# ASSESSING VENTILATIVE COOLING POTENTIAL IN ENERGY PERFORMANCE REGULATIONS STATUS AND PERSPECTIVES IN AUSTRIA, DENMARK, FRANCE

**Jointly organised by**:
- IEA - EBC Annex 62 project on Ventilative Cooling
- Venticool (www.venticool.eu )

**In cooperation with**:
- Air Infiltration and Ventilation Centre (www.aivc.org)
- QUALICHeCK consortium (www.qualicheck-platform.eu)
- CIBSE Natural Ventilation Group (associate partner of venticool)

**Hosted by:**
- INIVE (www.inive.org)

IEA EBC
Annex 62
The IEA project
on ventilative cooling
EBC

**IEA – EBC ANNEX 62** IS AN INTERNATIONAL IEA RESEARCH PROJECT INITIATED BY THE ENERGY IN BUILDINGS AND COMMUNITIES PROGRAMME (IEA EBC) IN NOVEMBER 2013.

THE PROJECT WILL BE RUNNING IN A FOUR YEAR WORKING AND REPORTING PHASE FROM 2014 – 2017.

COUNTRY PARTICIPATION INCLUDES: AUSTRIA, BELGIUM, CHINA, DENMARK, IRELAND, ITALY, JAPAN, NETHERLANDS, NORWAY, PORTUGAL, SWITZERLAND, UK, USA

OBJECTIVES

- To analyse, develop and evaluate suitable methods and tools for prediction of cooling need, ventilative cooling performance and risk of overheating in buildings that are suitable for design purposes.
- To give guidelines for integration of ventilative cooling in energy performance calculation methods and regulations including specification and verification of key performance indicators.
- To extend the boundaries of existing ventilation solutions and their control strategies and to develop recommendations for flexible and reliable ventilative cooling solutions that can create comfortable conditions under a wide range of climatic conditions.
- To demonstrate the performance of ventilative cooling solutions through analysis and evaluation of well-documented case studies.

OUTCOME

- Guidelines for energy-efficient reduction of the risk of overheating by ventilative cooling
- Guidelines for ventilative cooling design and operation in residential and commercial buildings
- Recommendation for integration of ventilative cooling in legislation, standards, design briefs as well as on energy performance calculation and verification methods
- New ventilative cooling solutions including their control strategies as well as improvement of capacity of existing systems
- Documented performance of ventilative cooling systems in case studies

venticool

the international platform for ventilative cooling

**VENTICOOL** IS THE INTERNATIONAL VENTILATIVE COOLING PLATFORM LAUNCHED IN OCTOBER 2012 TO ACCELERATE THE UPTAKE OF VENTILATIVE COOLING BY RAISING AWARENESS, SHARING EXPERIENCE AND STEERING RESEARCH AND DEVELOPMENT EFFORTS IN THE FIELD OF VENTILATIVE COOLING.

THE SCOPE OF VENTICOOL COVERS AS WELL NATURAL, MECHANICAL AND MIXED-MODE VENTILATION.

ITS AMBITION IS TO BE THE INTERNATIONAL MEETING POINT FOR VENTILATIVE COOLING RELATED ACTIVITIES.

## WEBINAR PROGRAMME

10:00 **WELCOME**
Per Heiselberg, University of Aalborg, Denmark

10:15 **VENTILATIVE COOLING IN THE DANISH REGULATION**
Per Heiselberg, University of Aalborg, Denmark

10:30 **Questions and answers**

10:40 **VENTILATIVE COOLING IN THE AUSTRIAN REGULATION**
Peter Holzer, Building Research and Innovation, Austria

10:55 **Questions & Answers**

11:05 **VENTILATIVE COOLING IN THE FRENCH REGULATION**
Charles Pelé, CSTB, France

11:20 **Questions & Answers**
11:30 **End of the webinar**

# VENTILATIVE COOLING IN THE DANISH REGULATIONS

PER HEISELBERG
DEPARTMENT OF CIVIL ENGINEERING

AALBORG UNIVERSITY
DENMARK

## BACKGROUND

THE DEVELOPMENT TOWARDS ”NEAR ZERO ENERGY BUILDINGS” HAS RESULTED IN AN INCREASED NEED FOR COOLING – NOT ONLY IN SUMMER BUT MOST OF THE YEAR!

TOO HIGH INDOOR TEMPERATURES ARE THE MOST REPORTED PROBLEM IN POST OCCUPANCY STUDIES OF THE INDOOR ENVIRONMENT IN LOW ENERGY BUILDINGS IN DENMARK – EVEN IN THE HEATING SEASON!

THE MAIN FOCUS IN THE DESIGN PROCES HAS BEEN TO REDUCE THE NEED FOR HEATING (INSULATION, AIR TIGHTNESS), BUT THERE IS A STRONG NEED TO ADRESS COOLING AS WELL.

BY USING THE COOLING POTENTIAL OF OUTDOOR AIR ATTRACTIVE AND ENERGY EFFICIENT SOLUTIONS CAN BE DEVELOPED

## WE HAVE EXPERIENCED AN OVERHEATING PROBLEM

OVERHEATING IS A ”NEW AND INCREASING PROBLEM” FOR LOW ENERGY RESIDENCES

- Is underestimated and are not given enough focus in the design process

TOO SIMPLIFIED DESIGN METHODS ARE USED

- Averaging heat loads in time and space
- Uncertain correlation between cooling need and overheating risk

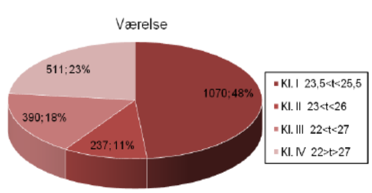
NO (VERY FEW) AVAILABLE STANDARD SOLUTIONS – ESPECIALLY FOR RESIDENCES

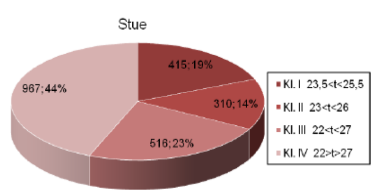
- Users have no (very limited) experience in handling overheating
- “One-of-a-kind” solutions are often not ”adapted to practical use”



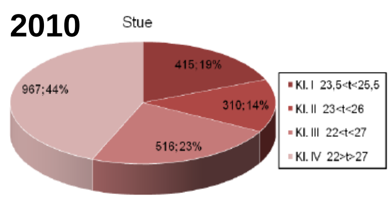
## OVERHEATING

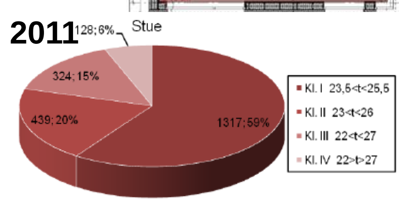
2010



## KOMFORTHUSENE
## – IMPACT OF INTERNAL SOLAR SHADING

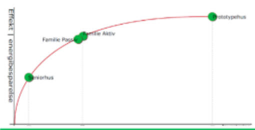



## ENERGIPARCEL, TILST, DENMARK

Realdania Byg
UDVIKLER OG BEVARER

# ENERGIPARCEL – RENOVATION EXAMPLES



| | Mejløvænget 9 Seniorhuset | Langøvænget 1 Familiehus - Passiv | Farøvænget 4 Familiehus - Aktiv | Langøvænget 8 Prototypehuset |
|---|---|---|---|---|
| Tætning og isolering af facader | | | | ● |
| Solceller | | | ● | ● |
| Ovenlys | | | ● | ● |
| Isolering fundament | | | | ● |
| Isolering mod terræn, overalt | | ● | | ● |
| Isolering mod terræn, delvist | | ● | ● | ● |
| Superlavenergi-vinduer, nordfacade | | | | ● |
| Superlavenergi-vinduer, østfacade | | | ● | ● |
| Superlavenergi-vinduer, vestfacade | ● | ● | | ● |
| Superlavenergi-vinduer, sydfacade | ● | | ● | ● |
| Isolering vinduesfalse | ● | ● | ● | ● |
| Automatisk styring, varmeanlæg | ● | ● | ● | ● |
| Isolering rem | ● | ● | ● | ● |
| Isolering loft/tag | ● | ● | ● | ● |

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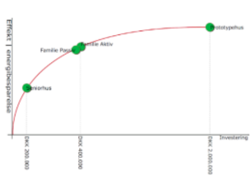
Source: Tine Steen Larsen, Jørgen Søndermark

# ENERGIPARCEL – THERMAL COMFORT 2010



| Temperatur Living Room | Mejløvænget 9 | Langøvænget 1 | Farøvænget 4 | Langøvænget 8 |
|---|---|---|---|---|
| > 26 C (hours) | 181 | 578 | 180 | 99 |
| > 27 C (hours) | 54 | 370 | 60 | 28 |

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Source: Tine Steen Larsen, Jørgen Søndermark

## VENTILATIVE COOLING IS A SOLUTION

VENTILATIVE COOLING CAN BE AN ATTRACTIVE AND ENERGY EFFICIENT PASSIVE SOLUTION TO AVOID OVERHEATING.

- Ventilation is already present in most buildings through mechanical and/or natural systems using opening of windows
- Ventilative cooling can both remove excess heat gains as well as increase air velocities and thereby widen the thermal comfort range.
- The possibilities of utilizing the free cooling potential of low temperature outdoor air increases considerably as cooling becomes a need not only in the summer period.



## VENTILATIVE COOLING IN A DANISH CONTEXT

APPLICATION OF VENTILATIVE COOLING FOR RESIDENTIAL BUILDINGS IS AT A LOW LEVEL

- It is considered difficult to evaluate
- Few technical solutions available – mainly manual window opening only very few automated

VENTILATIVE COOLING IS A STANDARD SOLUTION IN OFFICES WITH MECHANICAL VENTILATION

- Designed for IAQ criteria
- Limited benefit due to fan energy use

VENTILATIVE COOLING BY NATURAL/HYBRID VENTILATION IS KNOWN

- But only used in a few cases in offices

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## VENTILATIVE COOLING IN DANISH BUILDING REGULATIONS

DANISH BUILDING REGULATION ALLOWS IN GENERAL TERMS TO TAKE INTO ACCOUNT THE EFFECT OF VENTILATIVE COOLING

- But does not give any guidelines or recommendations.

FOR THERMAL COMFORT BUILDING REGULATIONS REFER TO ISO 7730 AND DS 447

- But states that air velocities above 0,15 m/s is acceptable if indoor temperature exceeds 24oC
- Indoor temperature level must not exceed 27C for more than 100 hours/year and 28C for more than 25 hours/year

A SIMPLIFIED METHOD IS AVAILABLE TO DOCUMENT COMPLIANCE

- But as it is based on a mean-monthly approach reliability could be better



## VENTILATIVE COOLING IN DANISH EBPD COMPLIANCE TOOL – BE10

THE DANISH COMPLIANCE TOOL *BE10* IS BASED ON A SIMPLIFIED MEAN-MONTHLY CALCULATION

- Must be used to document compliance with Danish building regulation
- Prediction of cooling needs and overheating risk not very accurate

VENTILATIVE COOLING IS POSSIBLE TO INCLUDE IN THE BUILDING ENERGY PERFORMANCE CALCULATION, ALSO FOR NATURAL VENTILATION – IF YOU ARE VERY CLEVER

THE TOOL ALLOWS YOU TO INPUT VENTILATION RATE VALUE FOR VENTILATIVE COOLING SEPARATED IN DAY AND NIGHT VALUES

- but does not assist you in determining the value
- Simple to use for mechanical systems, but difficult for natural ventilation.

THE TOOL DOES ESTIMATE THE COOLING NEED (AVERAGE FOR WHOLE BUILDING)

- It is possible to calculate the risk of overheating for a critical room
- It does not take into account effects of elevated air velocity

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## VENTILATIVE COOLING IN DANISH VENTILATION STANDARD – DS447

THE DANISH STANDARD DS 447 SPECIFIES REQUIREMENTS FOR MECHANICAL, NATURAL AND HYBRID VENTILATION SYSTEMS – AND ALSO INCLUDES VENTILATIVE COOLING EXPRESSED AS

- Free cooling,
- Night cooling,
- Passive cooling,
- Cooling by means of natural ventilation.
- Effects of elevated air velocities (informative annex)

HOWEVER NO GUIDELINES ARE GIVEN:

- for system design
- calculation of cooling performance
- or how elevated velocities can be achieved and documented



## STATUS OF VENTILATIVE COOLING IN DANISH REGULATORY CONTEXT

BUILDING REGULATIONS AND STANDARDS SUPPORT THE USE OF VENTILATIVE COOLING, MAINLY IN WORDS BUT WITHOUT MUCH GUIDANCE

THE DANISH EPBD COMPLIANCE TOOL DOES NOT SUPPORT A FAIR EVALUATION OF VENTILATIVE COOLING AS PART OF THE CALCULATION PROCEDURE.

**STATUS**

(NATURAL) VENTILATIVE COOLING IS CONSIDERED SOMEWHAT DIFFICULT TO WORK WITH AS DESIGNER OR ENGINEER - TOO LITTLE GUIDANCE AND TOO LARGE RESPONSIBILITY.

THEREFORE (NATURAL) VENTILATIVE COOLING IS NOT WIDELY INCLUDED BY BUILDING DESIGNERS.

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# FUTURE OF VENTILATIVE COOLING IN DANISH REGULATORY CONTEXT

LOOKS PROMISING

- Increased legislative focus on summer comfort

FUTURE NEEDS

- Simplified methods for calculating air change rates during nighttime and daytime in buildings with increased ventilation rates (with the purpose of cooling the building).
- Simplified methods for determining the cooling effect of increased ventilation rates.
- Control strategies for ventilative cooling based on relevant thermal comfort criteria.

# VENTILATIVE COOLING
# IN THE AUSTRIAN REGULATORY CONTEXT

**Dipl.-Ing. Dr. Peter Holzer**
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& Innovation

## a. Preventing from Summerly Overheating
## b. Limiting Technical Cooling Demand

a. Preventing from summerly overheating
WITHOUT TECHNICAL COOLING, mandatory
for all new and significantly renovated residential buildings
requirements according to OIB RL 6 (2015)
calculation procedure according to ÖNORM B 8110-3 (2012)

b. Limiting the technical cooling demand, mandatory
for all new and significantly renov. non residential buildings
requirements according to OIB RL 6 (2015)
calculation procedure according to ÖNORM B 8110-6 (2012)
together with ÖNORM H 5057 (2011)

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## Requirements according to OIB RL 6 (2015)

- Residential houses obligatorily have to offer summerly comfort without technical cooling, proven by simplified dynamic (hourly) energy balance against standardized climate and standardized usage patterns. Night Ventilation definitvely may be included.
- Non residential houses obligatorily have to keep within the limits of the net cooling demand, defined as the „outside induced cooling demand“, proven by monthly energy demand calculation. Night Ventilation may be included.

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## a. National Code B 8110-3 (2012)

Thermal protection in building construction
Part 3: Avoidance of summerly overheating

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## Background and Scope of Application

- Part of the OENORM B 8110 series „Thermal protection in building construction"
- Revised and relaunched in March 2012
- Valid for all types of rooms with constant human occupancy, without technical cooling



## Definition of „Summer Comfort"

- Max. 27°C operative Temperature in each room
- Max. 25°C operative Temperature in sleeping rooms at night

both on a statistically hot, mid-July, clear summer's day, occuring in infinite periodic repetition

## Calculation Procedure:
## Dynamic Heat Balance acc. to EN ISO 13791

**Input parameters**

- Climate
- Geometry
- Thermal Properties
- Solar properties, including shading
- Internal load profiles
- Ventilation

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## Calculation Procedure

**Input parameters**

- **Climate**
- Geometry
- Thermal Properties
- Solar properties, including shading
- Internal load profiles
- Ventilation

Site sensitive, hourly climate data, defined as a constantly repeated, mid summer's design day (obligatory)

to be taken from OENORM B 8110-5, defined by the mean day temp of 15. July plus an hourly defined day/night swing of ±7K

further referring to
EN 13791 (sky temp.)
EN ISO 13370 (ground temp.)

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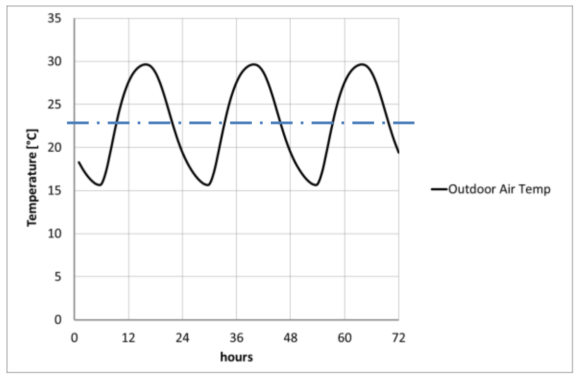
## Calculation Procedure

### Input parameters

- **Climate**

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## Calculation Procedure

### Input parameters

- Climate
- **Geometry**
- Thermal Properties
- Solar Properties, including Shading
- Internal Load Profiles
- Ventilation

Orientation sensitive input of the building's / room's envelope and volume

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## Calculation Procedure

**Input parameters**

- Climate
- Geometry
- **Thermal Properties**
- Solar Properties, including Shading
- Internal Load Profiles
- Ventilation

U-Values of both opaque and transparent building elements

including U-values, density, specific heat, conductivity

usable termal mass calculated according to simplified method of EN 13786

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## Calculation Procedure

**Input parameters**

- Climate
- Geometry
- Thermal Properties
- **Solar Properties, including Shading**
- Internal Load Profiles
- Ventilation

g-values (SHGC) of transparent layers according to manufacturers‘ information

Fc values (shading coefficients) of blinds according to EN 13363

additionally referring to

- EN 13561 and EN 13659 and EN 13791 (wind resistance)
- EN 13791 (fixed obstacles)

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## Calculation Procedure

**Input parameters**

- Climate
- Geometry
- Thermal Properties
- Solar Properties, including Shading
- **Internal Load Profiles**
- Ventilation

Mandatory lists of hourly internal load profiles and hygienic ventilation rates

for residential buildings, office buildings, schools and hospitals,

given in [W/m²], [W/workplace], [m³/h,pers]

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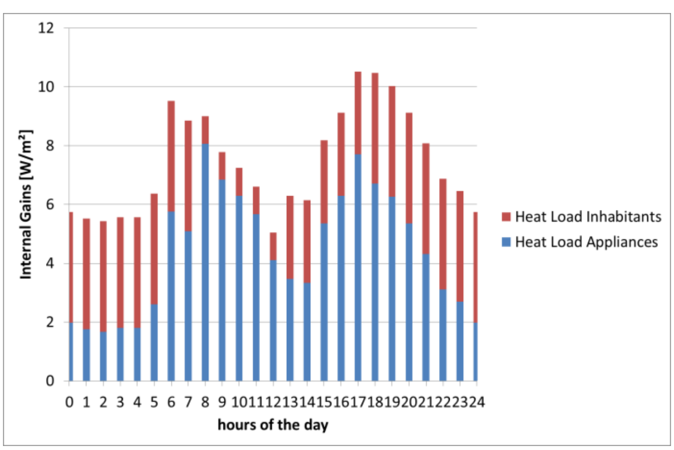
## Calculation Procedure

- **Internal Load Profile, exemplary for residential use**

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## Calculation Procedure

**Input parameters**

- Climate
- Geometry
- Thermal Properties
- Solar Properties, including Shading
- Internal Load Profiles
- **Ventilation**

- Window ventilation by formula, $V\ [m^3/h] = f(A_w, H_w, \Delta T)$
- Mechnical ventilation up to 1,5 ACH in occupied rooms and up to 2,5 ACH in unoccupied rooms, taking into account the thermal load from vents

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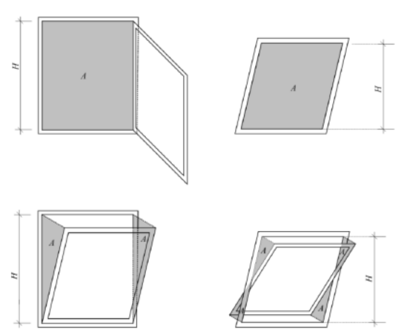
## Ventilative Cooling by Window Opening

$$\dot{V} = 0{,}7 \cdot C_{ref} \cdot A \cdot \sqrt{H} \cdot \sqrt{\Delta T}$$

with
$C_{ref}$ ... Discharge Coefficient
$C_{ref} = 100\ m^{0,5}/(h.K^{0,5})$



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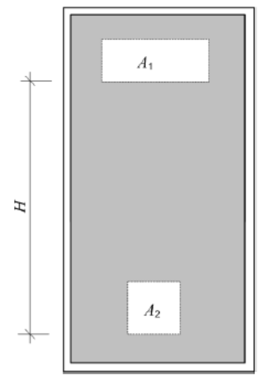
## Ventilative Cooling by Window Opening

$$\dot{V} = 0{,}7 \cdot C_{ref} \cdot A \cdot \sqrt{H} \cdot \sqrt{\Delta T}$$

with $C_{ref} = 300\ m^{0,5}/(hK^{0,5})$

with $A_{eff} = \sqrt{\dfrac{1}{\dfrac{1}{A^2{}_{oben}} + \dfrac{1}{A^2{}_{unten}}}}$

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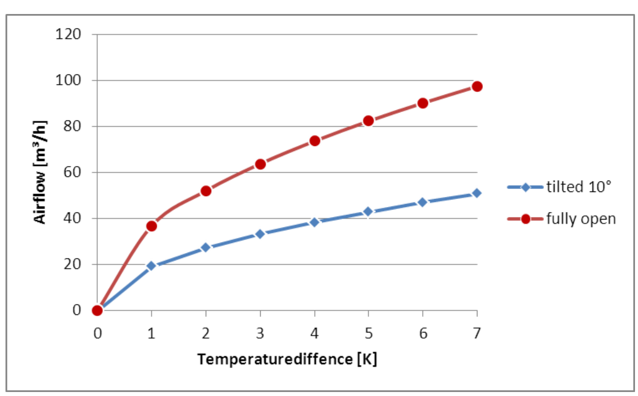
## Ventilative Cooling by Window Opening

$$\dot{V} = 0{,}7 \cdot C_{ref} \cdot A \cdot \sqrt{H} \cdot \sqrt{\Delta T}$$

W = 40 cm

H = 120 cm

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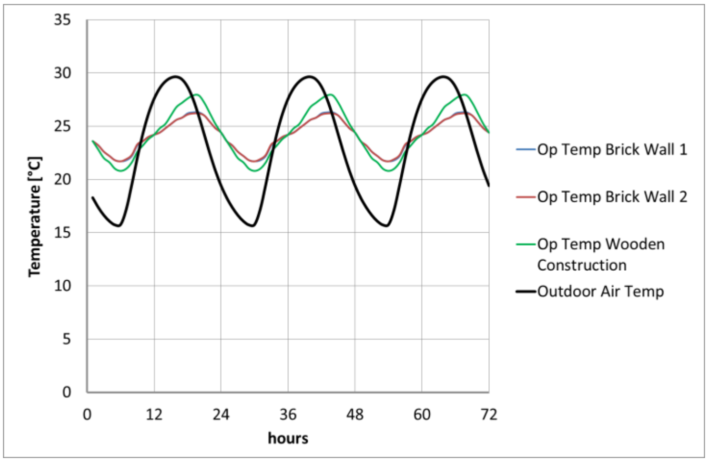
## Exemplary Outputs

taken from a specific residential room, comparing the effects of three different wall types, Holzer 2013

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## Learnings

- ✓ ÖNORM B 8110-3:2012 offers a well applicable method of evaluating the risk of summerly overheating, for rooms without mechanical cooling.
- ✓ Effects of Ventilative Cooling can be taken into account both for mechanical and for window-based solutions.
- ✓ The physical principle of a periodically repeated dynamic heat balance leads to robust and highly comparable outputs, given in a daily run of the room’s operative temperature.

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## Learnings

- Commercial simulation software products usually aren't prepared to calculate the air flow through windows exactly according to formula (1).
- The calculation model isn't well prepared for stack effect ventilation.
- The method of periodically repeated dynamic heat balance isn't sensitive to transient effects of heat storage during heat waves of limited duration.



## Learnings

- As regards the scope of the code, it's still is a point of discussion, how to define the summer performance of buildings with thermal mass activation but without Air-Conditioning:
  - By definition they are mechanically cooled.
  - By perception they are very much anticipated as free running mode buildings.

## b.

## National Code B 8110-6 (2014)

## Thermal protection in building construction

Part 6: Principles and verification methods
Heating demand and cooling demand

National application, national specifications and national supplements to ÖNORM EN ISO 13790

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## Background and Scope of Application

- Valid for all types of buildings with constant human occupancy, **WITH** technical cooling
- Limiting the outside induced net cooling demand
  KB* ≤ 1 kWh/m³a (newly built)
  KB* ≤ 2 kWh/m³a (major renovation)

  calculated by monthly energy balance against monthly mean outside temperature and mandatory 26°C inside temperature

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# Calculation Procedure

$$KB_V = \frac{Q_{c,a}}{V}$$

$$Q_{c,j} = f_{corr} \cdot (1 - \eta_{c,j}) \cdot Q_{g,j,c}\Big|_{Q \ldots -> Q \ldots}$$

$$\eta_c = \frac{1 - \gamma_c^{\,a}}{1 - \gamma_c^{\,a+1}} \text{ wenn } \gamma \neq 1$$

$$\gamma_c = \frac{Q_{g,c}}{Q_\ell} \qquad a = a_0 + \frac{\tau}{\tau_0}$$

$$Q_\ell = Q_T + Q_V$$

$$Q_V = \frac{1}{1000} \cdot L_V \cdot (\theta_i - \theta_e) \cdot t$$

$$L_{Vc,FL} = c_{p,L} \cdot \rho_L \cdot V_V \cdot n_{L,m,c}$$

$$n_{L,m,c} = \frac{n_{L,FL} \cdot t_{Nutz,d} \cdot d_{Nutz} + n_{L,NL} \cdot t_{NL,d} \cdot d_{Nutz}}{t}$$



# Calculation Procedure

$$KB_V = \frac{Q_{c,a}}{V}$$

$$Q_{c,j} = f_{corr} \cdot (1 - \eta_{c,j}) \cdot Q_{g,j,c}\Big|_{Q \ldots -> Q \ldots}$$

$$\eta_c = \frac{1 - \gamma_c^{\,a}}{1 - \gamma_c^{\,a+1}} \text{ wenn } \gamma \neq 1$$

$$\gamma_c = \frac{Q_{g,c}}{Q_\ell} \qquad a = a_0 + \frac{\tau}{\tau_0}$$

$$Q_\ell = Q_T + Q_V$$

$$Q_V = \frac{1}{1000} \cdot L_V \cdot (\theta_i - \theta_e) \cdot t$$

$$L_{Vc,FL} = c_{p,L} \cdot \rho_L \cdot V_V \cdot n_{L,m,c}$$

$$n_{L,m,c} = \frac{n_{L,FL} \cdot t_{Nutz,d} \cdot d_{Nutz} + n_{L,NL} \cdot t_{NL,d} \cdot d_{Nutz}}{t}$$

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## Calculation Procedure

$$KB_V = \frac{Q_{c,a}}{V}$$

-20%

$$Q_{c,j} = f_{corr} \cdot (1 - \eta_{c,j}) \cdot Q_{g,j,c}\Big|_{Q_{...}>Q_{...}}$$

+10%

$$\eta_c = \frac{1 - \gamma_c^{\,a}}{1 - \gamma_c^{\,a+1}} \quad \text{wenn } \gamma \neq 1$$

...

$$\gamma_c = \frac{Q_{g,c}}{Q_\ell} \qquad a = a_0 + \frac{\tau}{\tau_0}$$

+50%

$$Q_\ell = Q_T + Q_V$$

+100%

$$Q_V = \frac{1}{1000} \cdot L_V \cdot (\theta_i - \theta_e) \cdot t$$

+100%

$$L_{Vc,FL} = c_{p,L} \cdot \rho_L \cdot V_V \cdot n_{L,m,c}$$

+100%

$$n_{L,m,c} = \frac{n_{L,FL} \cdot t_{Nutz,d} \cdot d_{Nutz} + n_{L,NL} \cdot t_{NL,d} \cdot d_{Nutz}}{t}$$

1,5 ACH
8 h/d



## Conclusion

- ✓ ÖNORM B 8110-6: 2014 offers a simplified method of taking into account night ventilation / Ventilative Cooling
- ✓ both for mechanical and for window-based solutions.
- ✓ Resulting in a reduction of the outside induced cooling demand in the exemplary range of 20%, ofering an object to optimization.

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# Thank you !

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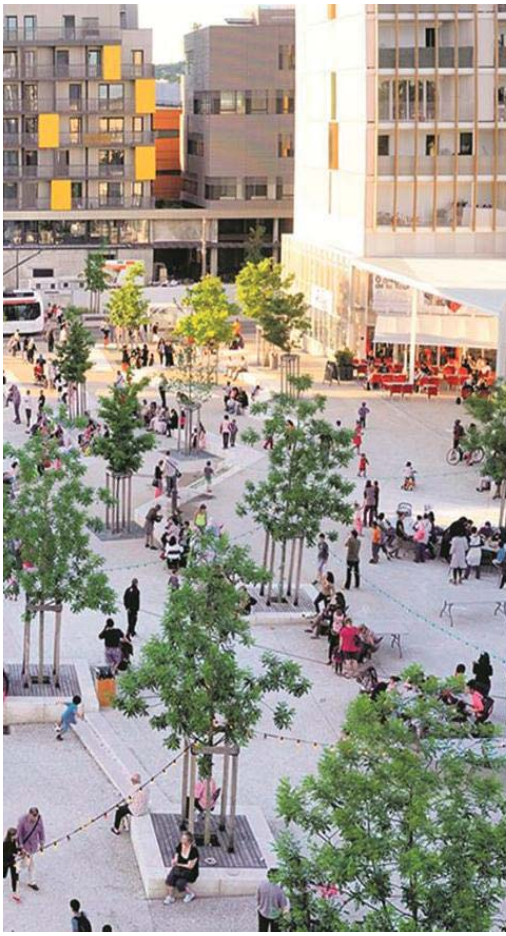

# Assessing ventilative cooling potential in Energy Performance regulations

Webinar 2015/12/08

CSTB
le futur en construction

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le futur en construction

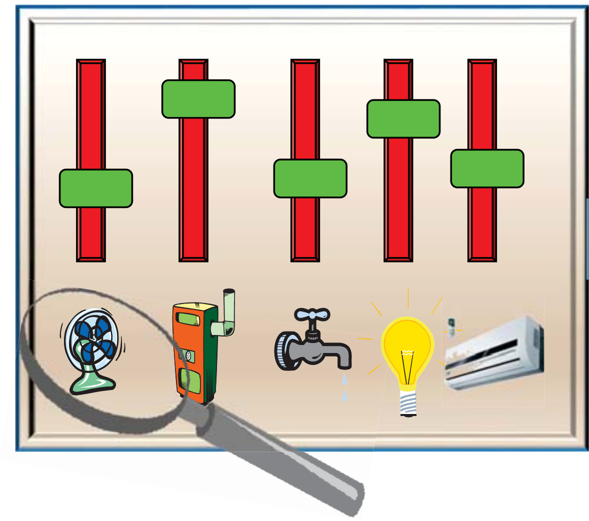
# Ventilative cooling in the French Regulation.


Charles PELE

charles.pele@cstb.fr

# French regulations

## RT2012 : French thermal regulation



**Energy needs**

Bbio < Bbio max

**Energy used**

On average, Cep < 50 kWh/m².year

**Summer comfort**

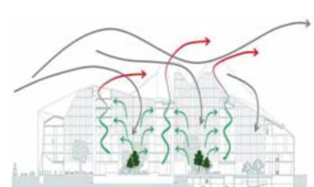
Tic < Tic Ref



# French regulations / ventilation

Residential building : Decree of March 1982 : ‘’ Aeration of the housing must be general and permanent at least during the period when the outside temperature requires to keep the windows closed.’’

Other buildings : minimum air flow rate depending on the type of buildings



RT 2012

## Natural ventilation strategy

1- Empirical model for monozone is usued at each time step (1 hour)

$$Q_v = \left(C_0 \times Aouv \times \sqrt{C_1 \times C_2 \times V^2 + C_3 \times h \times \Delta T}\right)$$

$C_0$ = 1800; $C_1$ = 0.001; $C_2 \geq 1$; $C_3$ = 0.0035; h: height of the opening ;

2 - Aouv: depending on the external temperature, the internal external temperature difference and the type of windows.

3 - COMETh : COre for Modeling Energy and THermal comfort

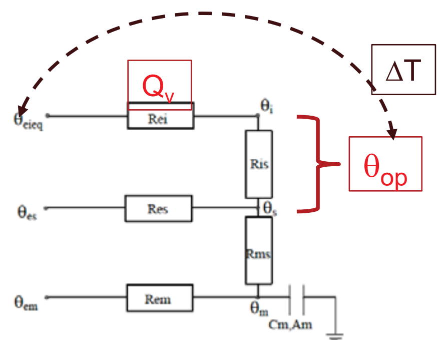
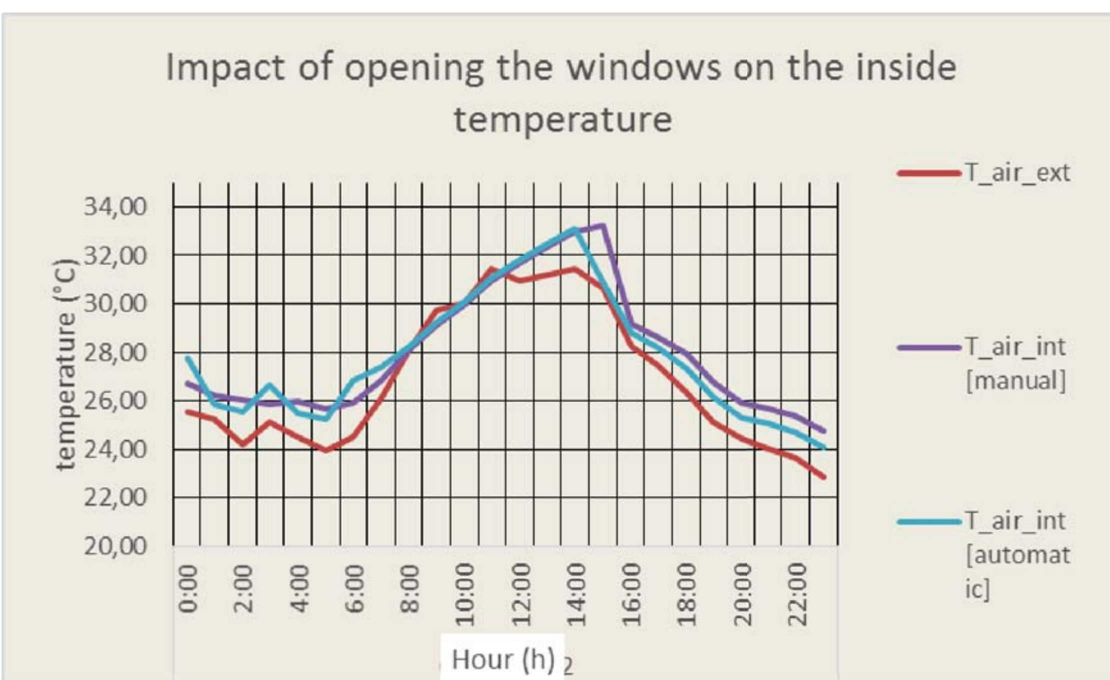



Figure 1 : 5RC network

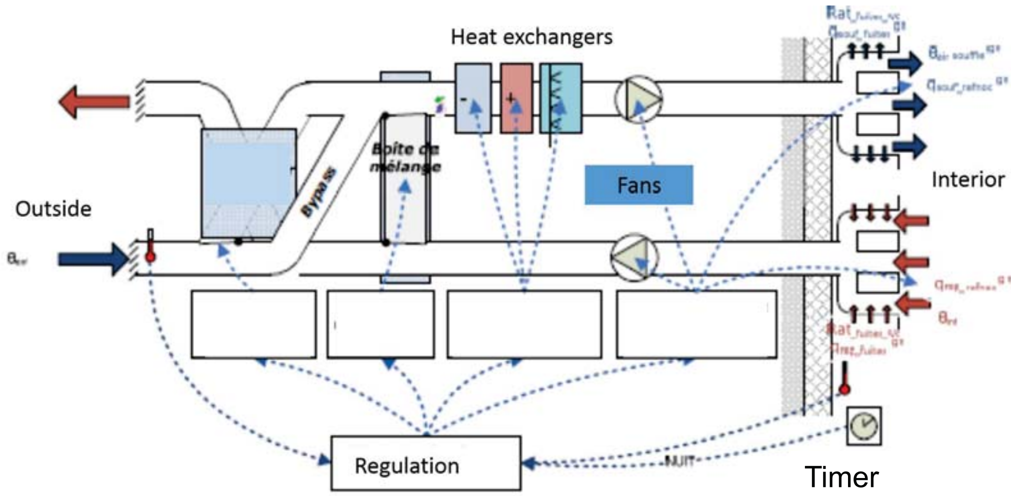


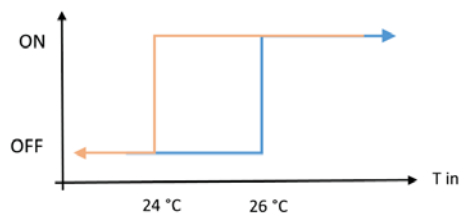
## Example

House in the south of France, ( 150m²; 1 level )



# Mechanical ventilation



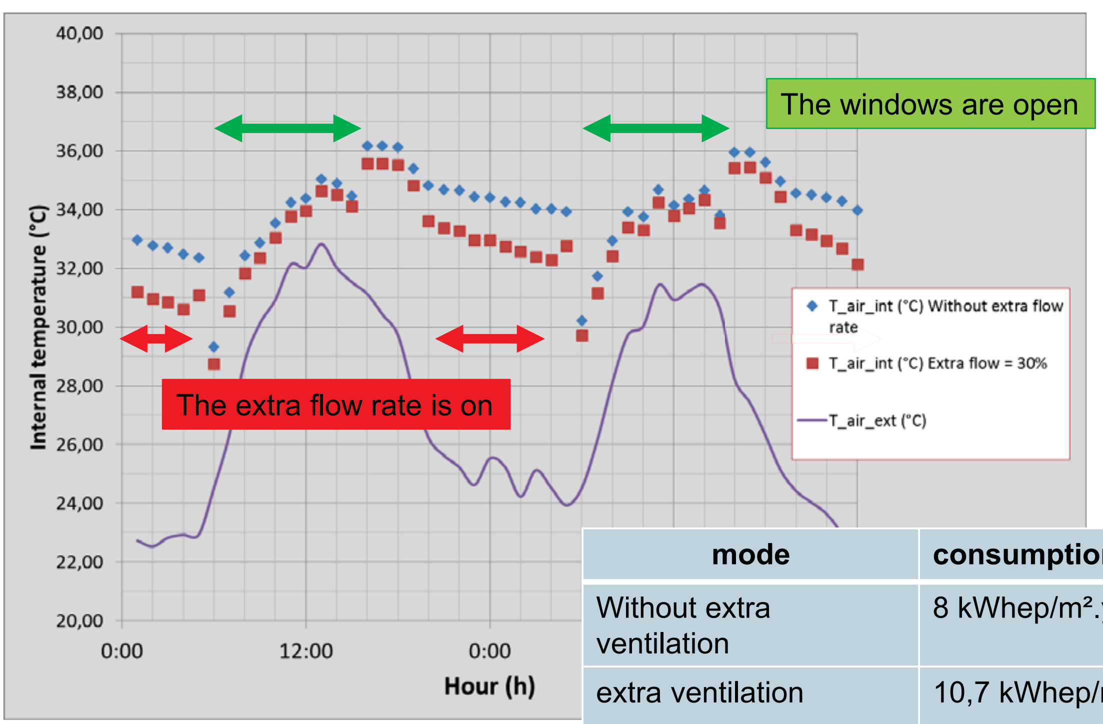




Night refresh





# Mechanical ventilation




| mode | consumption |
|---|---|
| Without extra ventilation | 8 kWhep/m².y |
| extra ventilation | 10,7 kWhep/m².y |

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# Conclusion

Ventilative cooling –i.e., the use of natural or mechanical ventilation strategies to cool indoor spaces– is already implemented in the French thermal regulation **RT 2012**, both for residential buildings and for commercial buildings.

Opening windows and night mechanical ventilation allow to reduce indoor temperatures and to maintain a comfortable thermal environment.

This allows to delay the startup of air-conditioning systems.

On cases presented and with our hypotheses, opening windows seems more effective and it does not consume energy.




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## RT 2012

http://www.rt-batiment.fr/batiments-neufs/reglementation-thermique-2012/textes-de-references.html

## Bibliography


- JB Videau and al; An Introduction to the Development of the French Energy Regulation Indicators and Their Calculation Methods ; Clima 2013
- B. Haas and al ; Etudes de sensibilité avec COMETH ; IBPSA 2013;
- MEEDDM, "Arrêté du 26 octobre 2010 relatif aux caractéristiques thermiques et aux exigences de performance énergétique des bâtiments nouveaux et des parties nouvelles de bâtiments." 2010.
- MEEDDM, Arrêté du 20 juillet 2011 portant approbation de la méthode de calcul Th-B-C-E, 2011.
- Ventilative Cooling State of the art, IEA – EBC Programme – Annex 62 Ventilative Cooling, Edited by

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