# VENTILATIVE COOLING INTEGRATED DESIGN




# WindowMaster

Provide and control

Natural ventilation

Mixed mode ventilation

Smoke ventilation

Additional control of

Sun screening

Cooling

Heating

Light

Mechanical ventilation

# Cases

**Office building**
0-energy office building utilising Hybrid ventilation.

**Court building**
Mechanical- and natural ventilation depending on the area.

**PNC Tower**
Hybrid ventilated office building.

**Moesgaard Museum**
Utilizing both a natural and hybrid ventilated approach.



# Office building in Denmark

**Solution**

Hybrid ventilation

Solar shading

**Buildings**

# IEA Annex 62 – tool to analyse the VC climate potential

### User guide


EBC

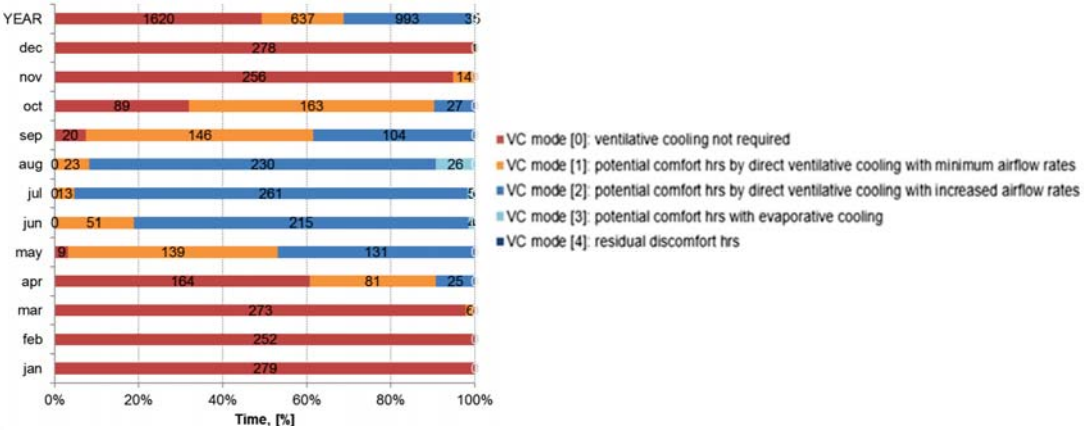
Ventilative Cooling potential tool

User guide

Version 1.0

IEA – EBC Programme – Annex 62 Ventilative Cooling

### 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 | - | - |

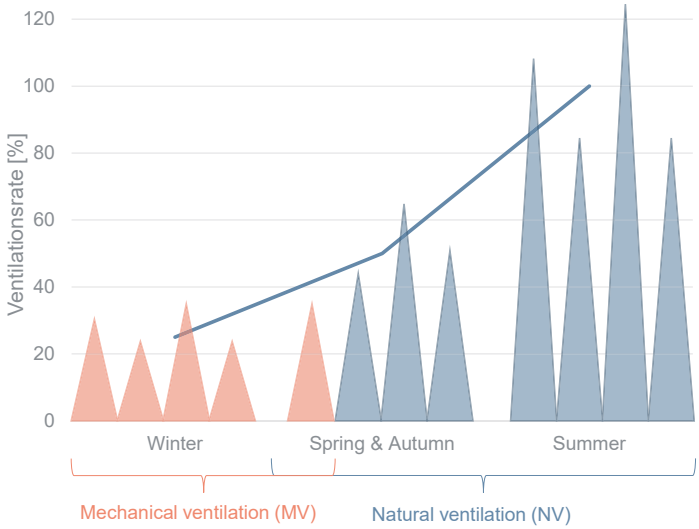
*Table 3. Required ventilation rates (average and standard deviation over each month) to cool the building during occupied hours when direct ventilative cooling with increased airflow rate is required (VC mode [2]). Data refer to example 1: office building in Copenhagen.*



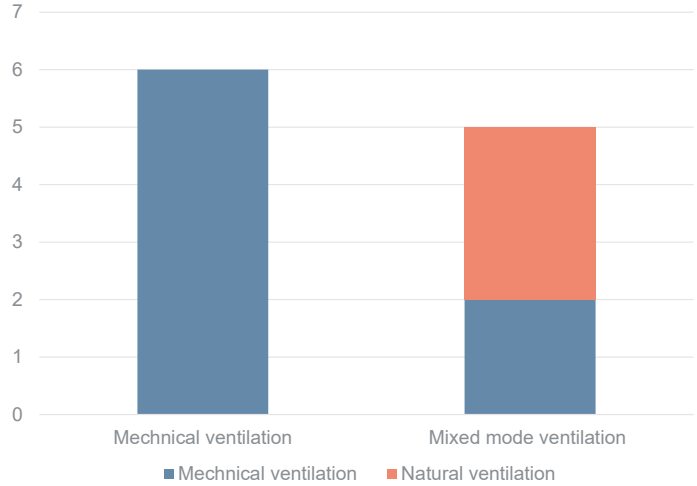
# Hybrid ventilation

Lowered; capital cost, energy consumption and solar panels.

### Hybrid ventilation strategy

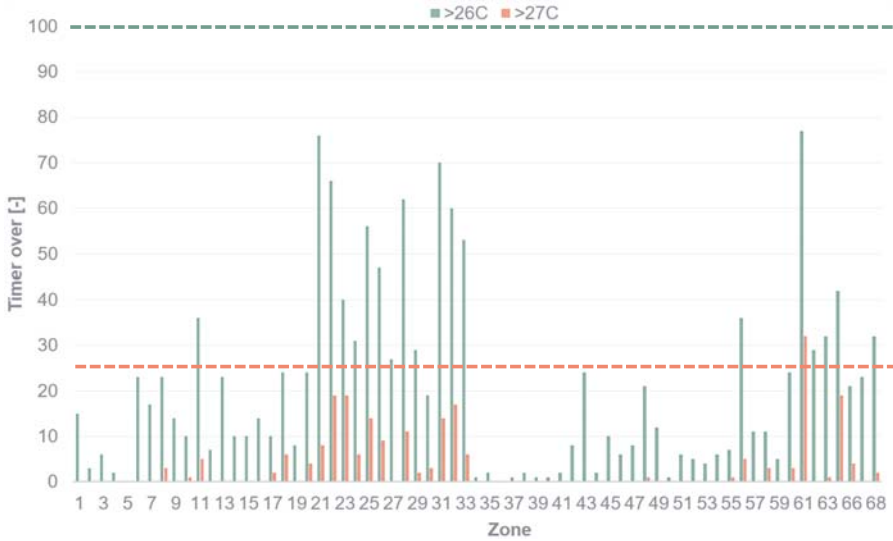



### Capital cost of the systems



# One year temperature data

**Worst performing rooms**




**Requirements (DK)**

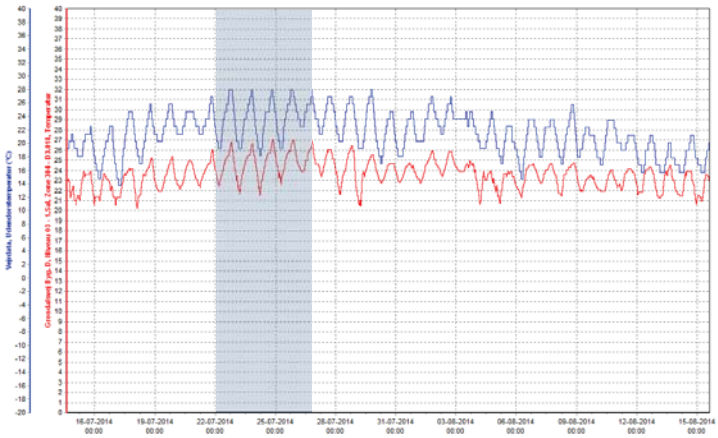
***Indoor temperature:***

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

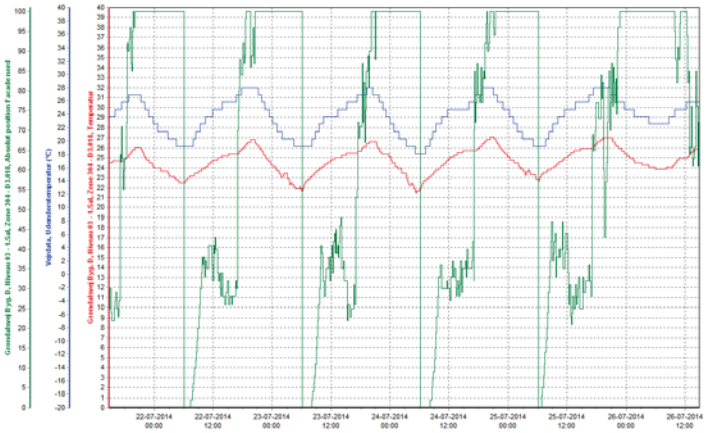


# Night time cooling

**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**

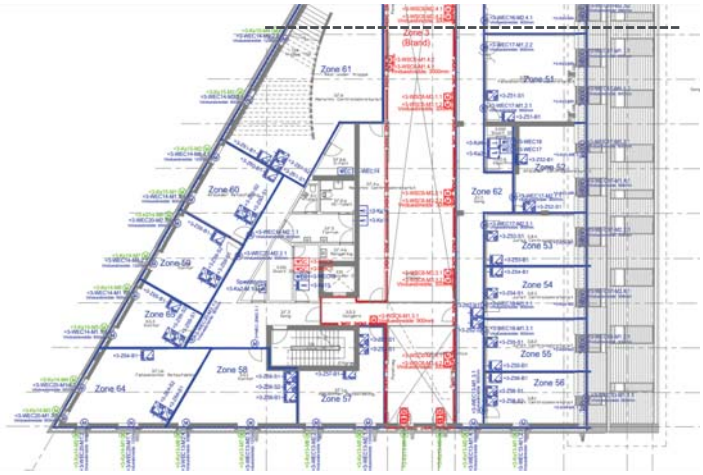
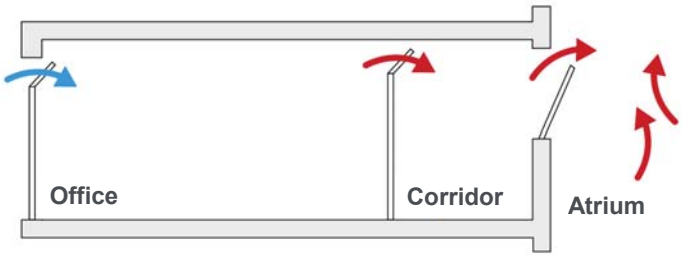


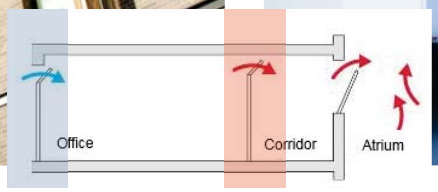
**Illustration of the ventilation principle**



# Ventilation walk-through

**Façade**

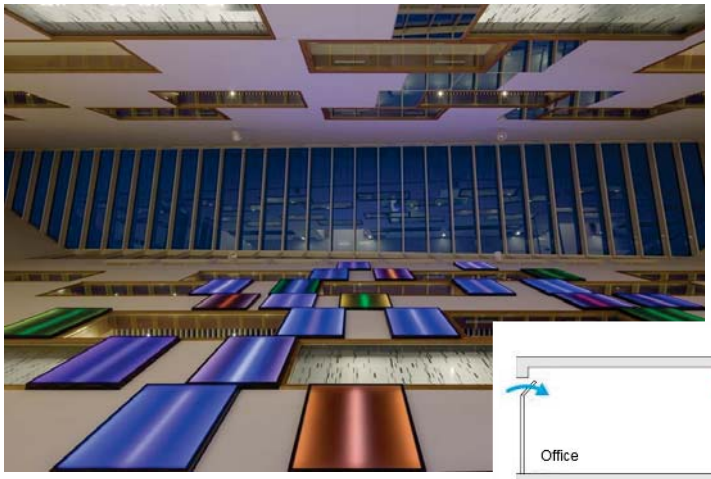
**Corridor**



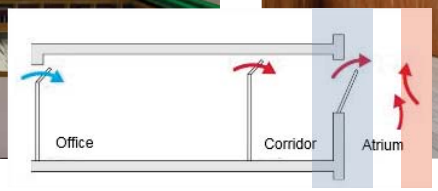



# Ventilation walk-through

**Atrium**

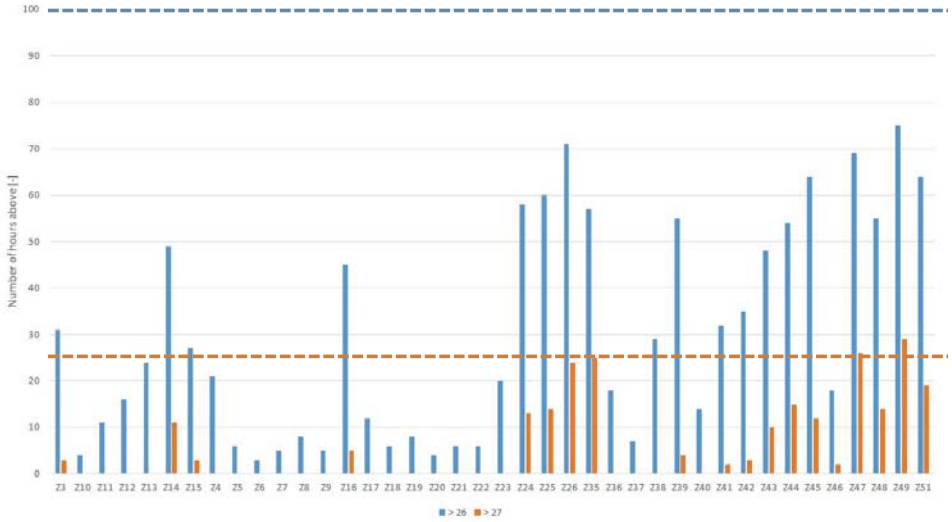


**Atrium**



# 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



# 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

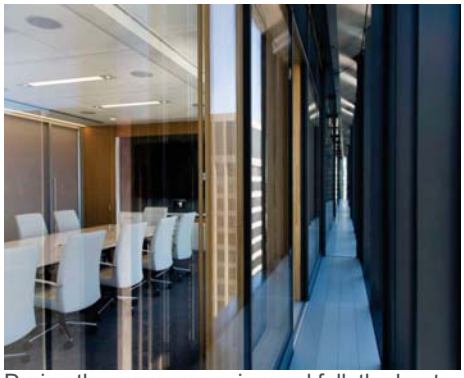
"45% of the time we would be able to open our windows for fresh air…"



# Ventilation principle


**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.

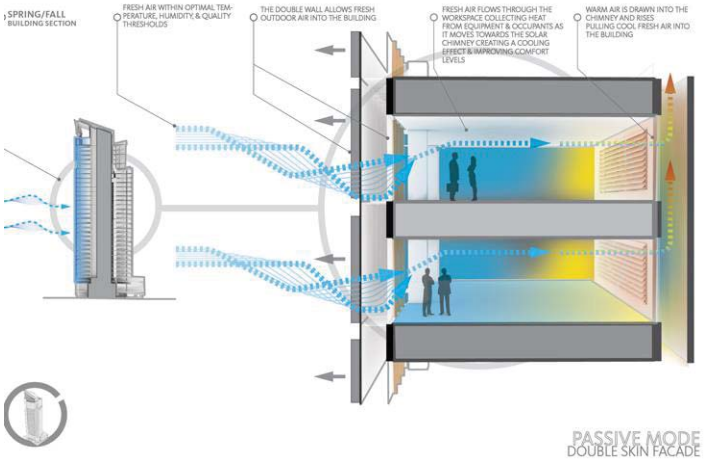


During the summer, spring and fall, the heat at roof level pulls air from the building up and out through the solar chimney. This facilitates natural ventilation and helps PNC maintain a comfortable indoor temperature within The Tower.

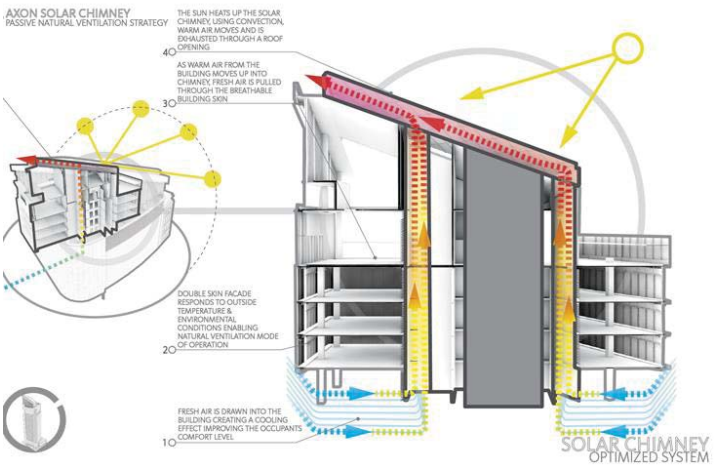
"The research told us that 45% of the time we would be able to open our windows for fresh air and essentially turn off the mechanical ventilation in the building."

# Ventilation principle

**The Tower's façade delivers fresh air at low velocity**




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

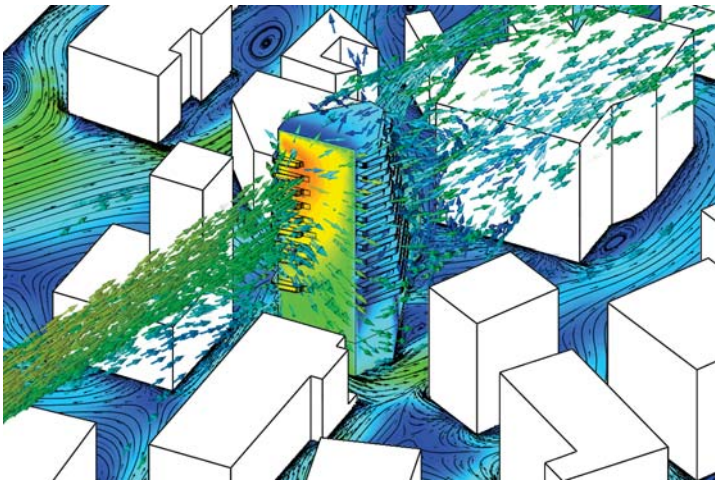




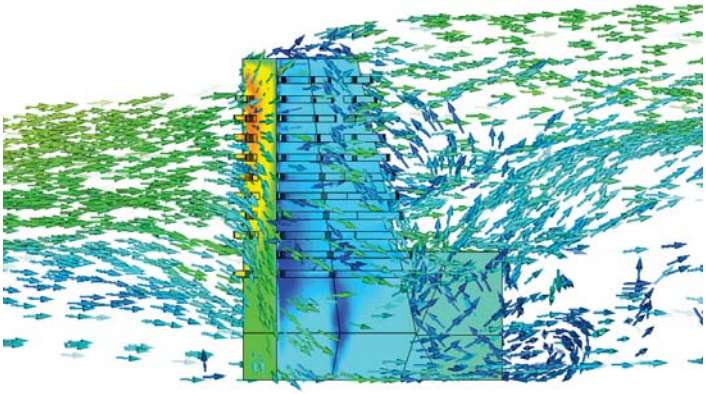

# Sophisticated control of the openings

…based on external CFD simulation

**Animation of wind distribution**



**Elevated wind speeds at higher levels**



# Moesgaard Museum

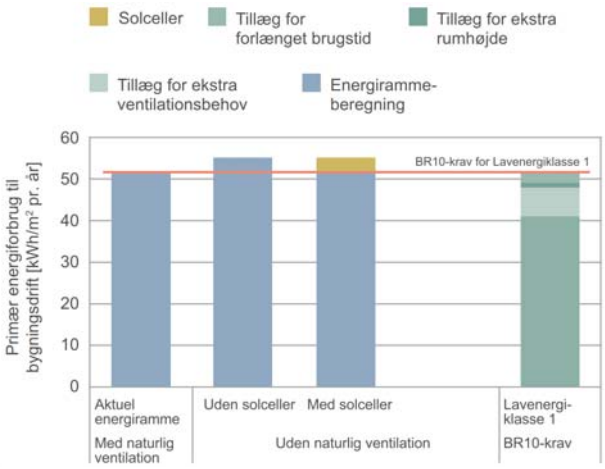
**Hybrid ventilation: Offices**

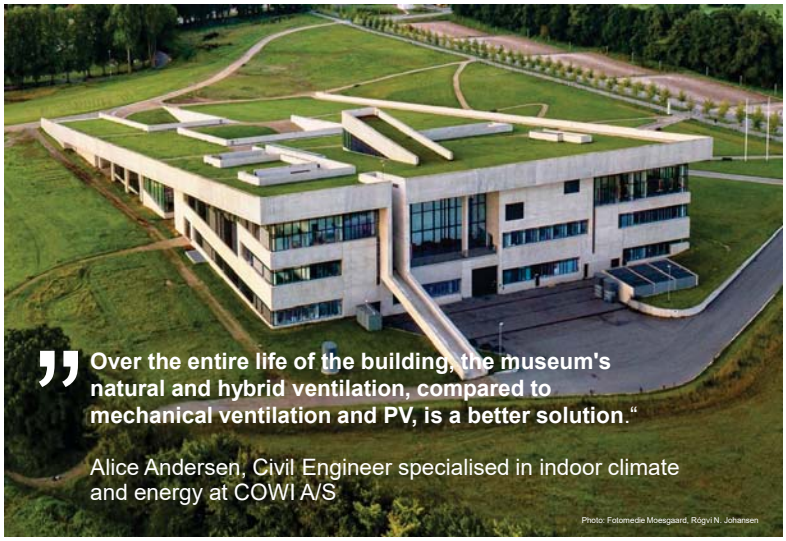

**Natural ventilation: Café, foyer & arrival area**



# Why natural and hybrid ventilation?

## Optimal LCA



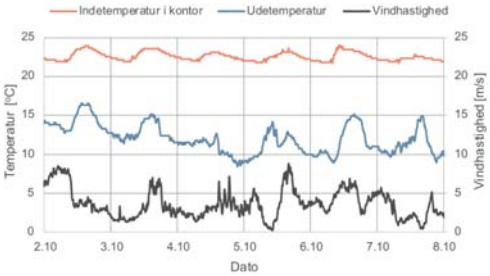
# Stable indoor climate and satisfied users

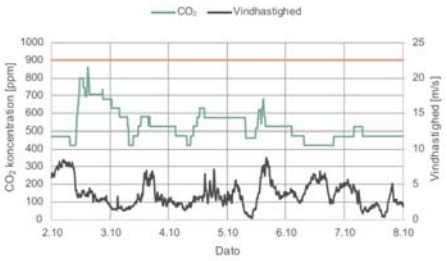
**Mikkel Berg Thorsager, Tech. Manager at Moesgaard Museum**

*"The indoor climate plays a key role here, so I am also excited that the comfort level of natural ventilation is so high.*

*There is always a special freshness inside, which obviously propagate to staff and guests "*

**Indoor climate**



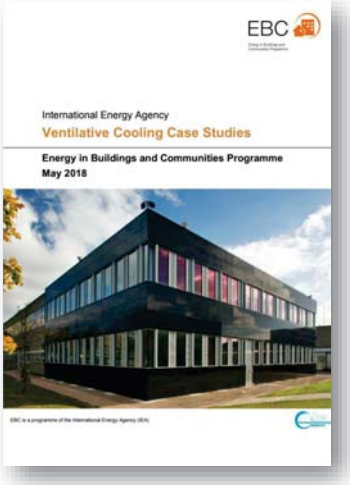






# IEA Annex 62 - Deliverables

Ventilative cooling case studies

**Case studies - book**




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




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

# Questions

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