarding trickle vents: Good integration in the window, available with sound attenuation functionality, wind pressure dependent pressure drop, integrated sound damper and insect mesh. Indicative airflow of 25 to even 50 m^3/h per meter at 1 Pa
- Regarding disc valves: covering airflows from 30 m^3/h up to > 1.000 m^3/h per unit. Indicative pressure drops of 10 to 40 Pa.

See Ventilative Cooling Sourcebook (Annex 62)
Pictures from Renson and saiductfab.

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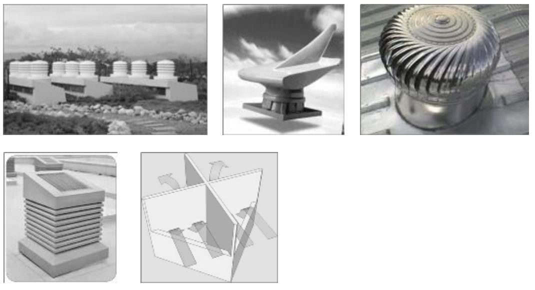
Airflow enhancing ventilation components

Powerless ventilators

Venturi ventilators, Powerless rotating ventilators, windcatchers and supply air windscoops, Ventilation chimneys



See Ventilative Cooling Sourcebook (Annex 62)
Pictures from Passivent, HASEC, industrialairventilator, monodraught

- Regarding Venturi Vents: Indicative negative pressure drop of 4 Pa at undisturbed wind speed of 2.5 m/s, up to 60 Pa at 10 m/s.
- Regarding Powerless rotating ventilators: Indicative airflow of 800 m³/h (300 mm diameter) up to 5.000 m³/h (900 mm diameter) at undisturbed windspeed of 1,5 m/s and very low pressure drop.
- Regarding Chimneys: Buoyancy driving force is low, equaling $\Delta p = (\frac{1}{30})\Delta T h$

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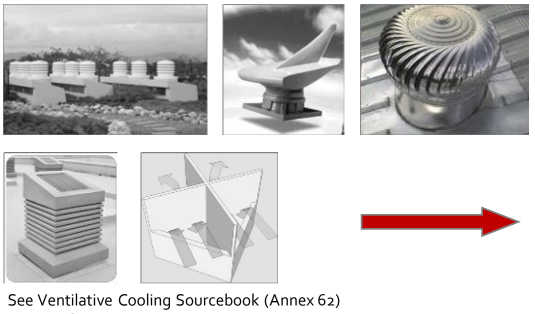
Airflow enhancing ventilation components

Powerless ventilators

Venturi ventilators, Powerless rotating ventilators, windcatchers and supply air windscoops, Ventilation chimneys



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EXAMPLES OF AIR FLOW ENHANCING AND NATURAL COOLING COMPONENTS
Nick Hopper, Monodraught, UK

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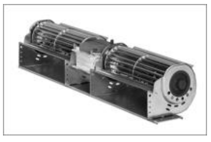
Airflow enhancing ventilation components

Mechanical ventilators

Axial, radial and tangential fans



- Ventilative Cooling with mechanical ventilators are highly effective as regards secured airflow.
- Ventilative Cooling with mechanical ventilators is limited by the acceptable pressure drop in the system:
  1.000 m³/h at ΔT=2K carries a cooling load of roughly 0,7 kW.
  An axial vent at Δp=300 Pa already consumes 0,3 kW and heats up the airflow already by 1K.
- Still, Ventilative cooling with mechanical cross flow ventilation and heat recovery is a good option.

See Ventilative Cooling Sourcebook (Annex 62)
Pictures from Rosenberg and EBM Papst

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Passive cooling ventilation components

Comfort Ventilators

Ceiling Fans, Personal Fans

- Air movement is a highly effective means of personal comfort. An air speed of roughly 0,8 m/s raises the acceptable temperature by roughly 3K.
- Equipped with modern EC motors the effectivity outreaches the effectivity of AC systems by a factor of 2-3.
- In open floor offices there's the shortcoming of incoherent personal comfort expectations, between cool breeze and draft.

See Ventilative Cooling Sourcebook (Annex 62)
Pictures from lampsplus and Stadler

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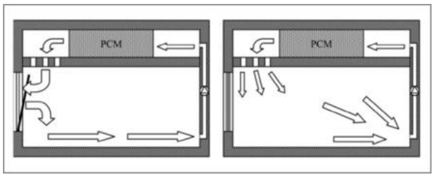
Passive cooling ventilation components

Evaporators and Phase Change Material



- Regarding Evaporators: Good performance of indirect evaporative cooling. Upcoming interest in ambient cooling, using mist nozzles, dry mist nozzles and dry mist fans. Both systems are limited to sufficient water supply. 1 kW evaporative cooling load causes a water demand of >2 l/h.
- Regarding PCM: Diurnal heat storage with PCM may increase the effectivity of night ventilation.

See Ventilative Cooling Sourcebook (Annex 62)
Picture from Transsolar at Mandai Zoo, Singapore

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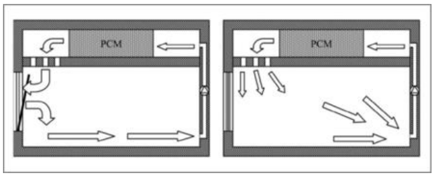
Passive cooling ventilation components

Evaporators and Phase Change Material



- Regarding Evaporators: Good performance of indirect evaporative cooling. Upcoming interest in ambient cooling, using mist nozzles, dry mist nozzles and dry mist fans. Both systems are limited to sufficient water supply. 1 kW evaporative cooling load causes a water demand of 1,6 l/h.
- Regarding PCM: Diurnal heat storage with PCM may increase the effectivity of night ventilation.

See Ventilative Cooling Sourcebook (Annex 62)
Picture from Transsolar and Monodraught

EXAMPLES OF AIR FLOW ENHANCING AND NATURAL COOLING COMPONENTS
Nick Hopper, Monodraught, UK

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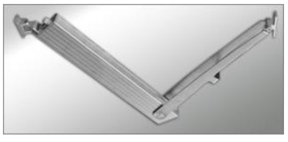
Automation Components

Actuators

Linear actuators, chain actuators,
folding and rotating arm actuators



- Relevant criteria in the selection of actuators are:
  Stroke, Force,
  space needed, visual appearance, water protection, insulation class
  Sound emission
  Durability, robustness
  energy consumption in operation and standby
- Linear actuators offer high stroke and force
- Chain actuators offer efficient use of space

See Ventilative Cooling Sourcebook (Annex 62)
Pictures from ultraflexgroup and simon-rwa

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Automation Components

Sensors

Temperature,
radiation,
humidity,
occupancy,
CO_2,
air velocity

- Relevant criteria in selection of actuators are
  accuracy and reproducibility
  measurement/operating range
  response time
  linearity deviation and hysteresis
  stability for a period of at least 5 years
  no interference with other sensors
  stable output signal with minimal noise
  Low cross-sensitivity
  energy consumption in operation and standby

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Automation Components

Controllers

Local controllers or central controllers

- Control of Ventilative Cooling is essential and tricky, since Ventilative cooling components can be seen, heard and “felt”. Weakness in control not only causes malfunction but instant annoyance.
- User information is an essential aspect of Ventilative cooling, e.g. informing the users about the actual mode of operation.
- It pays to install DDC systems, which are reely programmable, especially regarding parameter setting and derived variables
- Aspect of relevance: entrapment protection.

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Automation Components

Controllers

Local controllers or central controllers

VENTILATIVE COOLING
INTEGRATED DESIGN
Jannick Roth, WindowMaster, DK

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Further Readings and Invitation

- Annex 62 Ventilative Cooling Proceedings https://venticool.eu/annex-62-publications/deliverables/
- Annex 80 Resilient Cooling Information https://annex80.iea-ebc.org/
- peter.holzer@building-research.at

Thank you

Picture from Transsolar at Mandai Zoo, Singapore

21

Application of louvres to support ventilative cooling

AIVC venticool
the platform for resilient ventilative cooling

June 1st, 2021, Webinar – Resilient Ventilative Cooling in practice

RENSON® Creating healthy spaces

VENTILATION – SUNPROTECTION - OUTDOOR

ivan.pollet@renson.be

About Renson

Belgian family business

- 112 years
- Headquarters in Waregem
- Team of 1200 enthousiastic men & women
- Core business: ventilation, sunprotection & outdoor

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Products: background ventilation versus ventilative cooling

Louvres for ventilative cooling

Continuous louvre systems as façade cladding or ventilative cooling

RENSON
Creating healthy spaces

VENTILATION – SUNPROTECTION - OUTDOOR

June 1st, 2021 - Webinar "Resilient Ventilative Cooling in practice"

Connection of products towards smart buildings > servitization

Services

Data analysis

Connectivity

Actuators/sensors

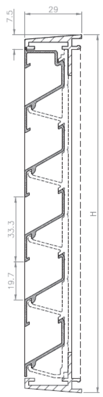
\+ ventilative cooling mode

Louvres: characteristics, testing and regulation ?

Louvres: multi-functionality combined within simplicity

Simplicity

Number of horizontal or vertical fixed or adjustable blades (alu/wood)



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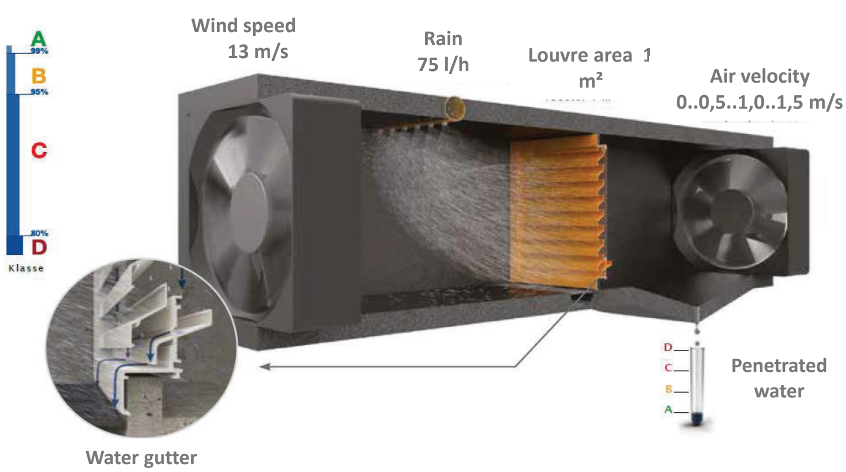
Multi-functionality

- → Ventilative cooling (renewable)
- → Solar shading
- → Insect-proof
- → Rain-tightness
- → Persons from outdoors (burglary) or indoors (fall-through)
- → Fire/smoke control
- → Noise insulation
- → Outdoor pollution control (?)
- → Opportunities for creativity, integration, accents, ...

How to characterize ?

Testing and optimization of louvres performance

Aerodynamic and rain tightness characteristics (EN13030)



Water tightness and air flow rate

Table 3 — Penetration classes

Class	Effectiveness ε	Maximum allowed penetration of simulated rain $l \cdot h^{-1} \cdot m^{-2}$
A	1 to 0,99	0,75
B	0,989 to 0,95	3,75
C	0,949 to 0,80	15,00
D	Below 0,8	Greater than 15,00

Table 4 — Discharge loss coefficient classification

Class	Discharge loss coefficient
1	0,4 to 1,0
2	0,3 to 0,399
3	0,2 to 0,299
4	0,199 and below

NOTE The above classes also apply to entry loss coefficient.

$$q_v = C_d\, A \sqrt{\frac{2\,\Delta p}{\rho}}$$

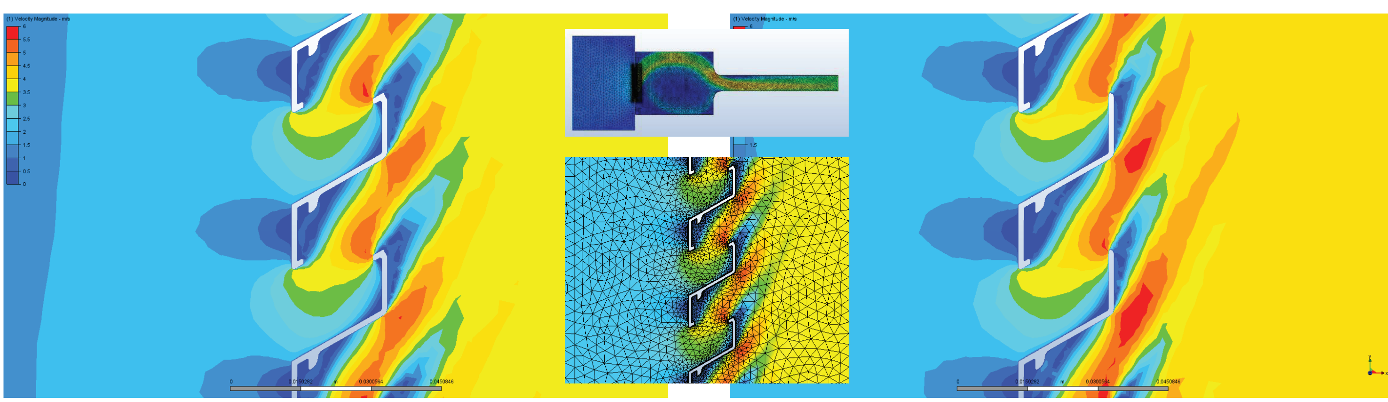
Testing and optimization of louvres performance

Aerodynamic and rain tightness characteristics (EN13030)

Testing and optimization of louvres performance

$$q_v = C_d\, A \sqrt{\frac{2\,\Delta p}{\rho}}$$

Optimization based on CFD: air flow resistance ↓ and/or water tightness ↑



Ventilative cooling: quick design, rules of thumb

- Air flow rate through opening: $q_v = \boxed{C_d} A \sqrt{\frac{2\Delta p}{\rho}}$
  - Available natural pressure difference: **Δp ~ 1 to 2 Pa**
  - Required air exchange rate: **q_v = 4 to 8 volumes/h** → Area (m²) of louvre is known
- Cooling capacity: **~ 5 W/m²/air exchange rate**
- Temperature reduction during night in case of at least 10°C ΔT between max. indoor T and min. outdoor T : **~ 0,75 to 1 °C/(vol/h)**

Louvres: flow resistance ↑ + usage or VC potential ↑

Resistance

Reduction of air flow rate

~ 50%

↔

Guarantee on higher operation time

Fully openable windows (90°) instead of tilted (10%)

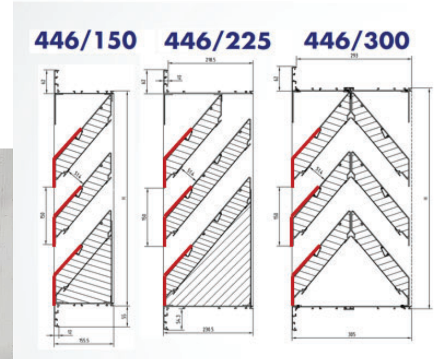
More in use during night and absence

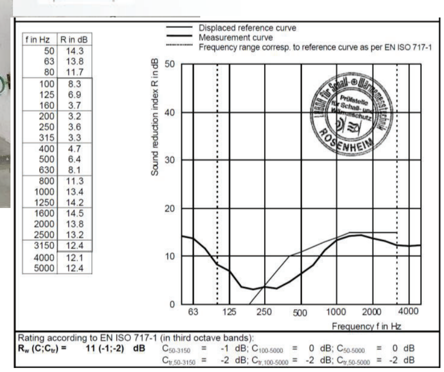
~ higher utilization factor

On average, net effect of louvres on air exchange rate is mostly limited

Testing and optimization of louvres performance

Sound insulation: sound reduction index Rw (EN ISO 10140 & 717)





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Testing and optimization of louvres performance

Burglary resistance of window openings (~ building assurances): RC class

8 Manual burglary attempts

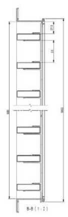
When tested in accordance with prEN 1630 using the tool sets and times specified in Table 6, the test specimen shall not fail at the resistance class claimed. For construction products of resistance class 1 no manual test will be carried out. The tool set A1 is intended for preparation of the test specimen.

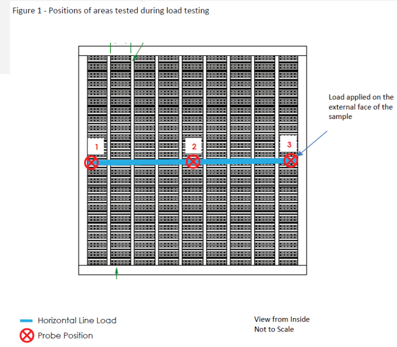
Table 6 — Tool sets and resistance time

Resistance class	Tool set (see prEN 1630:2009, Clause 7)	Resistance time min	Maximum total test time min
1	A1	–	–
2	A2	3	15
3	A3	5	20
4	A4	10	30
5	A5	15	40
6	A6	20	50

Testing and optimization of louvres performance

Barrier load testing / Fall prevention safety (EN13049)



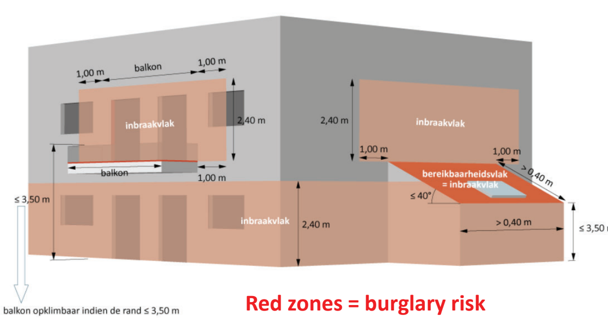


Integration of VC louvres within EPBD regulation

Impact of VC on overheating risk and PE consumption depending on:

Belgium (residential)

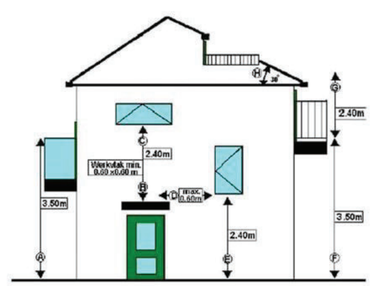
- Physical free area of VC openings
  (≥ 6,4% of room net floor area)
- Accessibility/burglary resistance
  (location, max opening, resistance class ≥ 2)
- Control possibilities



Red zones = burglary risk

The Netherlands (all buildings)

- Physical free area of VC openings
- Accessibility/burglary resistance
  (location, max opening, resistance class ≥ 2)
- Control possibilities
- Insect-proof requirement
- Rain tightness requirement (louvre, sensor)



Louvres applications in-situ

RENSON
Creating healthy spaces

VENTILATION – SUNPROTECTION - OUTDOOR

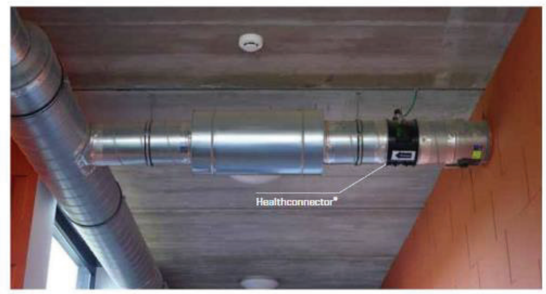
Schools (Gent, Belgium)

Passive cooling measures, no active cooling, small or no occupation in summer

RENSON
Creating healthy spaces

VENTILATION – SUNPROTECTION - OUTDOOR

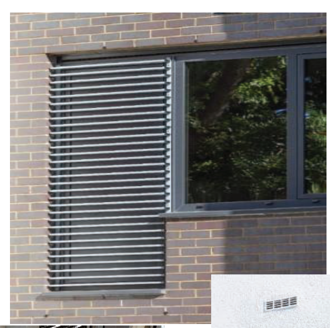
Schools (Gent, Belgium)

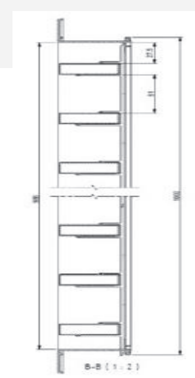


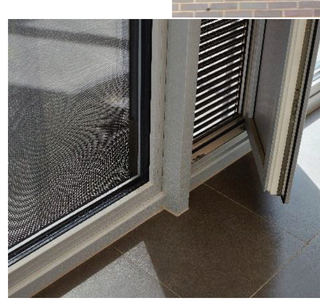
Student homes (Bournemouth University, Southern England)

Burglary resistance, fall prevention safety, daylight

Different shapes and colors
> attractive façade

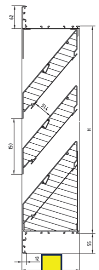


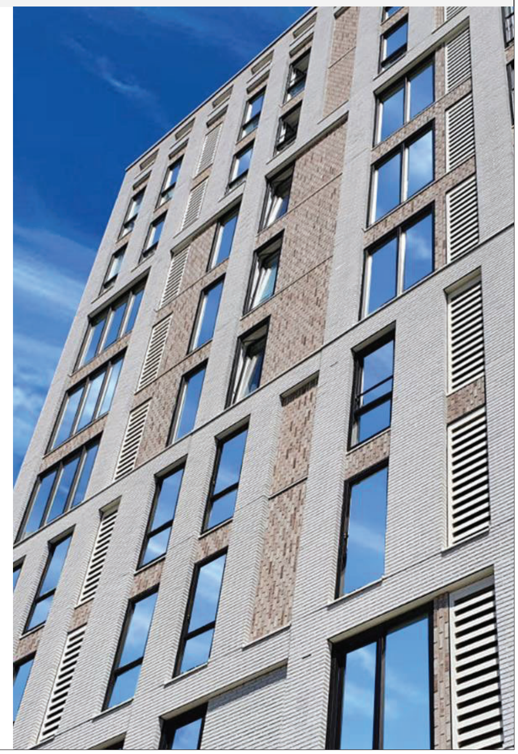




Student homes (Campus Diemen Zuid, The Netherlands)

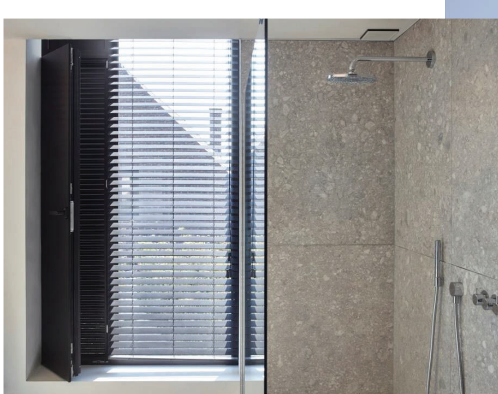
Acoustic insulation for intensive ventilation and ventilative cooling

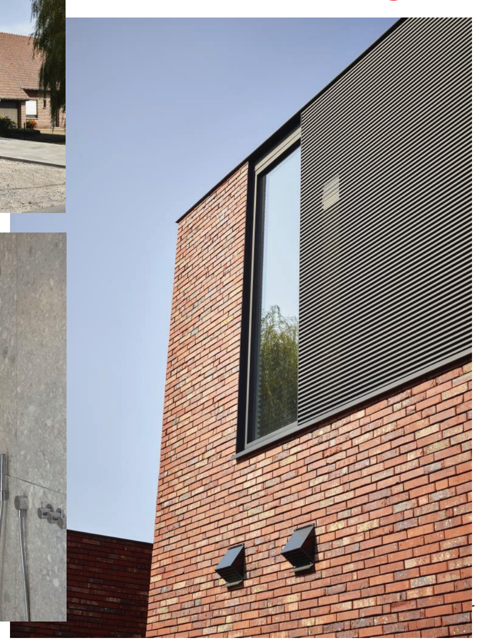


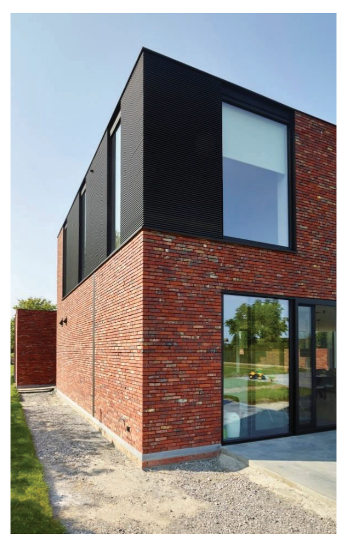


Continuous louvre systems as façade cladding and VC louvre

Private home > Belgium







"Resilient Ventilative Cooling in practice"

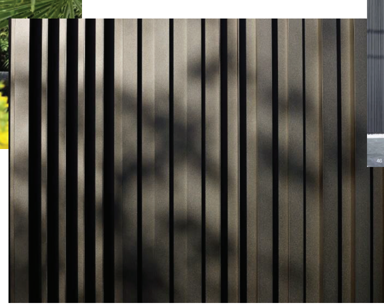
Continuous louvre systems as façade cladding and VC louvre

International Lyceum > Luxembourg

Private houses (Belgium)

Vertical blades, integration in façade/LED-lighting

Privacy ↔ daylight



Concept home of Renson (Waregem, Belgium)

Vertical blades, integration in façade

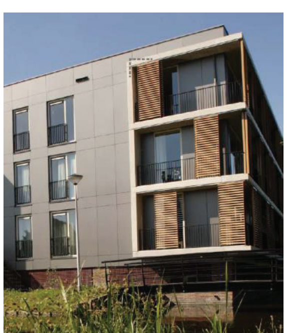
Privacy ↔ daylight

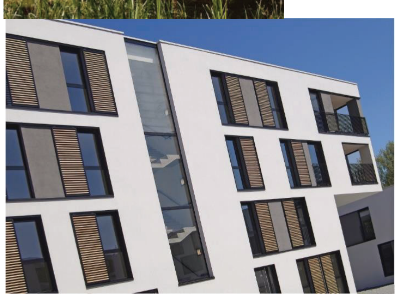
RENSON
Creating healthy spaces

VENTILATION – SUNPROTECTION - OUTDOOR

Louvre: movable/adjustable versus fixed

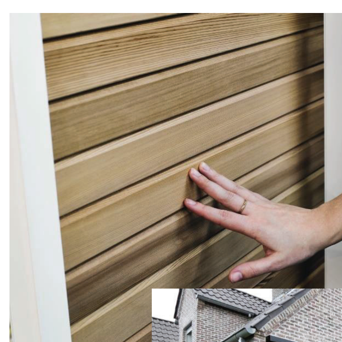
Movable/sliding louvre panels



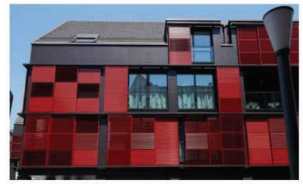


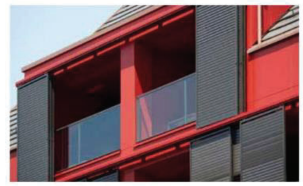
Green office (Paris – France, 2011)

Adjustable/orientable blades



Apartments (Weinfelden, Switzerland)





Adjustable in zones
Personalization

Combination of ventilative cooling and solar shading

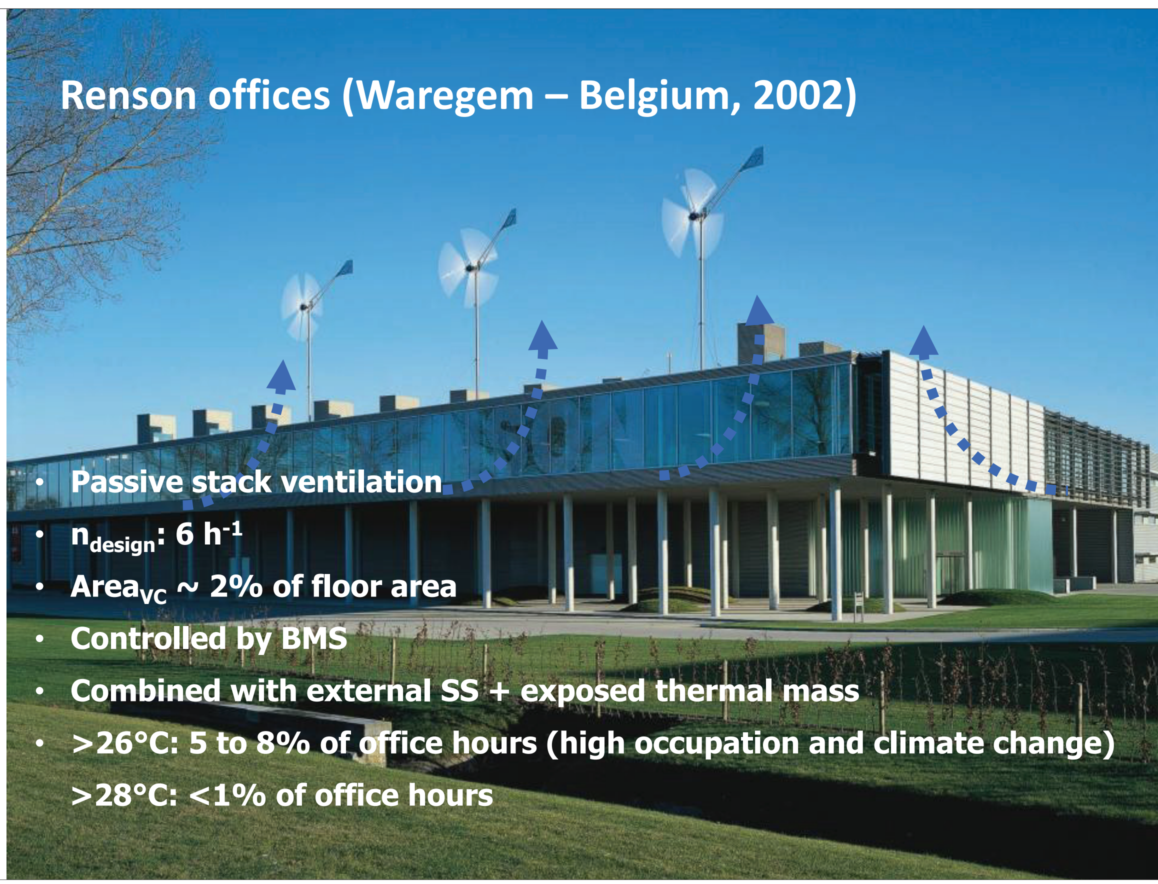
Screens and awning

Screens on roof windows

Integrated screens

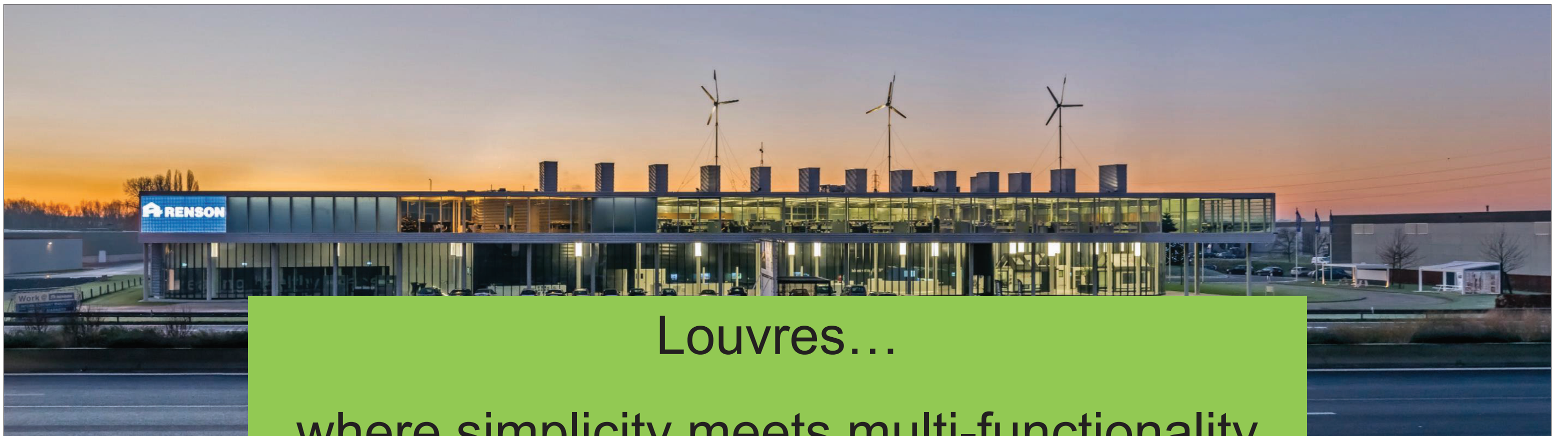
Renson offices/showroom (Waregem, Belgium, 2002)

Designed 20 years ago as a living lab of bioclimatic architecture, and still contemporary



Renson offices (Waregem – Belgium, 2002)

- Passive stack ventilation
- n_{design}: 6 h^{-1}
- $Area_{VC}$ ~ 2% of floor area
- Controlled by BMS
- Combined with external SS + exposed thermal mass
- >26°C: 5 to 8% of office hours (high occupation and climate change)
  >28°C: <1% of office hours



Louvres…

where simplicity meets multi-functionality

AIVC venticool
the platform for resilient ventilative cooling

June 1st, 2021, Webinar – Resilient Ventilative Cooling in practice

RENSON
Creating healthy spaces

VENTILATION – SUNPROTECTION - OUTDOOR

ivan.pollet@renson.be

Monodraught

Wind Assisted Ventilation and Natural Cooling

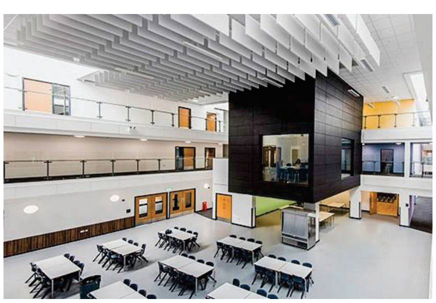
01/06/2021

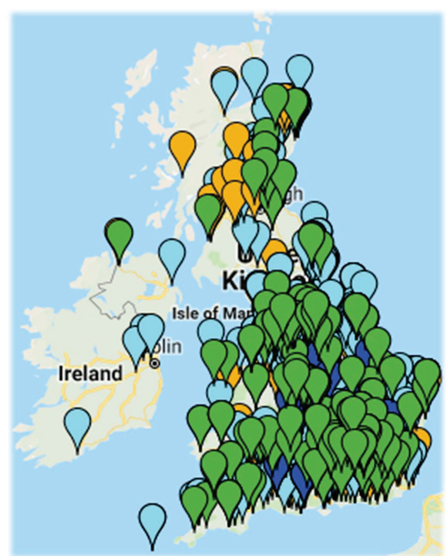
THE QUEEN'S AWARDS FOR ENTERPRISE: INNOVATION 2018

We are
Pioneering British Greentech

Monodraught

- Over 45 years experience
- 1000's of projects UK and global
- UK design and manufacture
- Innovation is part of our DNA
- Very active in R&D





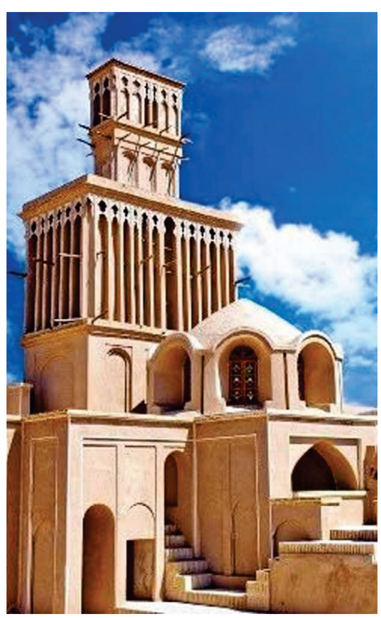
THE QUEEN'S AWARDS FOR ENTERPRISE: INNOVATION 2018

BUILDING PERFORMANCE AWARDS 2017 SHORTLISTED

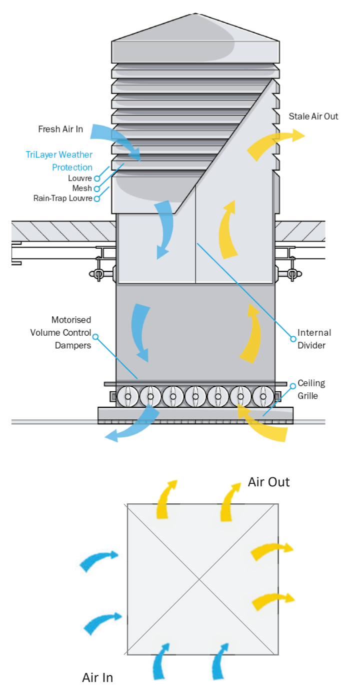
CIBSE BUILDING PERFORMANCE AWARDS 2012 WINNER RECOGNISING EXCELLENCE IN MAKING BUILDINGS WORK

Natural Ventilation

History



Windcatcher principles



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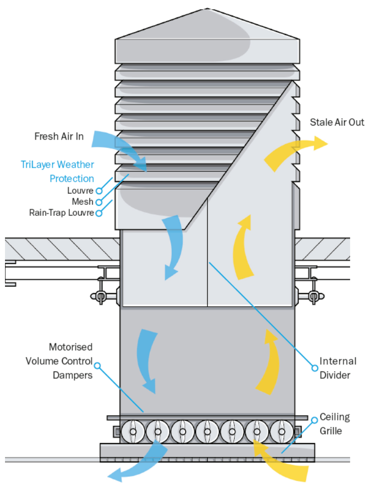
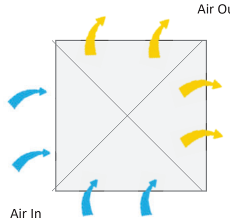
Windcatcher principles

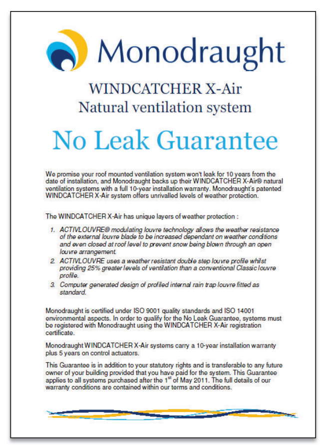


1. Wind movement
2. Air intake
3. Positive pressure
4. Cooler air
5. Low pressure
6. Natural buoyancy



Active Louvre

- The X-Air system has patented active-louvre technology, which enabled the louvre aperture to be modulated to several positions from closed to fully open.
- When fully open the systems has a free louvre area which is 25% greater than that of a standard unit.
- The ability to modulate or close the louvres helps with rejection of inclement weather conditions
- This helps to control winter season cold buffeting airflow at the unit face prior to fine control by the dampers inside.



Monodraught

WINDCATCHER X-Air
Natural ventilation system

No Leak Guarantee

We promise your roof mounted ventilation system won't leak for 10 years from the date of installation, and Monodraught backs up their WINDCATCHER X-Air® natural ventilation systems with a full 10-year installation warranty. Monodraught's patented WINDCATCHER X-Air system offers unrivalled levels of weather protection.

The WINDCATCHER X-Air has unique layers of weather protection :

1. *ACTIVLOUVRE® modulating louvre technology allows the weather resistance of the external louvre blade to be increased dependant on weather conditions and even closed at roof level to prevent snow being blown through an open louvre arrangement.*
2. *ACTIVLOUVRE uses a weather resistant double step louvre profile whilst providing 25% greater levels of ventilation than a conventional Classic louvre profile.*
3. *Computer generated design of profiled internal rain trap louvre fitted as standard.*

Monodraught is certified under ISO 9001 quality standards and ISO 14001 environmental aspects. In order to qualify for the No Leak Guarantee, systems must be registered with Monodraught using the WINDCATCHER X-Air registration certificate.

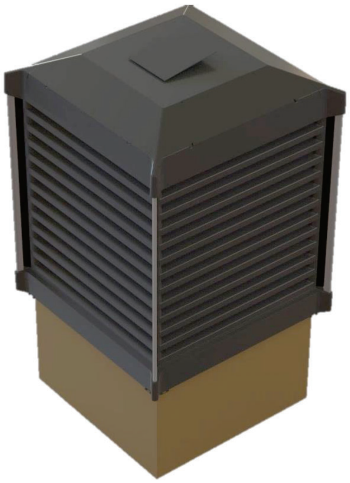
Monodraught WINDCATCHER X-Air systems carry a 10-year installation warranty plus 5 years on control actuators.

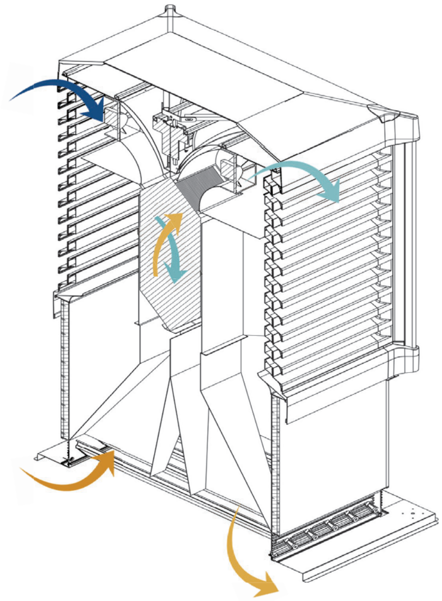
This Guarantee is in addition to your statutory rights and is transferable to any future owner of your building provided that you have paid for the system. This Guarantee applies to all systems purchased after the 1st of May 2011. The full details of our warranty conditions are contained within our terms and conditions.

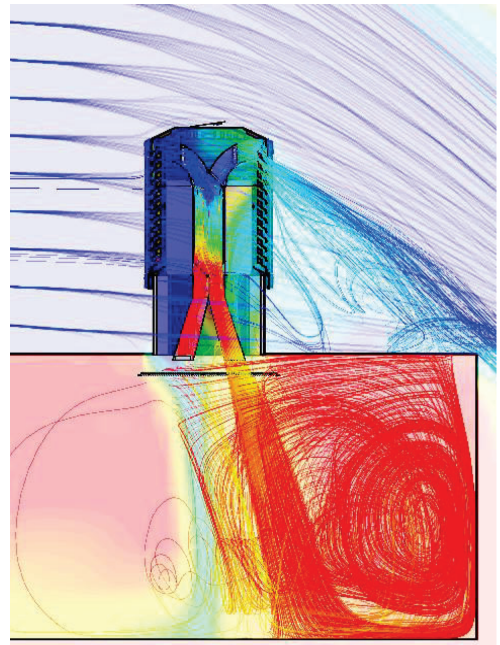
Fully Opened

Fully Closed

Windcatcher HX







Monodraught

Natural Cooling

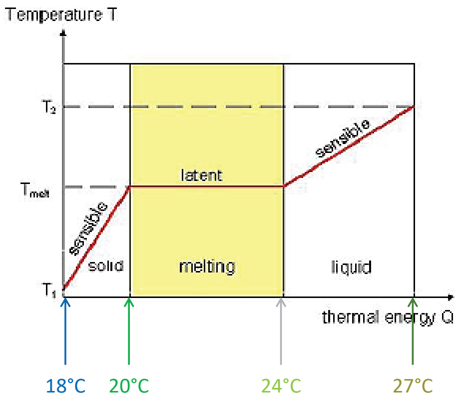
Phase Change Materials

What is a PCM?

A phase-change material (PCM) is a substance which melts and solidifies at a certain temperature and in doing so is capable of storing or releasing large amounts of energy.

Using PCM's to store and release thermal energy

- During the day as warm air is passed over the PCM it absorbs thermal energy from the air to turn from a solid to a liquid, thus cooling the air.
- Over night as cooler air is passed across the PCM it releases the thermal energy it absorbed from the warm air during the day returning to its solid state.
- This provides us with a **cooling cycle,** using only a low energy fan that is intelligently controlled.



ICE

MELTING / FREEZING

WATER

Monodraught

Thermal Battery

- Aluminium casing achieves excellent heat transfer from air to PCM.
- Non-flammable.
- PCM is tested to the German RAL standard – 10,000 cycles which equates to 27 years assuming 1 complete cycle a day.

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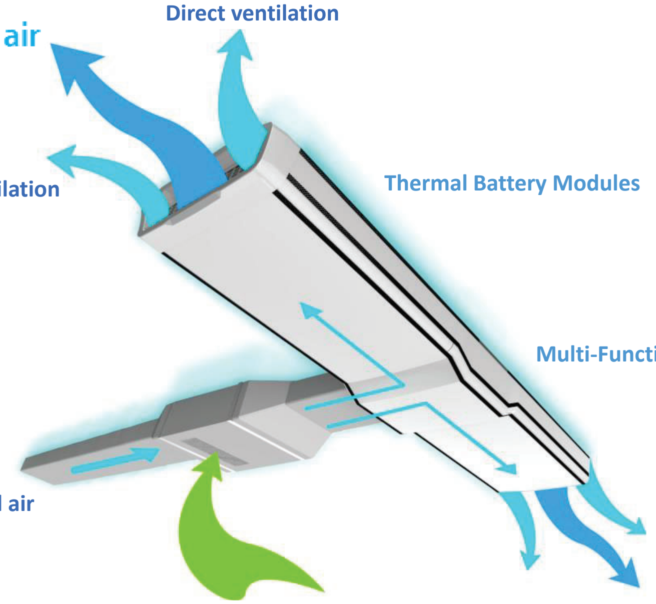
How Does COOL-PHASE work?



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Performance

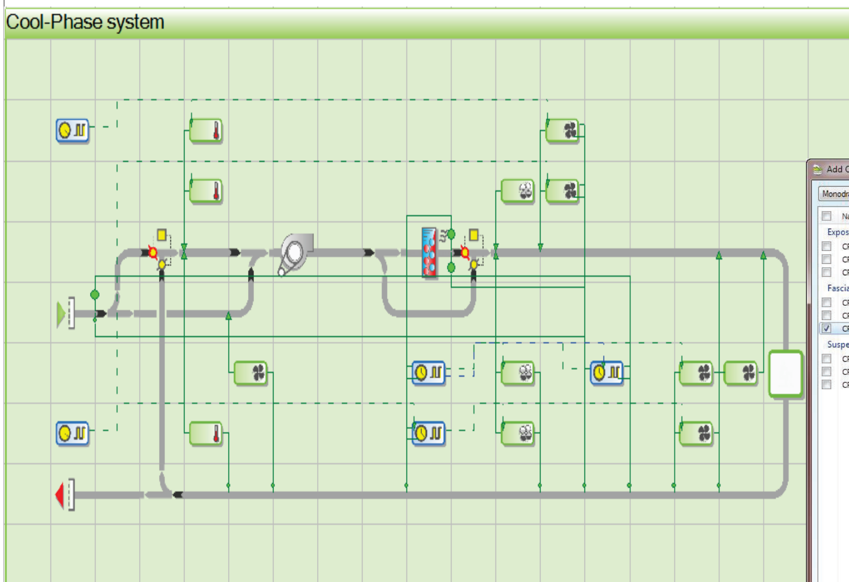
Per COOL-PHASE® Unit:

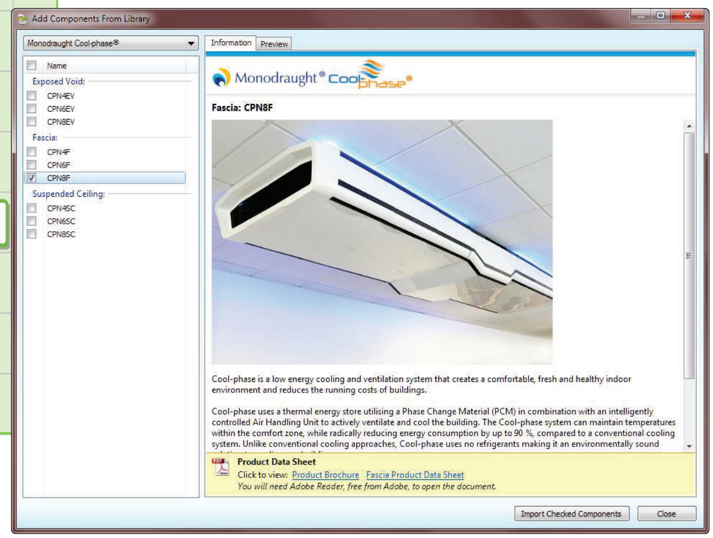
- Normal ventilation rate – **100 to 260** l/s
- Maximum ventilation rate - **300** l/s
- Total thermal energy storage – **6/8/10 KWhrs**
- Typical cooling in 24 hour period **>14/16/20 KWhrs**

Total Cooling = Free Cooling (Ventilation) + Night Time Cooling (Building + Flush) + Thermal Batteries (Energy Sorted)

Monodraught

Dynamic Building Simulation





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Case Study – Bournemouth University

Bournemouth University

Location: Bournemouth
Systems: Cool-phase®

Results

The Cool-phase system monitors and records temperatures, CO2 levels and energy use. The results below are based on data collected by the units installed in each Classroom between 20th April 2012 and 24th June 2013.

Temperature Comparison

This table shows the overall average daily temperatures for each Classroom. It is clear from the table that the Cool-phase systems have kept the temperature within a very comfortable band.

This table shows the percentage of time that the internal temperature has spent at over 25°C , 28°C and 32°C during the logged period.

Daily Temperatures (°c) Science Lecture Room		
Average	Min Average	Max Average
20.6°c	19.0°c	21.9°c

Max Temperatures (%) Science Lecture Room		
>25°c	>28°c	>32°c
0.01%	0%	0%

Air Quality

Background or atmospheric CO^2 level is approximately 400 parts per million (ppm) and 1500ppm or above would be considered a high level.

CO^2 Levels Science Lecture Room		
> 1000ppm	>1200ppm	>1500ppm
0%	0%	0%

Energy Use

As shown in this table the two Cool-phase units installed in the Science Lecture Room used a combined 138.5KWHs of energy across the logged period. Assuming 0.11£/KWh that amounts to £15.24 or an average of **£0.25p a week.**

Energy Used **Science Lecture Room – 61 weeks**			
Cost in £'s (Assumed 0.11£/KWh)	**138.5** KWhs	**£15.24 total**	**£0.25p Wk**

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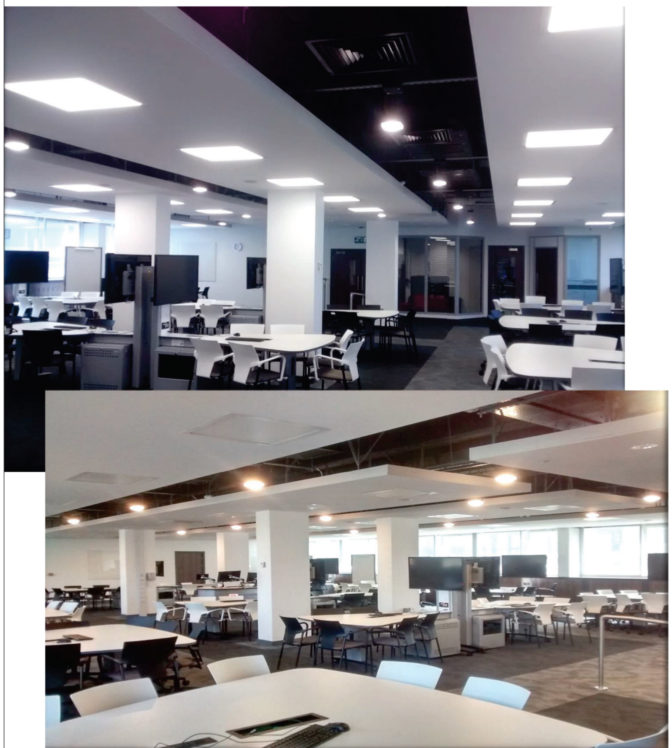
Installation Examples



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Thank you!

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Buckinghamshire, HP12 3SE

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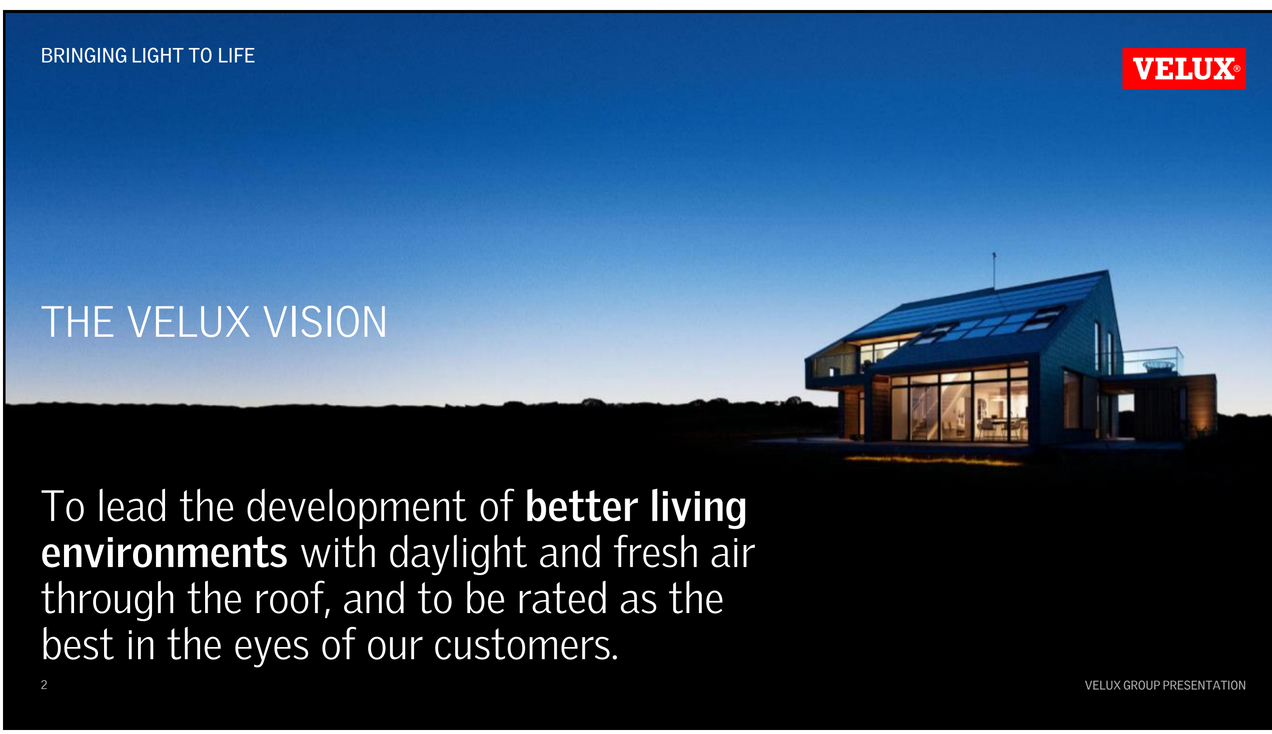
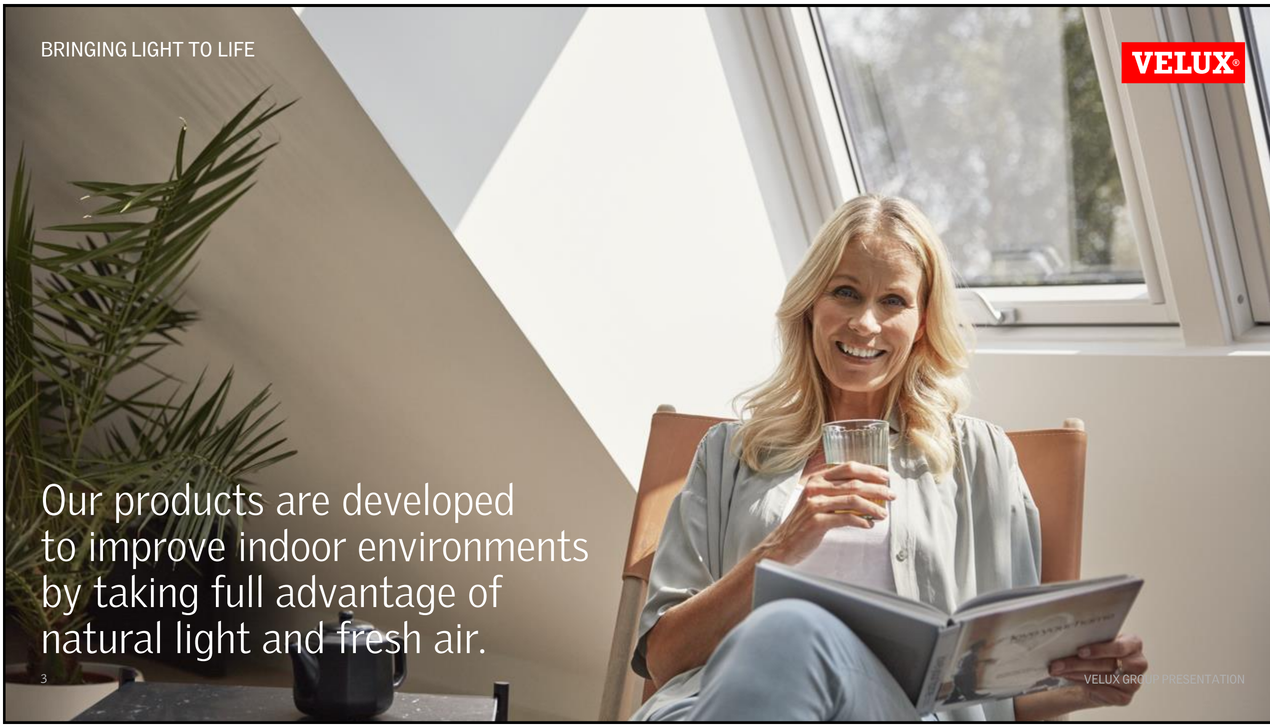
VELUX
Controlled windows for ventilative cooling
Best practice examples of residential ventilative cooling
AIVC & Venticool webinar on June 1, 2021
Peter Foldbjerg, VELUX A/S
Photo: Adam Mørk

1

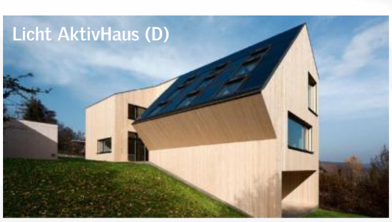

BRINGING LIGHT TO LIFE
VELUX
THE VELUX VISION
To lead the development of **better living environments** with daylight and fresh air through the roof, and to be rated as the best in the eyes of our customers.
2
VELUX GROUP PRESENTATION

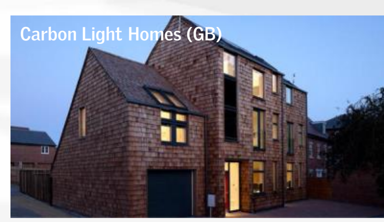
2



THE MODEL HOME 2020 PROGRAMME

Six buildings to explore if it is possible to build healthy and sustainable buildings for the future – today. 2009-2016





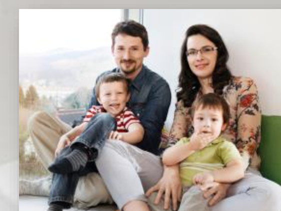
VELUX

POST-OCCUPANCY EVALUATIONS AND MONITORING

Continuous hourly measurements in each room:

- Temperatures
- lux
- Humidity
- CO_2-level
- Energy production and consumption
- Position of windows and solar shading

Post Occupancy Evaluations by anthropologists



Dorfstetter family in Sunlighthouse

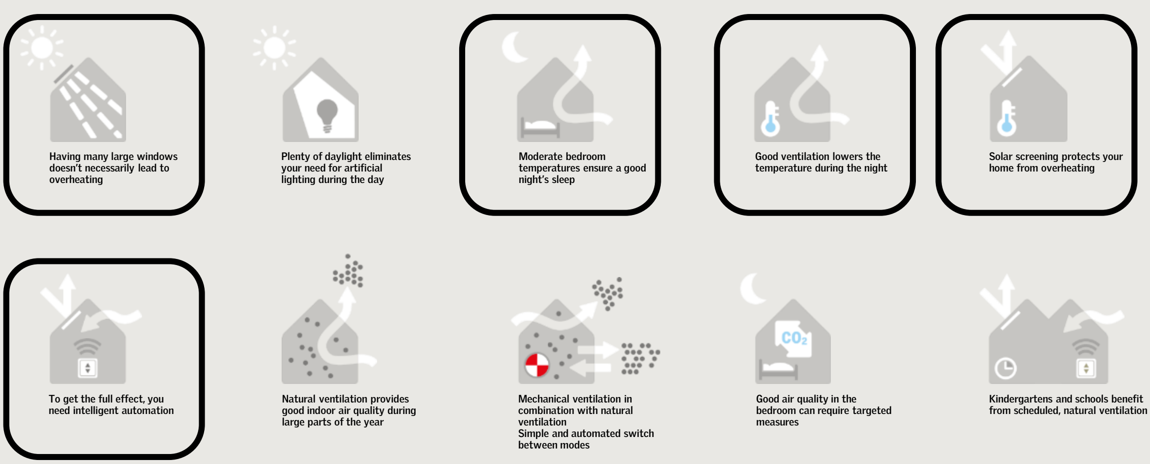
Oldendorf family in LichtAktiv Haus

5

5

VELUX

KEY RESULTS FROM MODEL HOME 2020



6

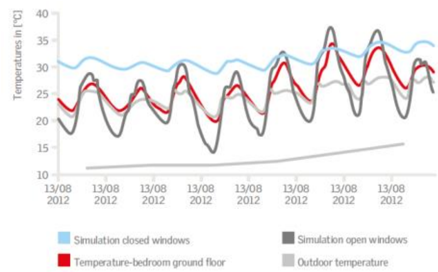
MODEL HOME 2020: MAISON AIR ET LUMIÈRE

VELUX®

It was possible to keep the **indoor temperature below the outdoor temperature** during daytime

Indoor temperature was typically 5-8°C lower than without ventilative cooling

Control of windows by a WindowMaster control system, for overheating control parameters are indoor temperature and solar radiation



MODEL HOME 2020: MAISON AIR ET LUMIÈRE

VELUX®

" During the summer heat wave the outside temperature reached 32 °C, but inside we had a bearable temperature of 26 °C thanks to the awnings.

At night the house quickly cooled down when windows at ground floor level and roof windows were opened to create a flow of cool night air through the house

HIGH AIR FLOWS WITH VENTILATIVE COOLING CAN BE MEASURED AND CALCULATED

ARMINES VELUX

- Good correspondence between measured and simulated air change rate in main room in summer
- Air change rates between 10 and 23 ACH

		Wind speed m/s	Tracer Gas ACH	Simulated CONTAM ACH
Morning	Closed door	3.6	13.4	13.9*
	Open door	2.8	22.5	20.6
Afternoon	Closed door	2.3	13.2	16.6*
	Open door	2.3	19.8	19.5
Morning	Closed door	3.6	13.4	14
	Open door	3.6	14.6	17.4
Afternoon	Closed door	2.9	10.6	13.2
	Open door	2.8	13.1	17

Max 30% difference per case, 10% difference in average

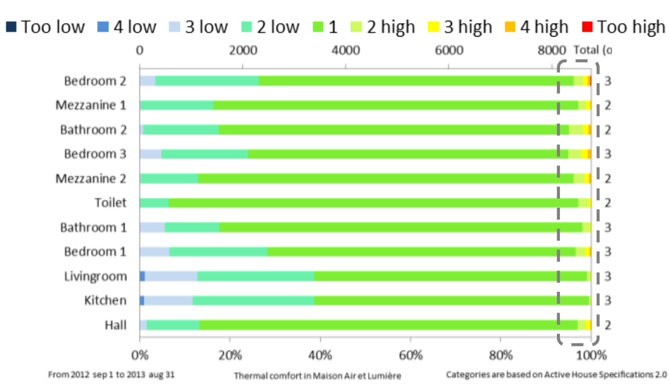
9

MEASUREMENTS PERFORMED ON A SUMMER DAY IN MAISON AIR ET LUMIERE BY ARMINES IN FRANCE IN COOPERATION WITH VELUX

9

HIGH DAYLIGHT LEVELS WITHOUT OVERHEATING

VELUX



Maison Aire et Lumiere, Paris, France

Each hour is categorised according to the measured temperature, following the Active House Specification (corresponds to EN 16798-1)

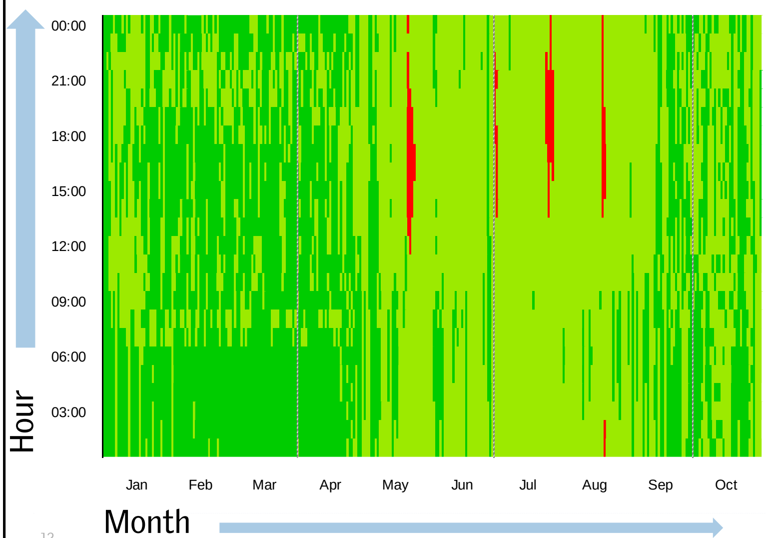
Daylight factor in all main rooms: 5% average

Almost all main rooms achieve EN 16798-1 category 1 for summer comfort

10

10

FREQUENT USE OF VENTILATIVE COOLING



Cat 1 or 2, windows closed

Cat 1 or 2, windows open

Cat 3 or 4, windows closed

Cat 3 or 4, windows open

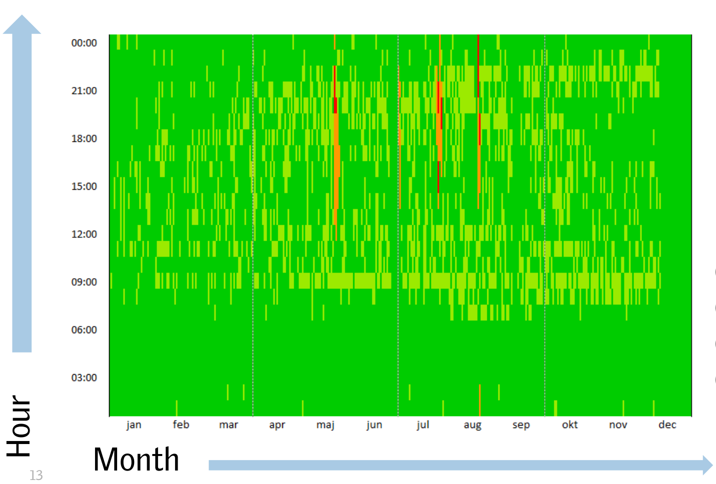
Category refers to Active House / EN 16798-1 category
"Open window" if one or more windows are open in the room

12

Kitchen/dining room LichtAktiv Haus

12

SOLAR SHADING USED FREQUENTLY



Cat 1 or 2, Awnings inactive

Cat 1 or 2, Awnings on

Cat 3 or 4, Awnings inactive

Cat 3 or 4, Awnings on

13

Kitchen/dining room LichtAktiv Haus

13

VELUX

AUTOMATION IS IMPORTANT

Automated solar shading and window openings were used frequently during work-hours on weekdays, and during the night

.. e.g. at times when the families cannot be expected to be able to operate the products themselves

The indoor climate could not have been achieved with only manual products.

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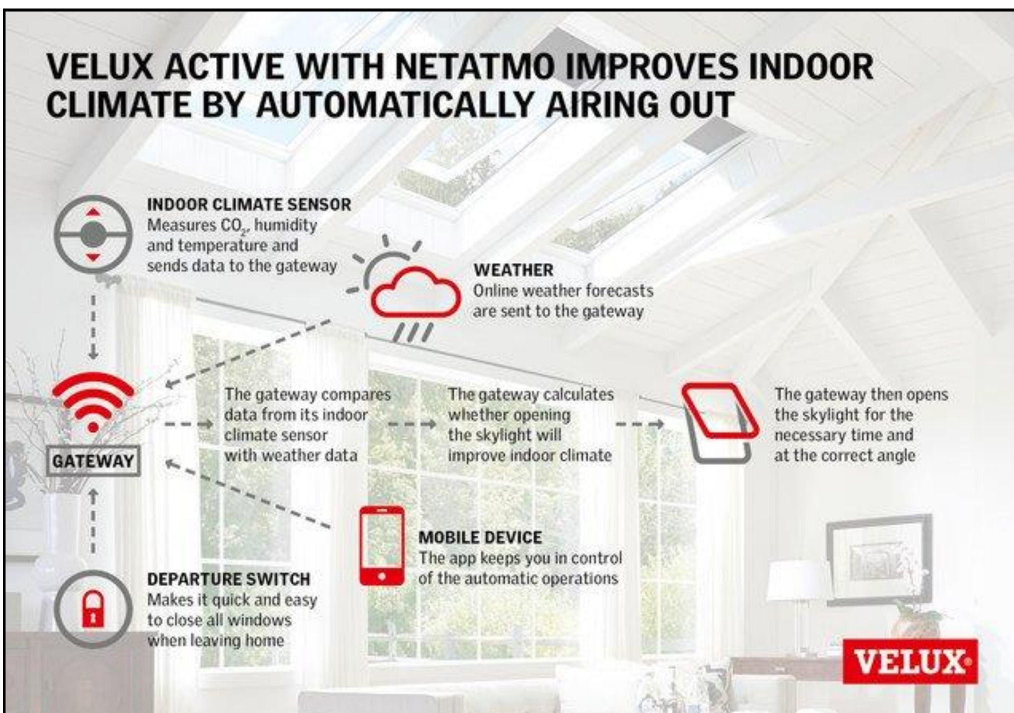
VELUX



TLE/DEPARTMENT/ARCHIVE/AUTHOR


RenovActive
Replicable and affordable renovation
of run-down social housing in Bruxelles
VELUX
Photo: Adam Mørk

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UX

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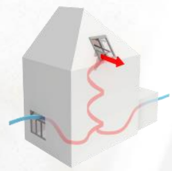
A HEALTHY AND AFFORDABLE RENOVATION CONCEPT

RenovActive | VELUX

RenovActive - the 7 elements

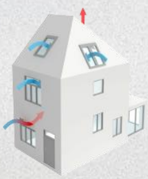
Growing from within

Daylight treatment



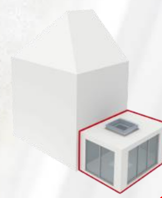
Respiratory channel

3rd skin



Hybrid breathing

Envelope upgrade



New life space

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A HEALTHY AND AFFORDABLE RENOVATION CONCEPT

RenovActive | VELUX

Challenge: Overheating
RenovActive elements

3rd skin

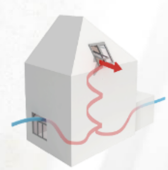
- Use sun screening to prevent the building from getting too hot.
- Equip windows with automated sun screening.

Envelope upgrade

- For better thermal comfort, keep your home cool in summer.
- Some glasses can protect you from sun gains
- Ensure you have well insulated windows, walls and roof so you keep the heat outside.

Hybrid breathing

- In summer, prioritise natural ventilation. In winter, combine natural and mechanical ventilation.
- Use automated cross-ventilation and stack effect to increase ventilation rates.



Respiratory channel

- Use automated ventilative cooling to cool the building when too hot.
- To do so efficiently, you may want to place the staircase in the center of your home, with 1 or 2 roof windows over it.

Improved insulation and air-tightness create a need for preventive solutions against excessive heat

Back

Documentation

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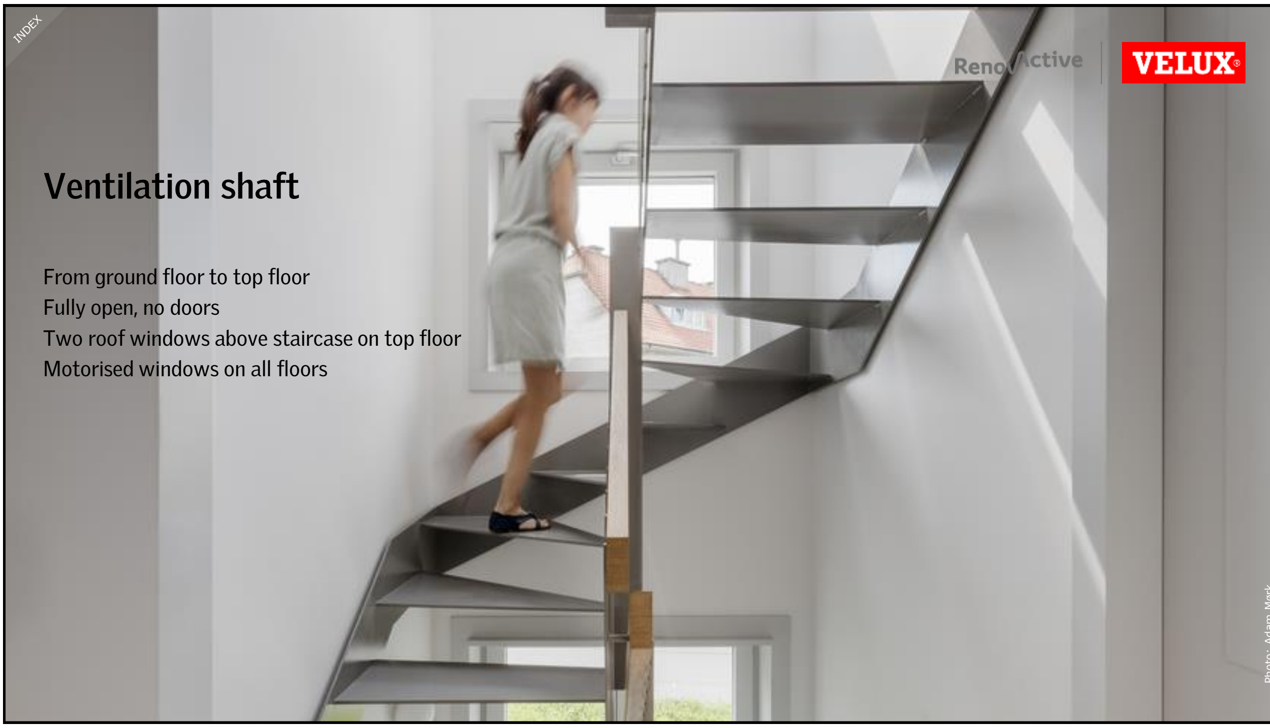

Ventilation shaft

From ground floor to top floor
Fully open, no doors
Two roof windows above staircase on top floor
Motorised windows on all floors

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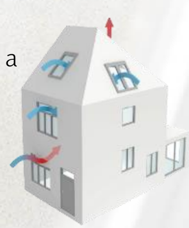
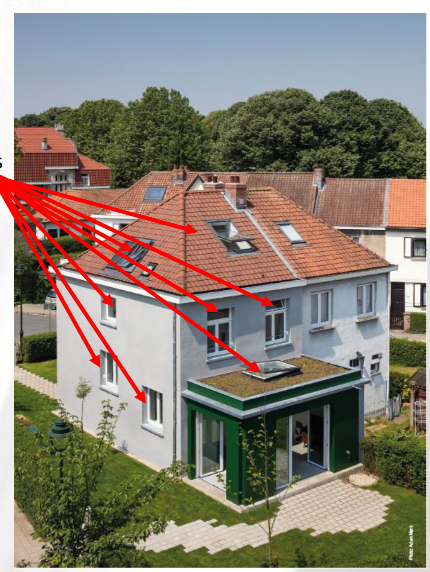
RenovActive | VELUX

Ventilation of RenovActive

- Ventilation system in RenovActive (Renson HealthBox):
  - Ventilation system C (extract ventilation)
  - Natural supply vents above the windows
  - Extraction by fan
  - Automatically controlled window openings.
- The switch between hygienic and peak ventilation is controlled based on indoor air quality and in order to prevent overheating.
- Where possible, the façade windows were sectioned with a 20 cm motorized window at top for natural ventilation without impact on privacy or risk of burglary



Motorised windows



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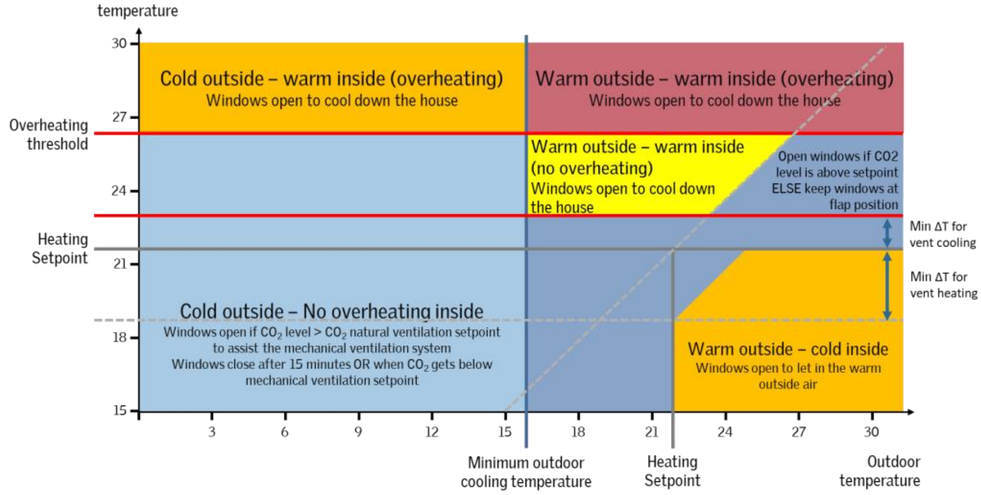
Renson Hybrid ventilation system + control of window opening

VELUX

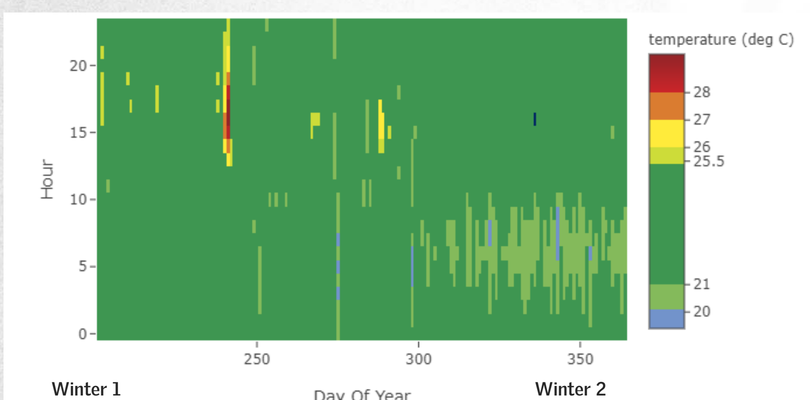
Renson Healthbox



BUILDING MONITORING - QUANTITATIVE DATA

RenovActive | VELUX

Temperature in the living room



Winter 1
ventilation by
- pivoting windows
- fan extraction

Winter 2
ventilation by
- natural supply vents
- fan extraction

1 June 2021

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VELUX

Bringing light to life™

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CONTACT INFO

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Resilient Ventilative Cooling in practice

- VENTILATIVE COOLING INTEGRATED DESIGN

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1

Our business areas

Stand-alone solutions or full integration with BMS

Provide and control

Natural ventilation

Mixed mode ventilation

Smoke ventilation

Additional control of

Sun screening

Cooling

Heating

Light

Mechanical ventilation

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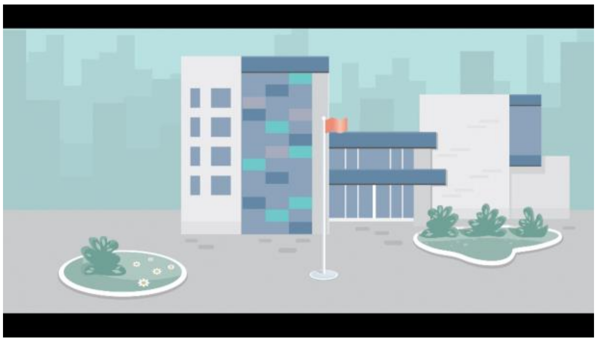
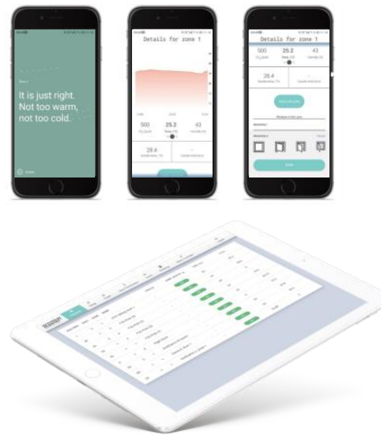
2

Cloud-based control system

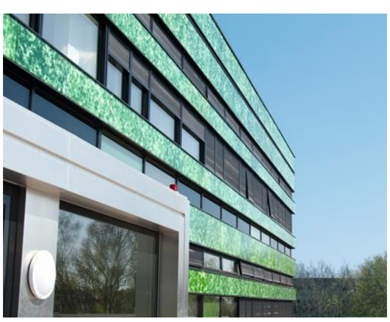
How does it works?



App and dashboard

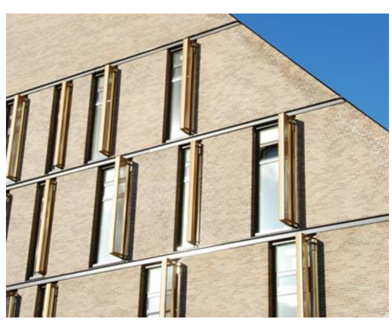


Cases



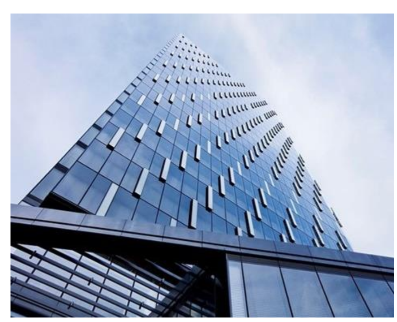
Municipality building

- 0-energy office building utilising Hybrid ventilation.



Court building

- Mechanical- and natural ventilation depending on the area.



PNC Tower

- Hybrid ventilated office building.

Office building in Denmark

WindowMaster
Fresh Air. Fresh People.

Solution

Hybrid ventilation

Solar shading

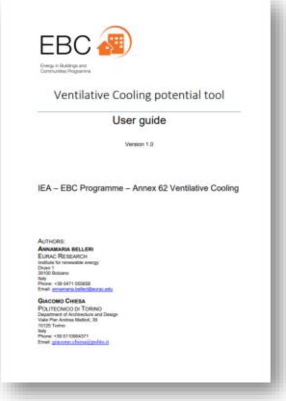
Buildings

IEA Annex 62 – tool to analyse the VC climate potential

WindowMaster
Fresh Air. Fresh People.

https://venticool.eu/information-on-annex-62/annex-62-publications/deliverables/

User guide



EBC

Ventilative Cooling potential tool

User guide

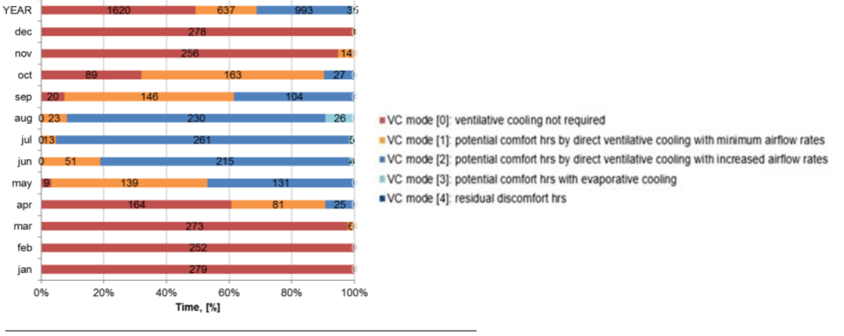
Version 1.0

IEA – EBC Programme – Annex 62 Ventilative Cooling

Authors:
Annamaria Belleri
Eurac Research

Giacomo Chiesa
Politecnico di Torino
Department of Architecture and Design

Results from tool



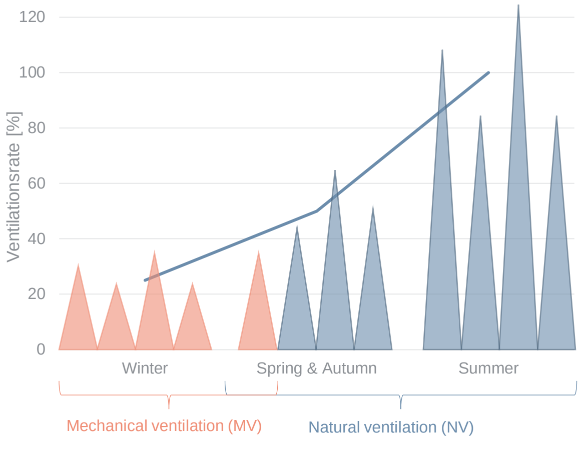
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average airflow rate	-	-	-	2.91	3.22	3.53	3.69	3.58	2.85	2.68	-	-
Standard deviation	-	-	-	0.37	0.76	1.11	1.22	1.38	0.33	0.21	-	-

Table 3. Required ventilation rates (average and standard deviation over each month) to cool the building during occupied hours when direct ventilative cooling with increased airflow rate is required (VC mode [2]). Data refer to example 1: office building in Copenhagen.

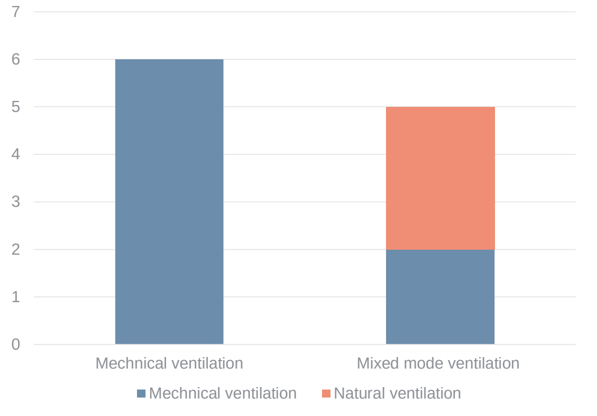
Hybrid ventilation

Lowered; capital cost, energy consumption and solar panels.

Hybrid ventilation strategy

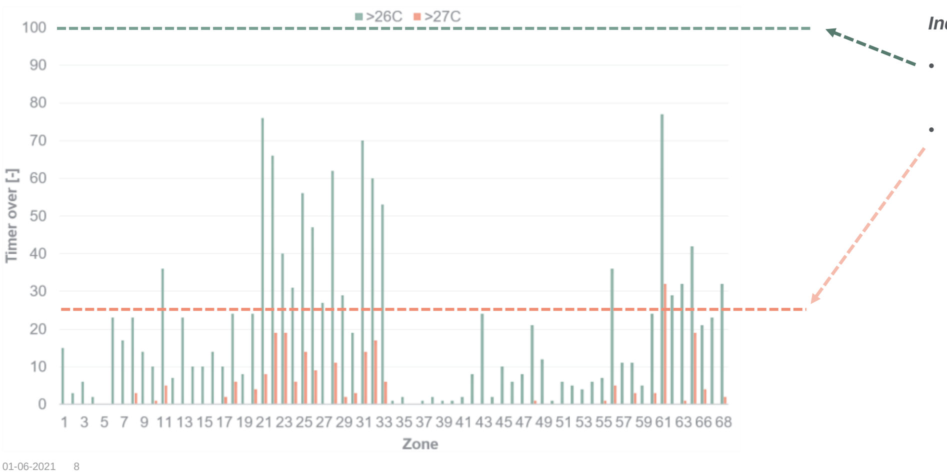


Capital cost of the systems



One year temperature data

Worst performing rooms



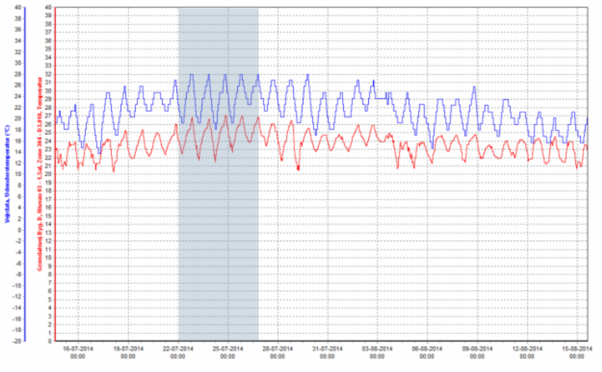
Requirements (DK)

Indoor temperature:

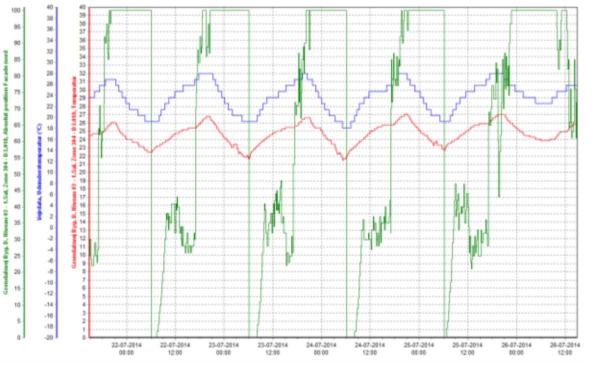
- Not more than 100 hours above 26°C
- Not more than 25 hours above 27°C

Night time cooling

External vs. internal temperatures

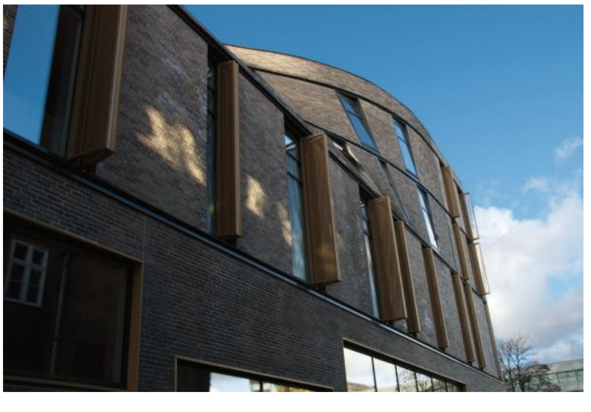


External vs. internal temperatures and opening degree



Court House (Retten på Frederiksberg)

Copenhagen, Denmark



Court House (Retten på Frederiksberg)

Copenhagen, Denmark

Solution and control of

Natural ventilation
Mechanical ventilation
Hybrid ventilation
Smoke ventilation
Solar shading
Heating

Layout

Court rooms at ground floor level

are mechanical ventilated

Ventilation overview

Plan drawing

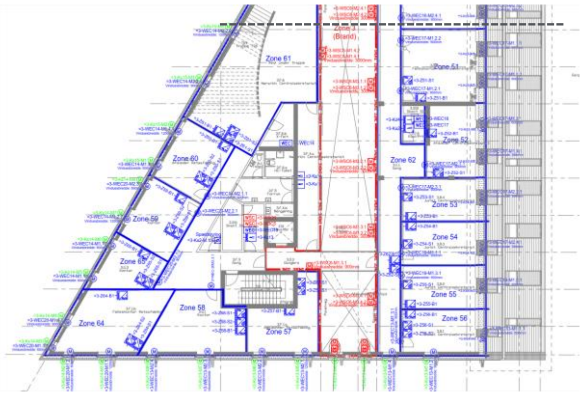
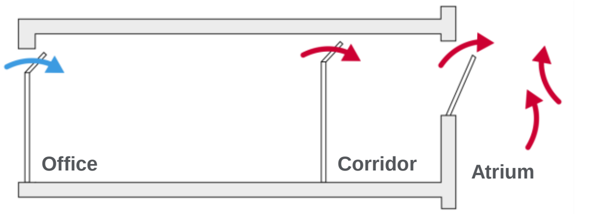


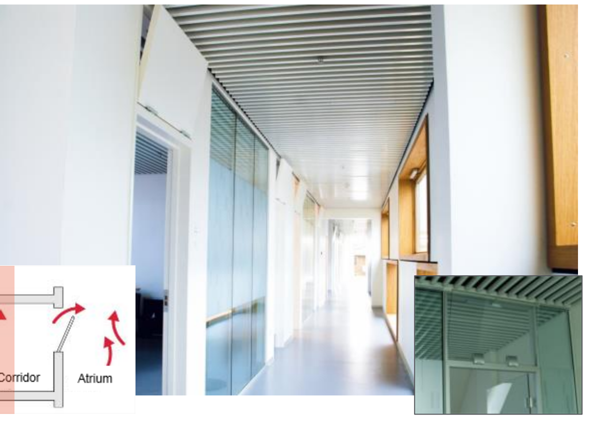
Illustration of the ventilation principle

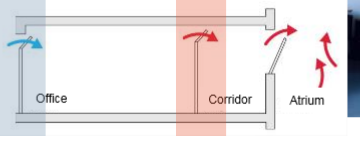


Ventilation walk-through

Façade

Corridor

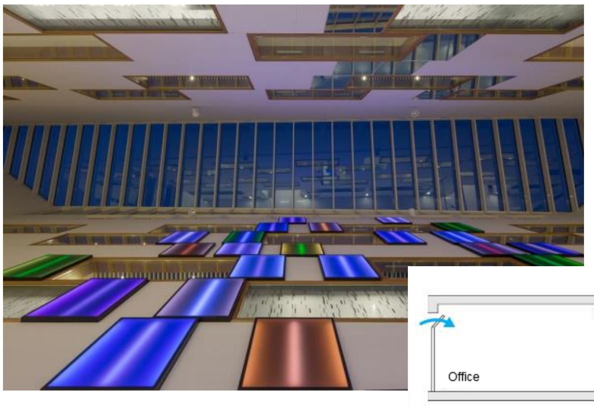


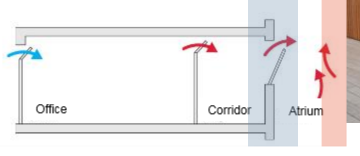


Ventilation walk-through

Atrium

Atrium





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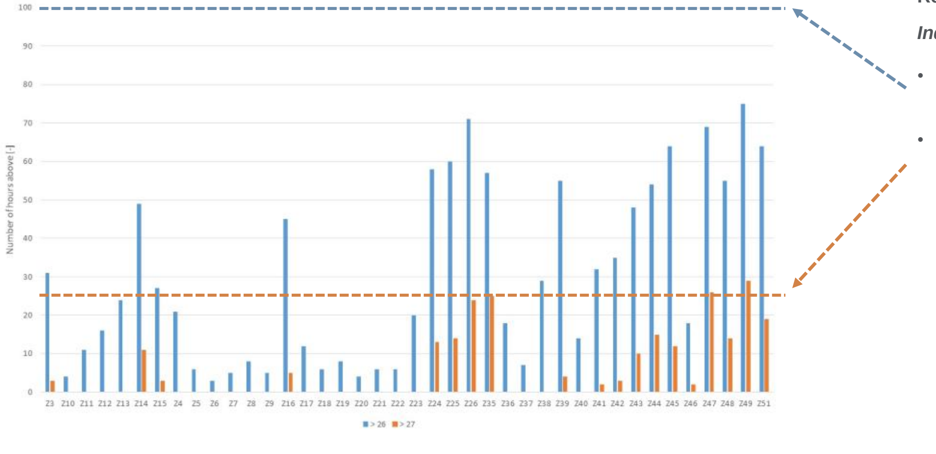
In line with thermal requirements

Measured indoor climate during 1 year



Requirements (DK)

Indoor temperature:

- Not more than 100 hours above 26°C
- Not more than 25 hours above 27°C

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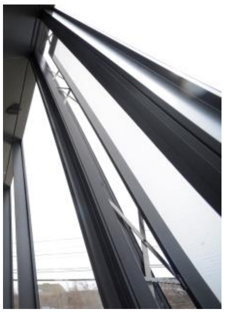
Statement from the Head of Administration

Jesper Christiansen:

"The natural ventilation works well. It is possible to control the air temperature and the employees are satisfied."

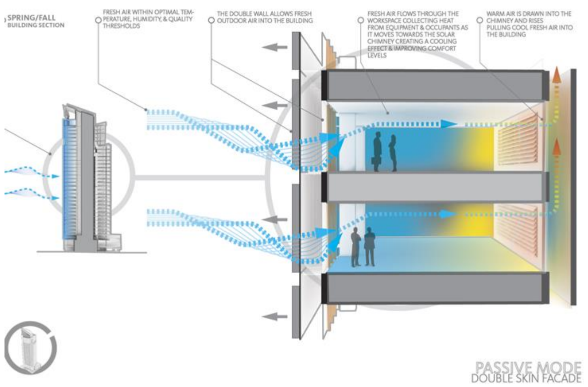
The Tower at PNC Plaza, Pittsburgh, US

"45% of the time we would be able to open our windows for fresh air…"

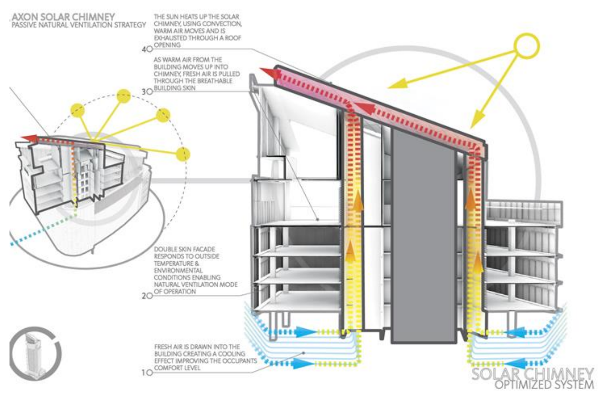


Ventilation principle

The Tower's façade delivers fresh air at low velocity



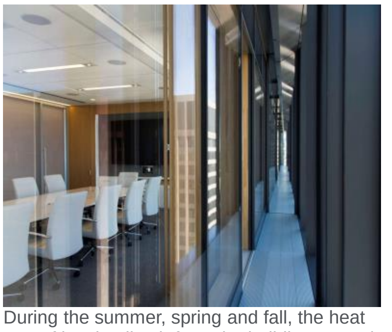
The Tower's solar chimney pulls cooler air into the building



Ventilation principle

6300 MotorLink actuators to control:

- synchronization of 4 actuators on 1 parallel window, 700 parallel windows in the outer DSF
- 1450 automated air vents in the inner facade.
- Feedback & control position via BMS.



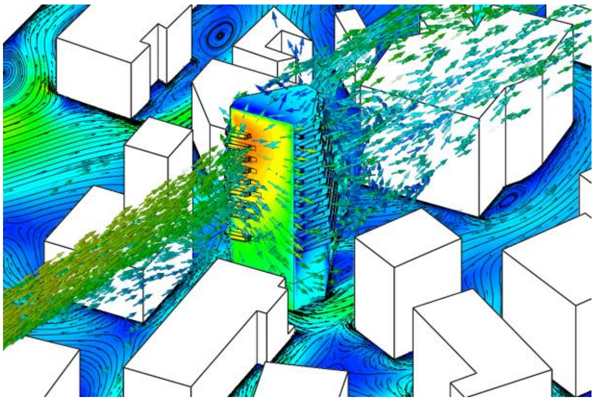
During the summer, spring and fall, the heat at roof level pulls air from the building up and out through the solar chimney. This facilitates natural ventilation and helps PNC maintain a comfortable indoor temperature within The Tower.

"The research told us that 45% of the time we would be able to open our windows for fresh air and essentially turn off the mechanical ventilation in the building."

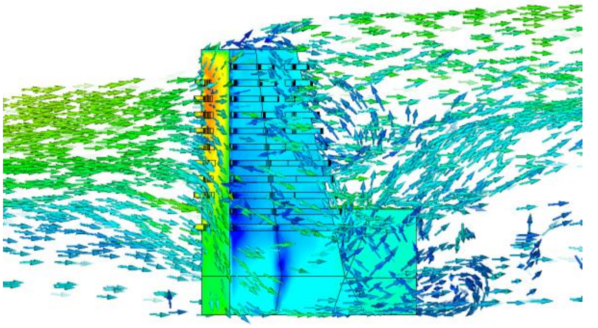
Sophisticated control of the openings

…based on external CFD simulation

Animation of wind and pressure distribution



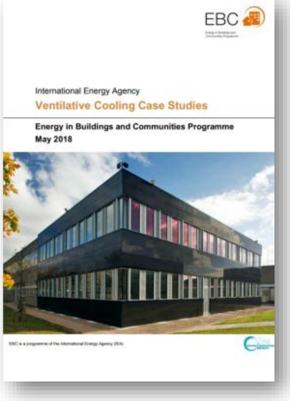
Elevated wind speeds at higher levels



IEA Annex 62 - Deliverables

Ventilative cooling case studies

Case studies - book



Ventilative Cooling Application - buildings incl. ventilative cooling from several countries

IEA EBC Annex 62 Ventilative Cooling
International Ventilative Cooling Application Database

DK_Frederiksberg_Retten på Frederiksberg

IEA EBC Annex 62 Ventilative Cooling
International Ventilative Cooling Application Database

DK_Copenhagen_Pakhus

IEA EBC Annex 62 Ventilative Cooling
International Ventilative Cooling Application Database

DK_ Kongens Lyngby _DTU building 324

Download: www.venticool.eu/annex-62-publications/deliverables/

Questions

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