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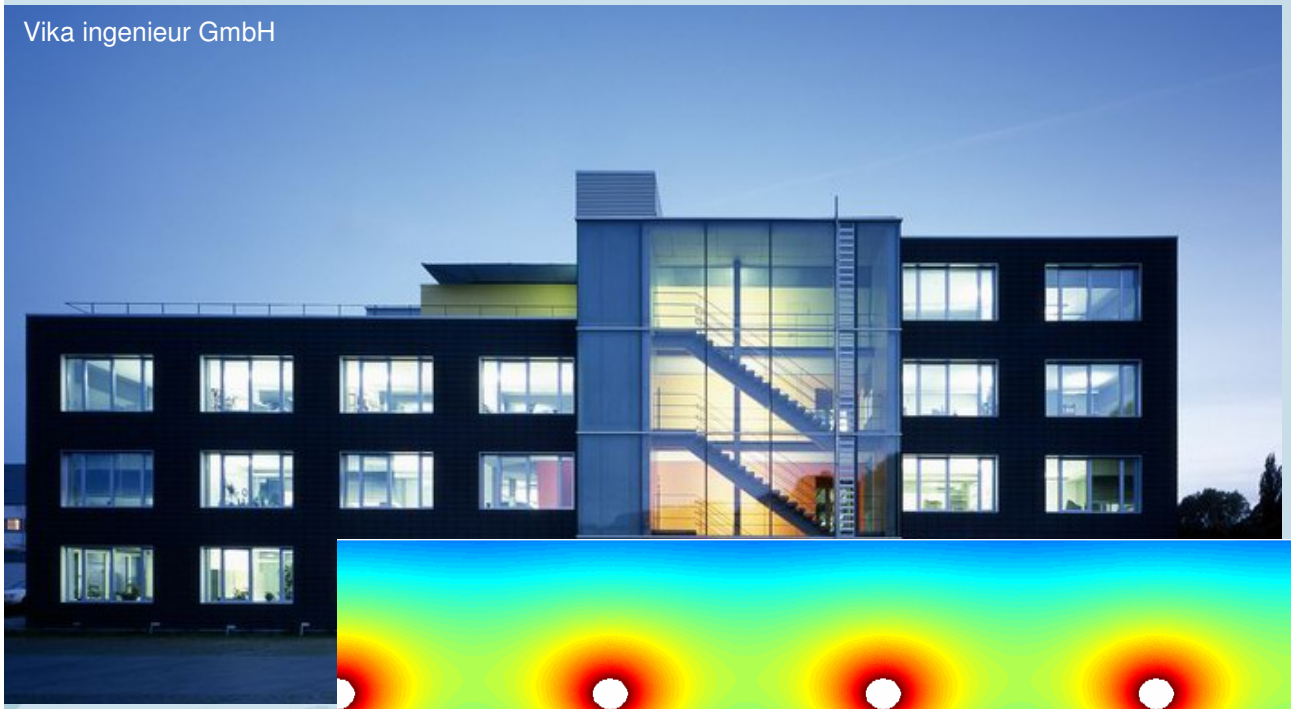
Thermally Activated Building Systems (TABS): Exploiting inertia

KIC Storage, November 23th 2011, Leuven

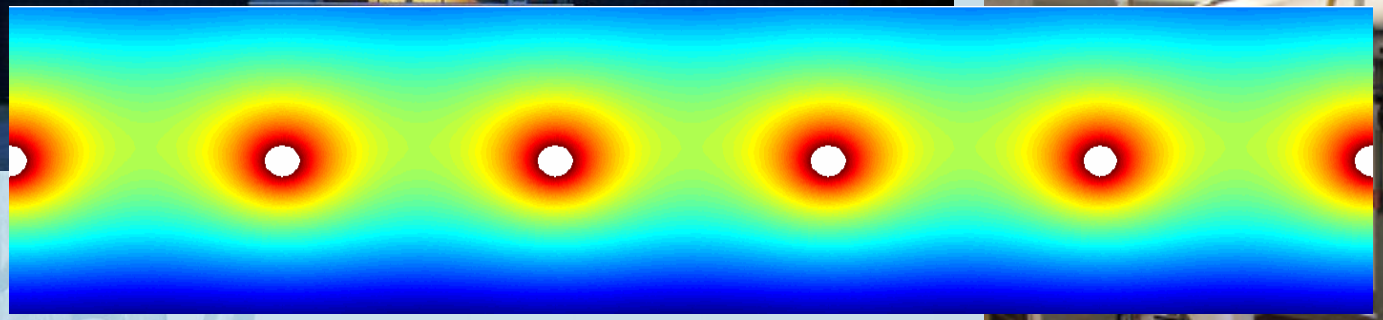
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http://www.mech.kuleuven.be/en/tme/research/thermal_systems/

TABS : part of a whole









TABS and heat/cold production



High T heating
Low T cooling



Backup

HeatPump



Low T heating
High T cooling

Content

- TABS operation
- Transient behaviour
- Control
- Case studies



Office building

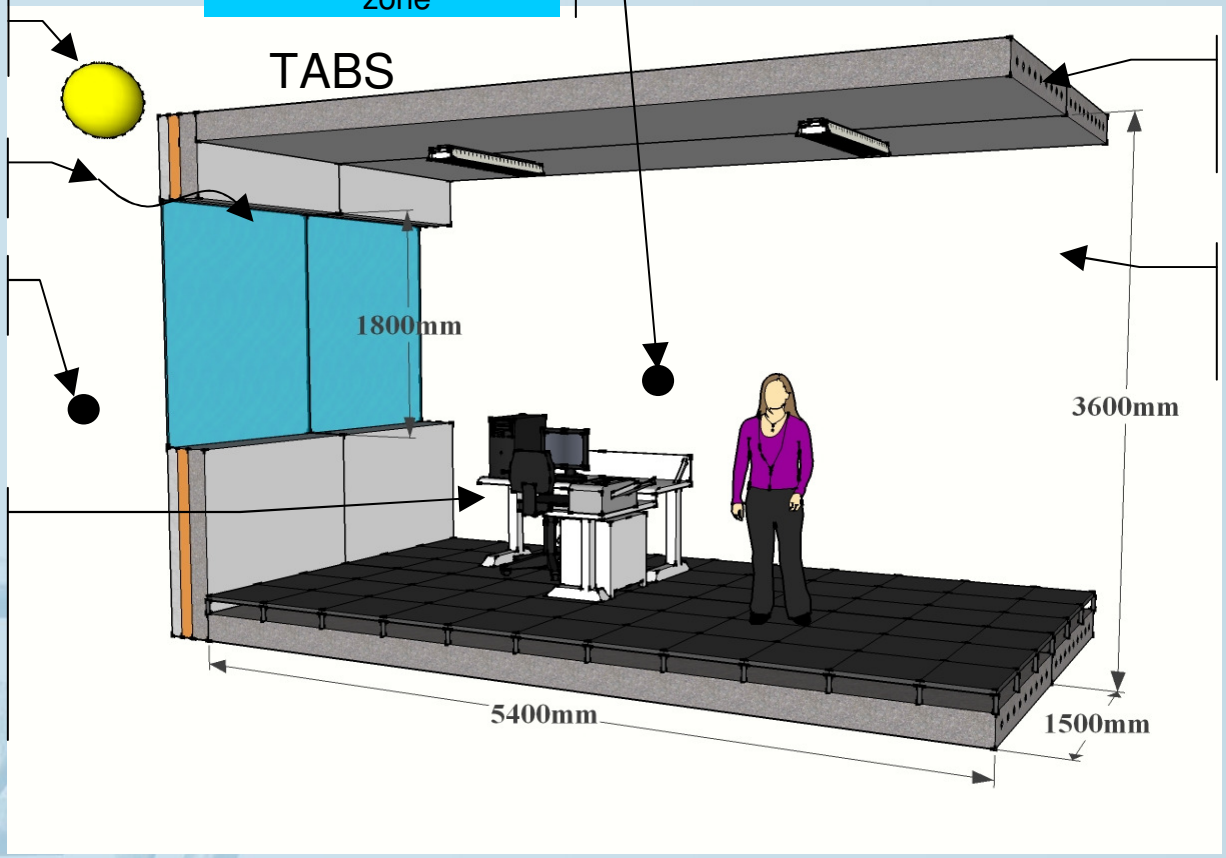
Required :
T_{zone}

Q_{solar}

Infiltration

$T_{outdoor}$

$Q_{internal}$ (people, appliances, lights)

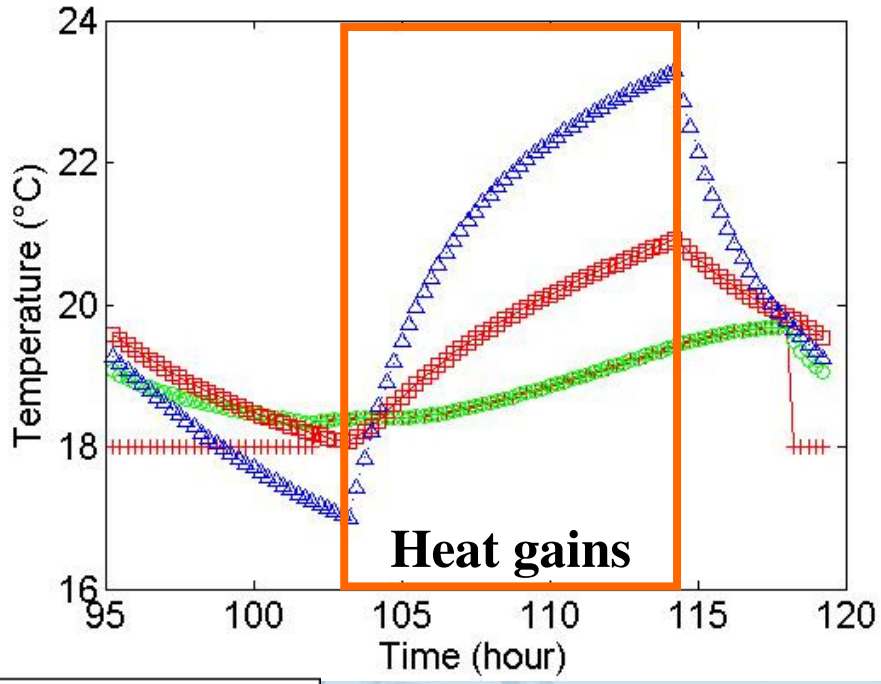


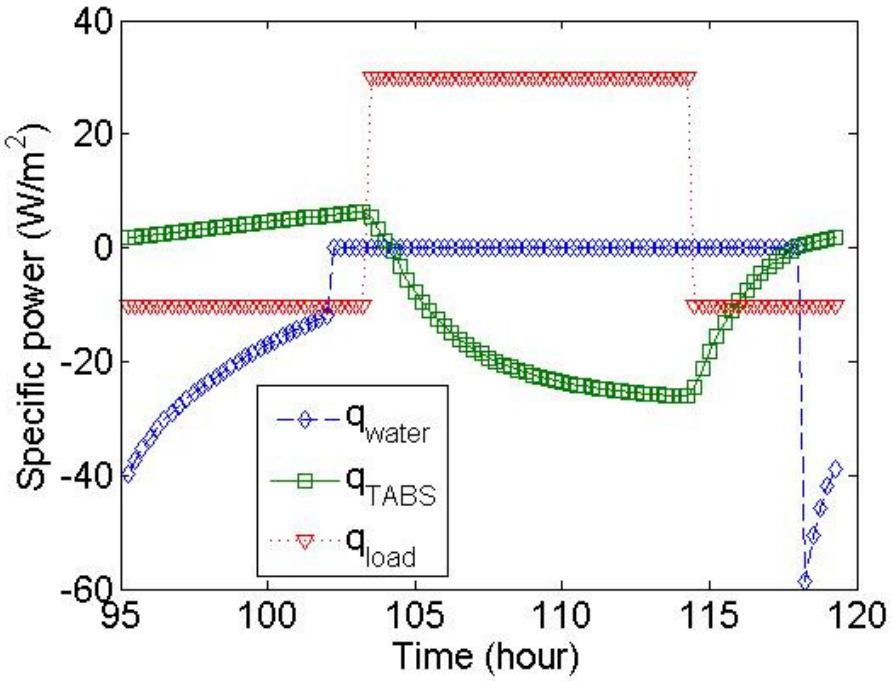
Control :
T_{water}, F_{water}

Control :
T_{vent}, F_{vent}

Typical TABS behaviour

- Night-time operation, $T_{water,supply}$ = 18 °C





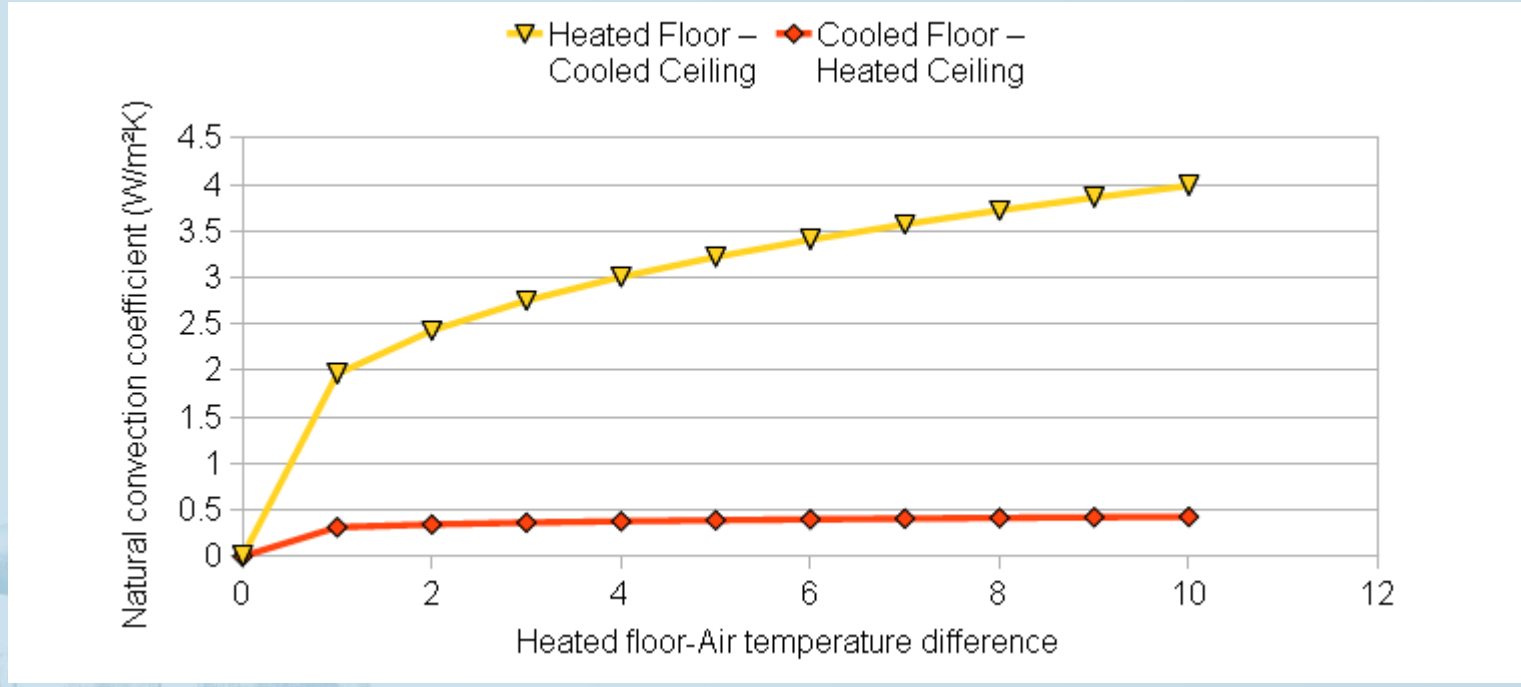
Office building

- Heat loss : 20 – 40 W/m²
- Heat gains : >100 W/m²
  - People : **7.5 W/m²** (40% convective – 60% radiative)
  - PC's, printers, … : **14 W/m²** (85% – 15%)
  - Lighting : **10 W/m²** (50% - 50%)
  - Solar radiation : **0 tot >100 W/m²**



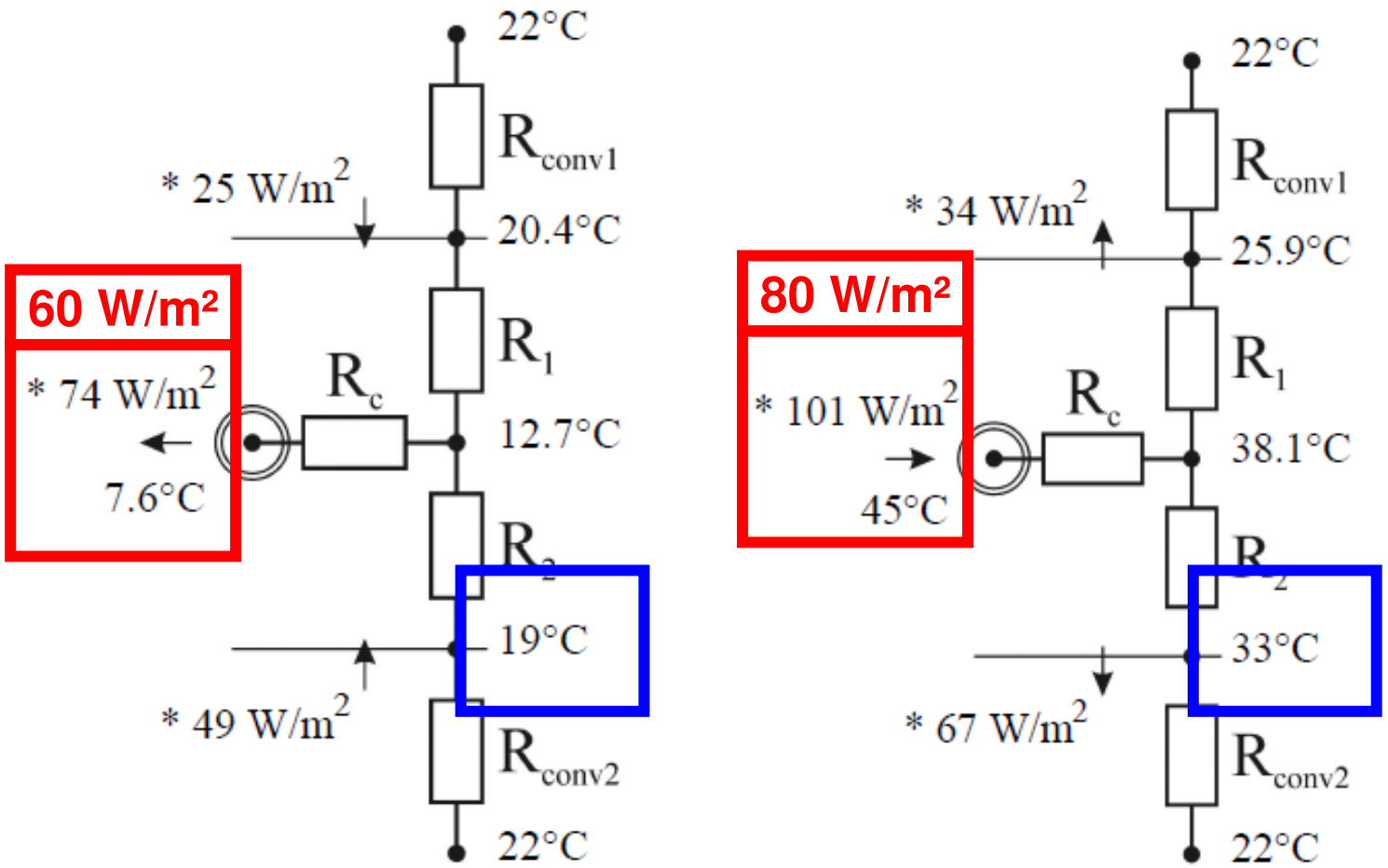
TABS heat exchange with room

- Radiative : 5.6 W/m²K, convective : f(ΔT)

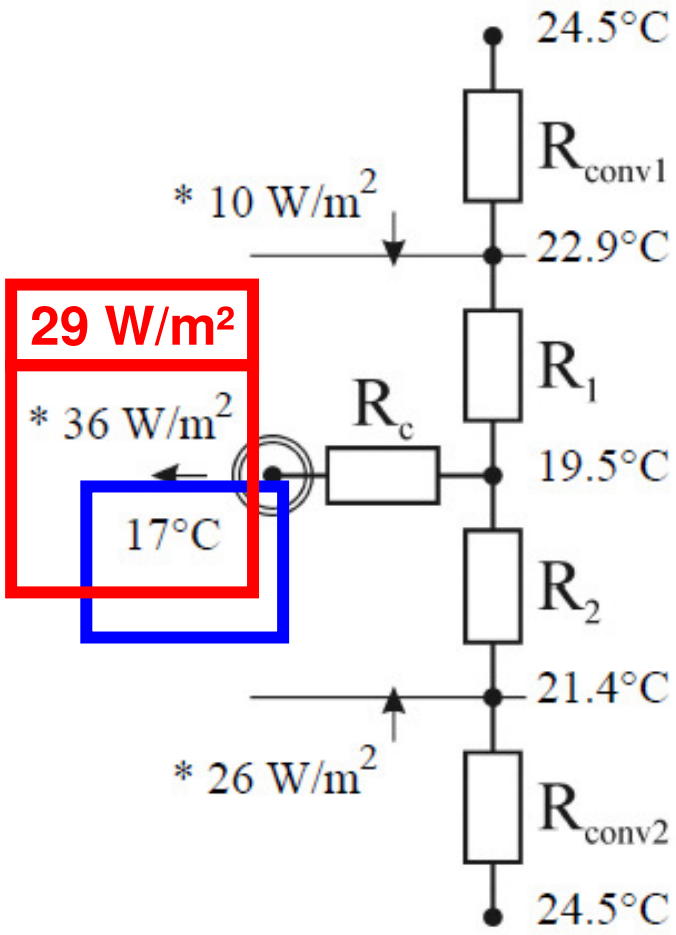


- Hot ceiling/cold floor : **6 W/m²K**
- Cold ceiling/hot floor: **7.5 – 9.5 W/m²K**

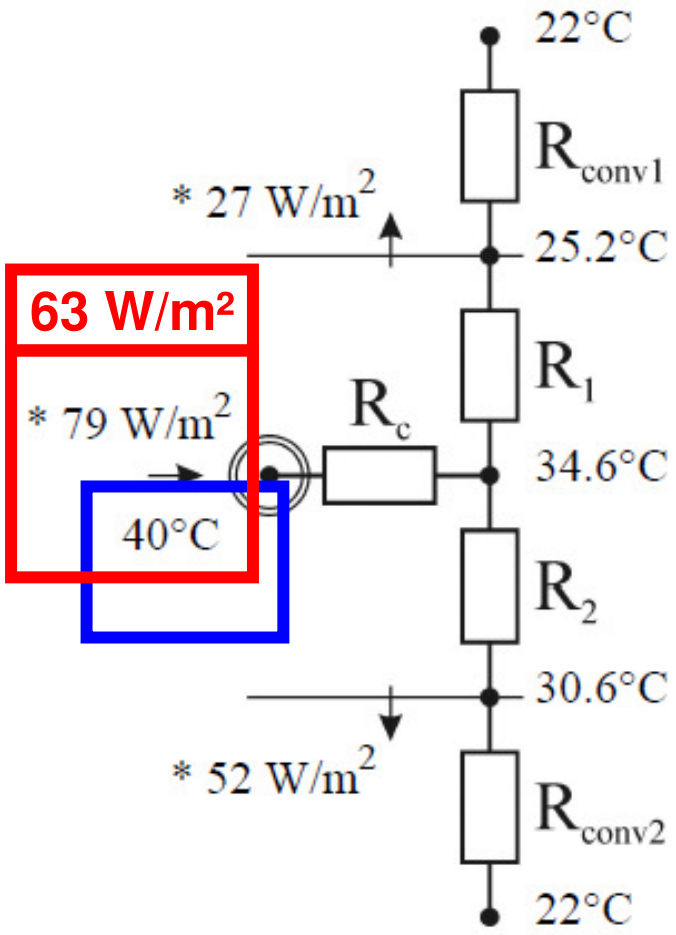
TABS steady state



TABS steady state with heat pump



(a) Cooling

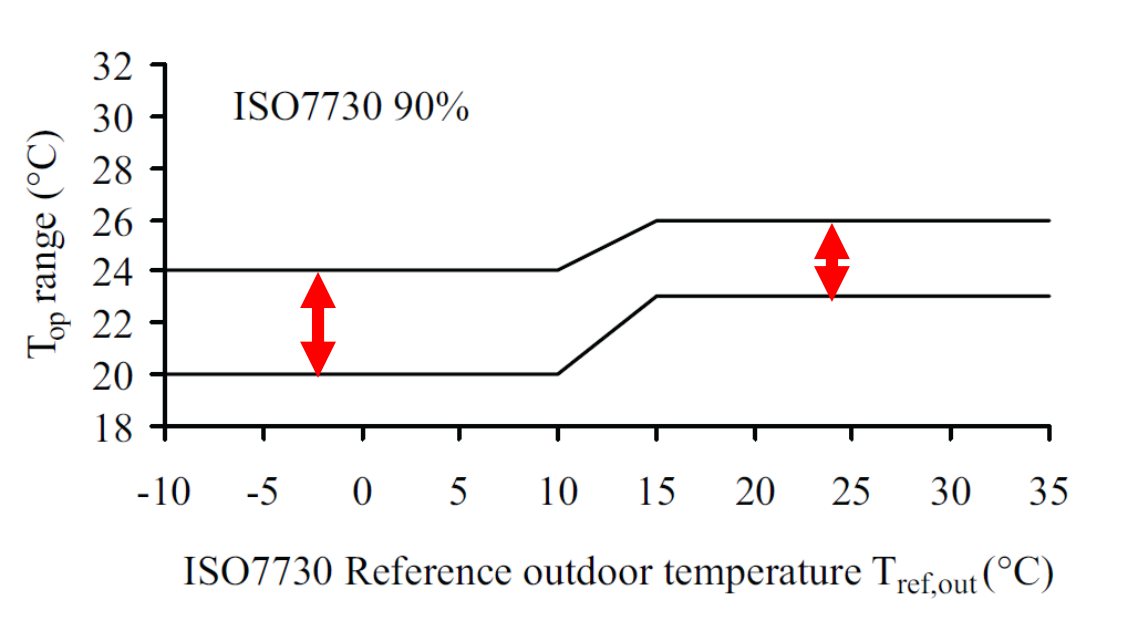


(b) Heating

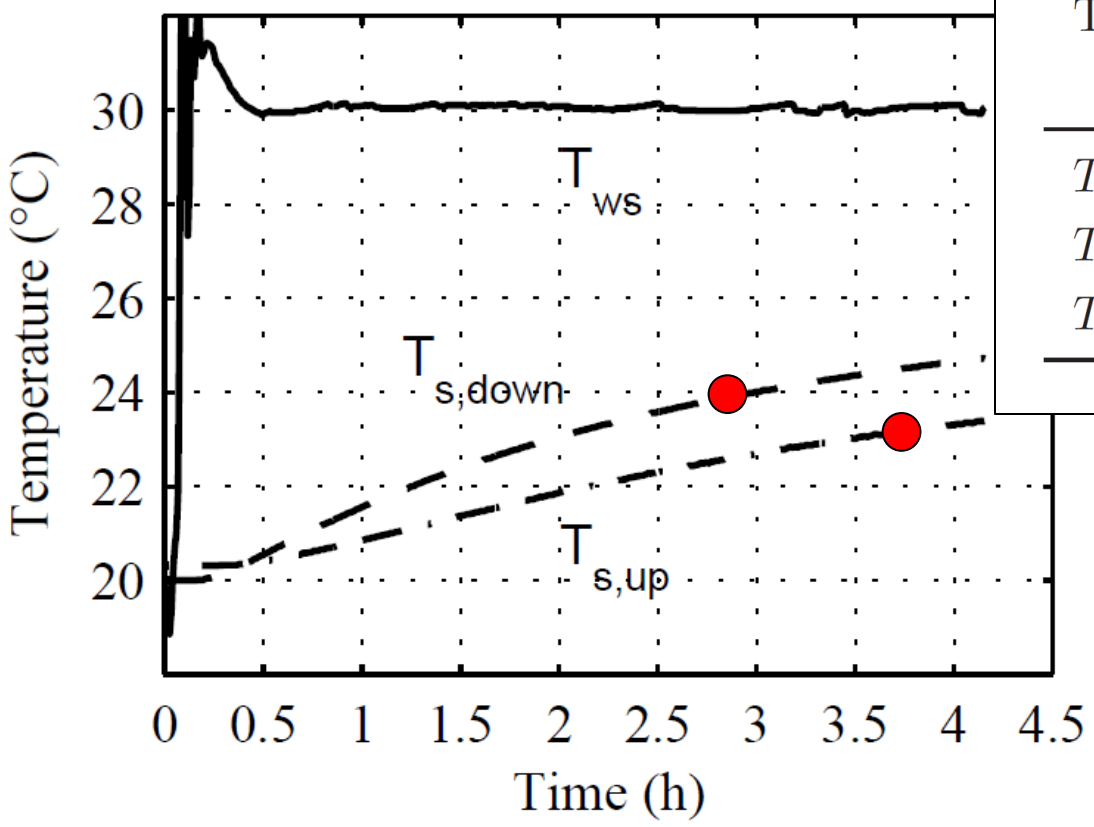
Office building vs. TABS

- Heat loss : **20 – 40 W/m²**
- Heat load : **> 100 W/m²**
- Thermal comfort band

- Heating : **63 W/m²**
- Cooling : **29 W/m²**



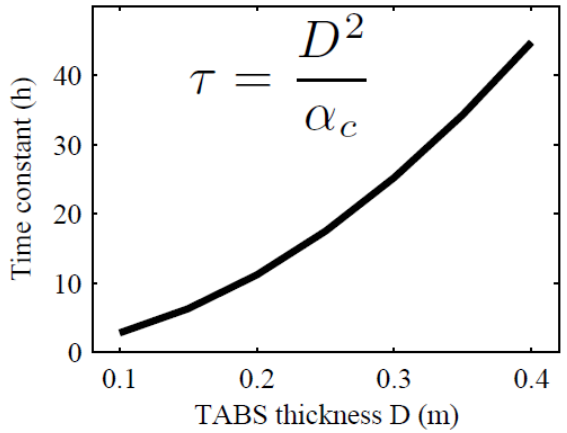
TABS transient behaviour



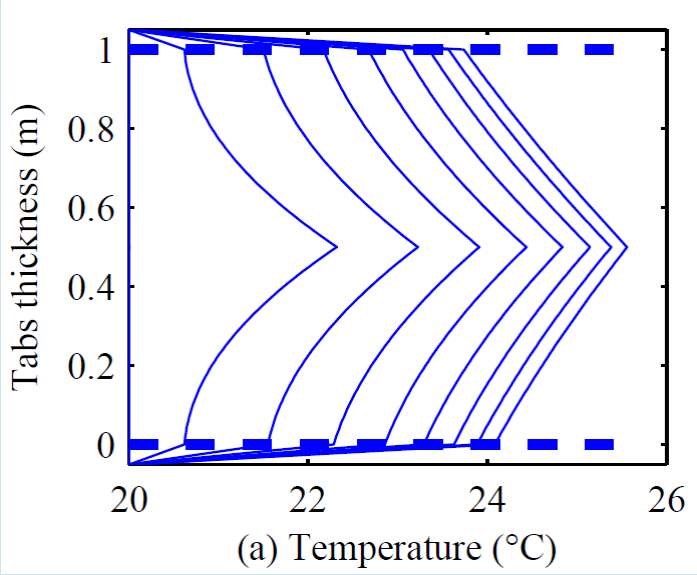
Measurements

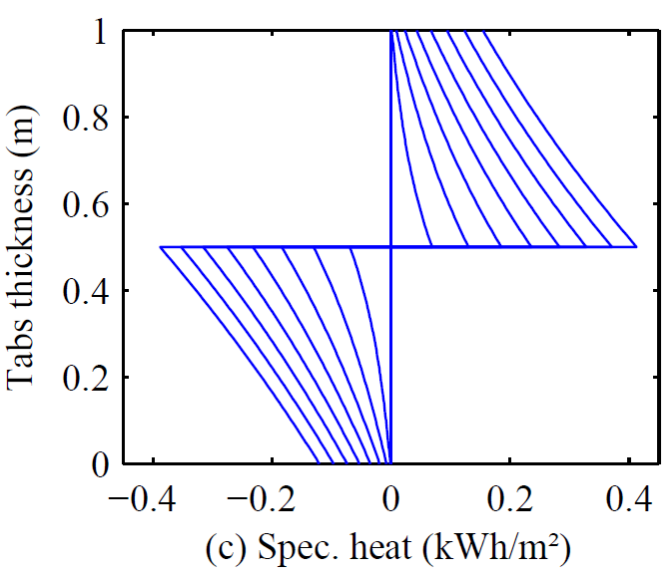
Temperature	τ (min)
T_c	139
$T_{s,up}$	220
$T_{s,down}$	166

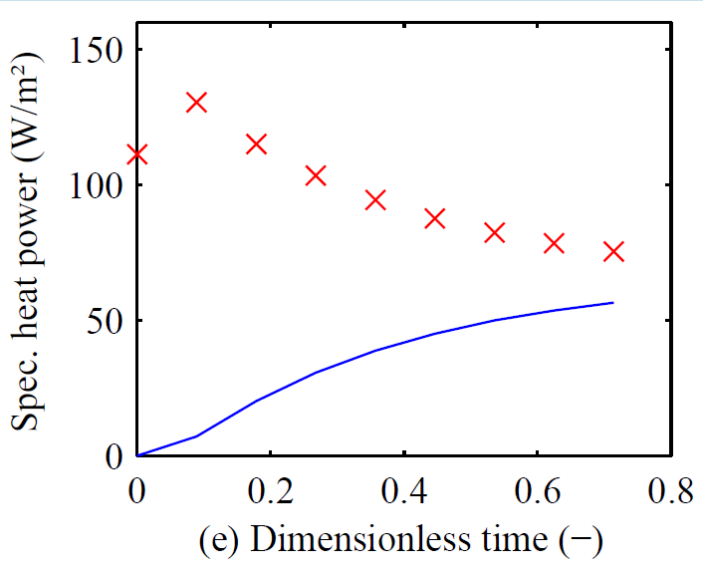
Uncovered slab

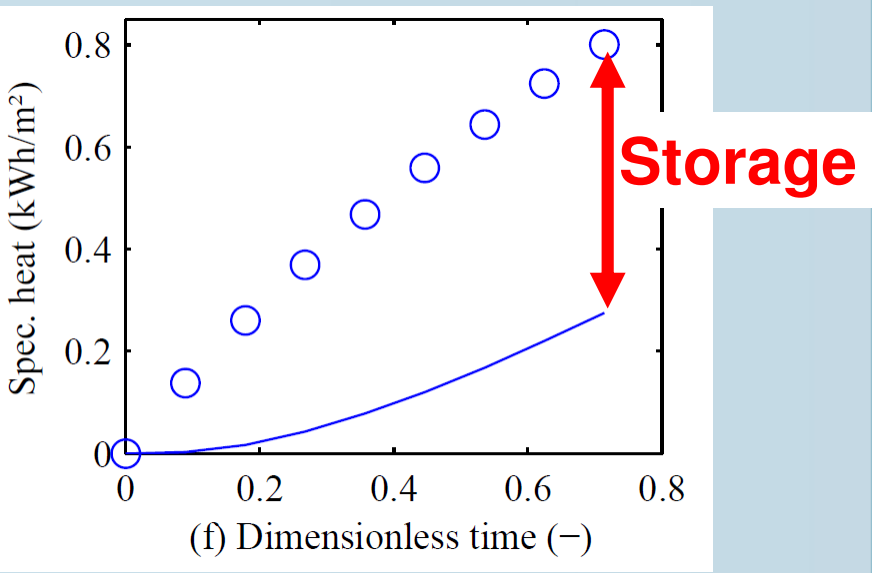


Heat storage – heat transfer



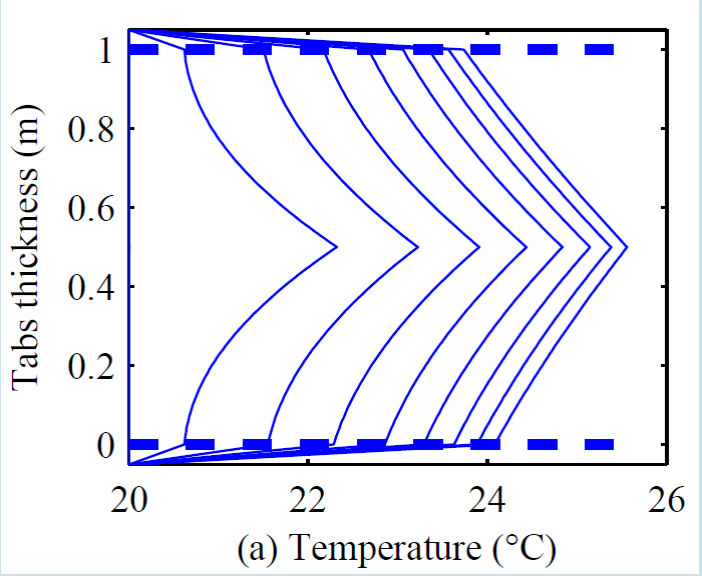


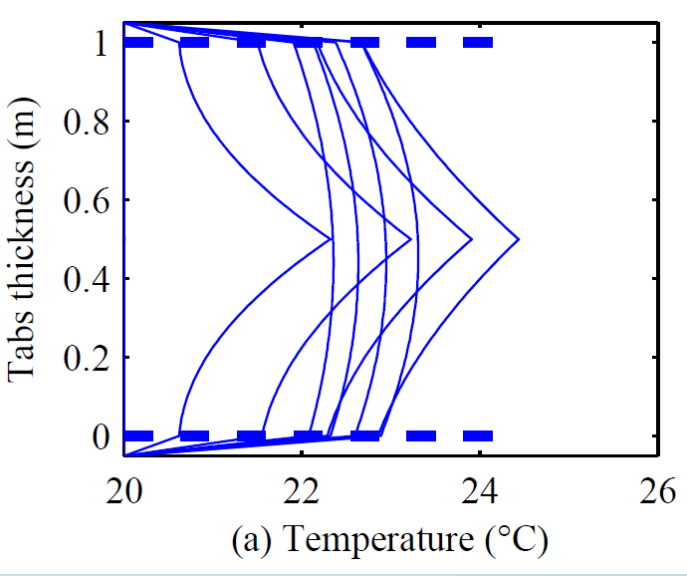


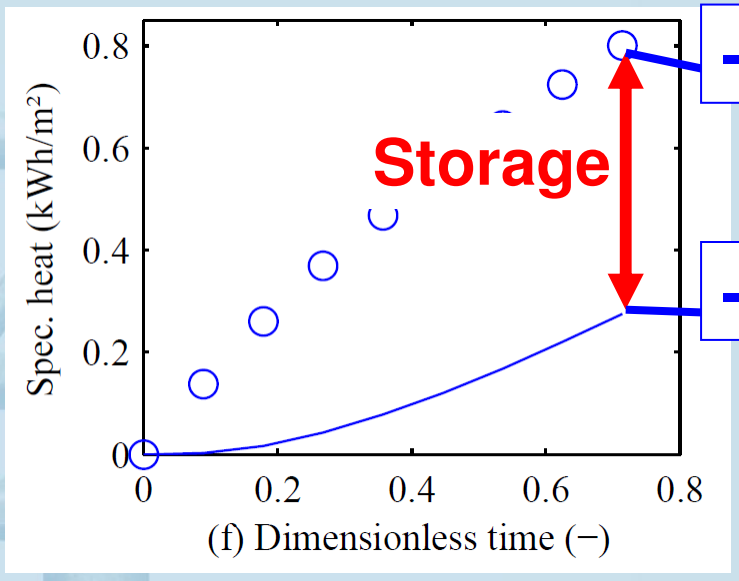


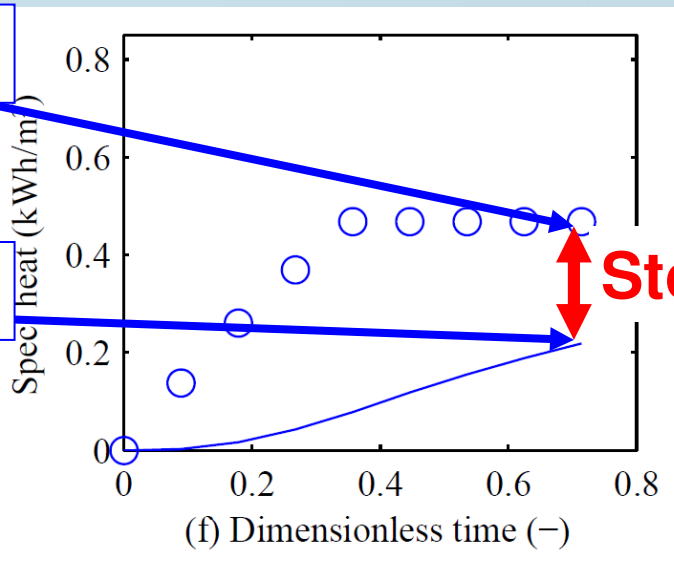
T_{ws}=30 °C, T_{room}=20 °C

Heat storage – heat transfer





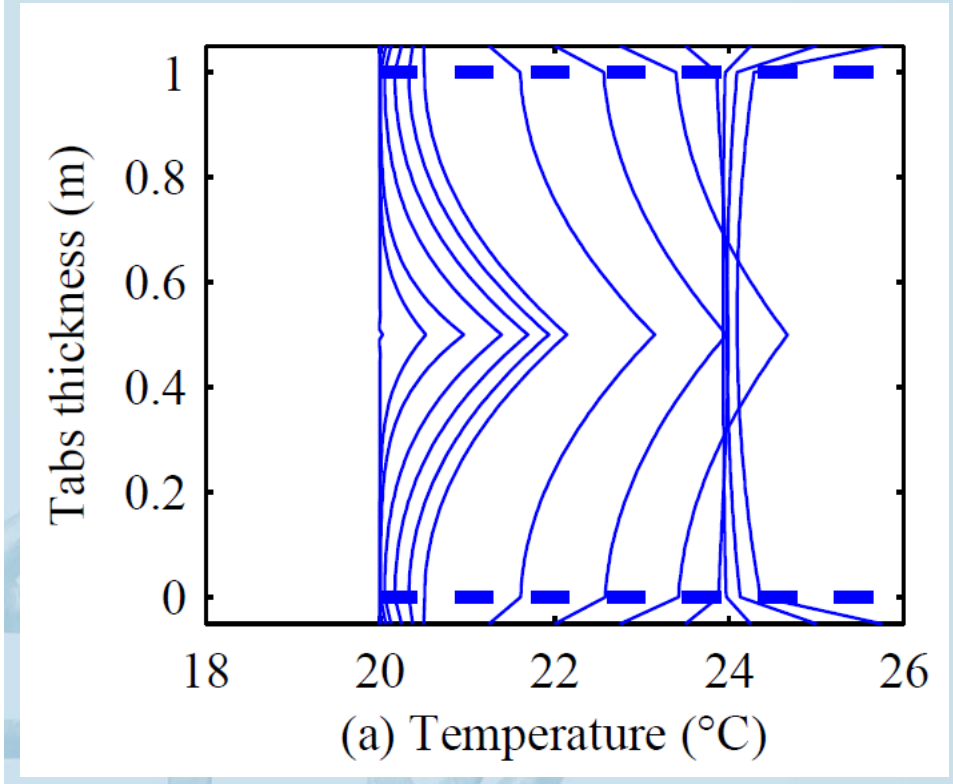


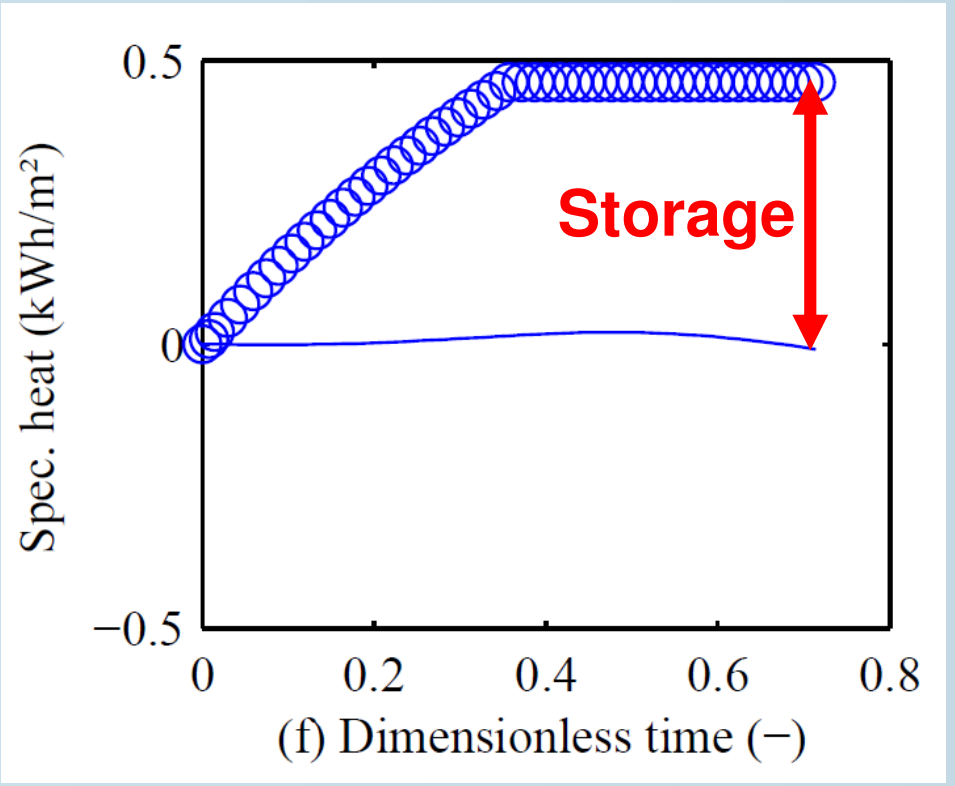


T_{ws}=30 ℃, T_{room}=20 ℃

Selfregulating effect

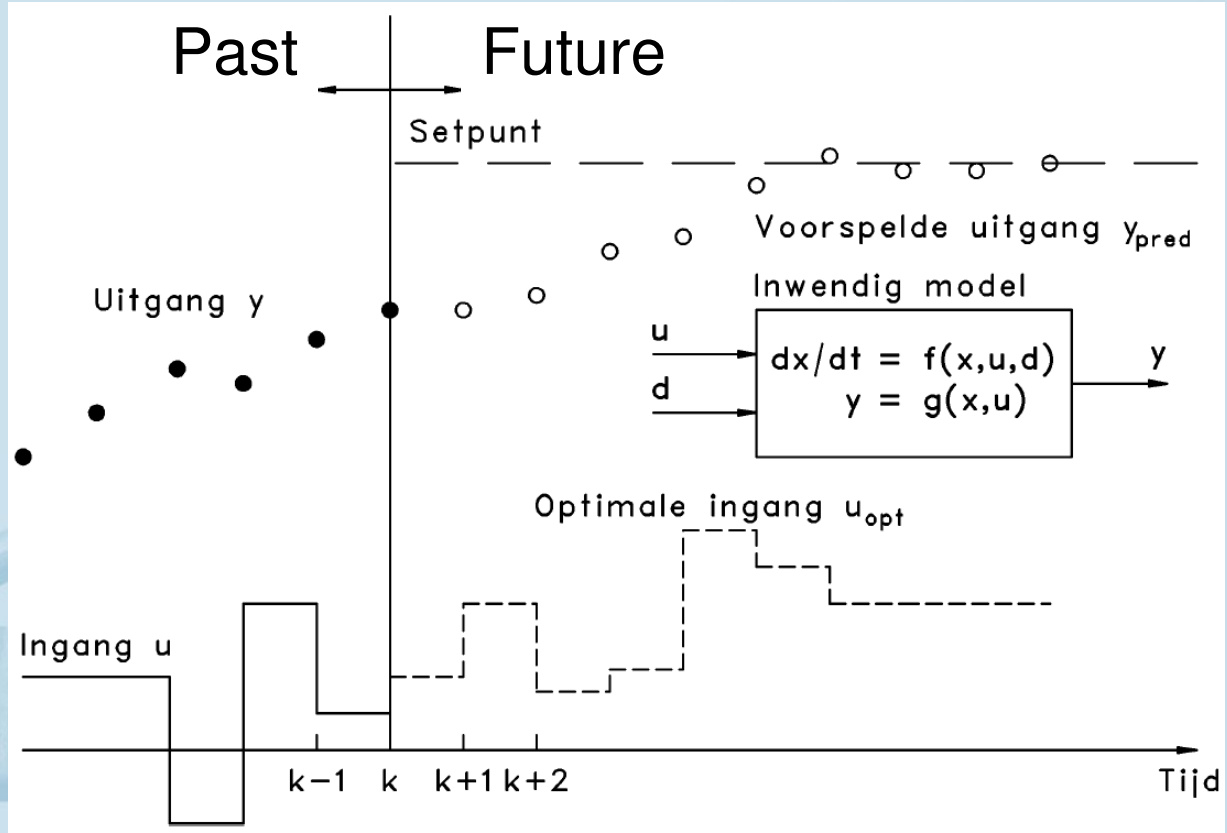
- TABS and floating room temperature





Optimal control

- MPC: Model based Predictive Control



Minimize
Cost function:

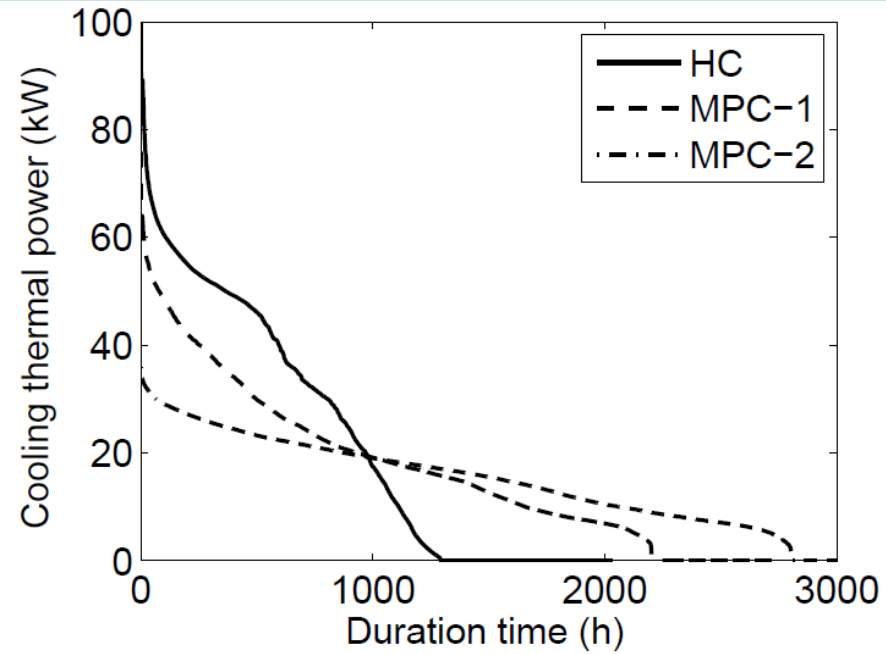
Thermal discomfort
$(T_{zone} - T_{opt})^2$

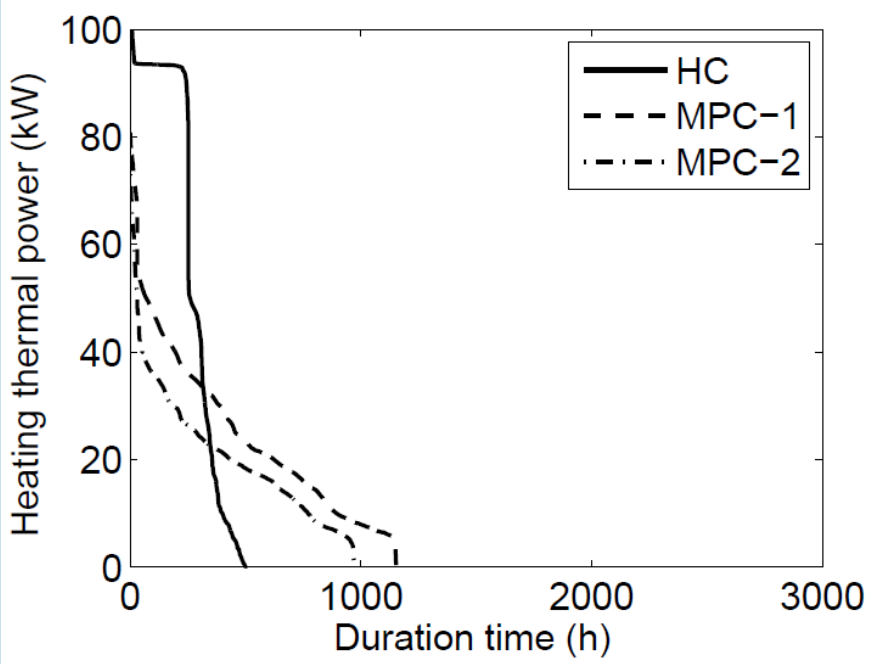
Energy use
$(Q_{production})^2$

Storage?

Optimal control

- MPC application : reduction of peak loads
  - HC : Conventional heating/cooling curve controller
  - MPC : Model based Predictive Controller

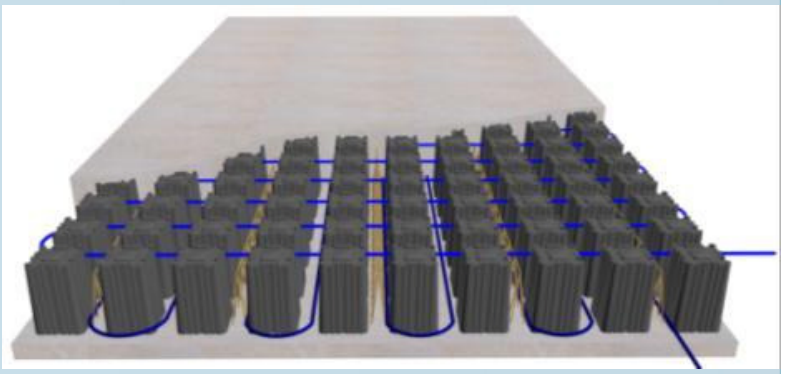


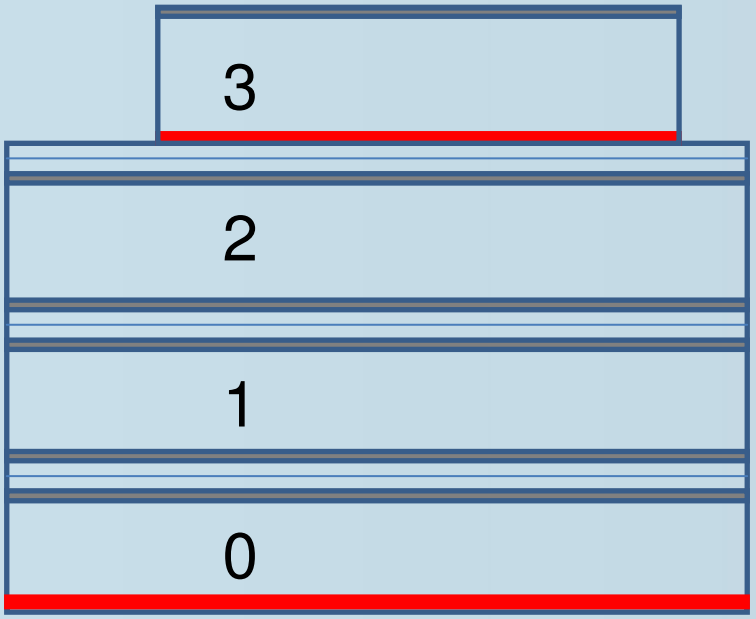


Case studies

- Hollandsch Huys (Hasselt, Belgium)



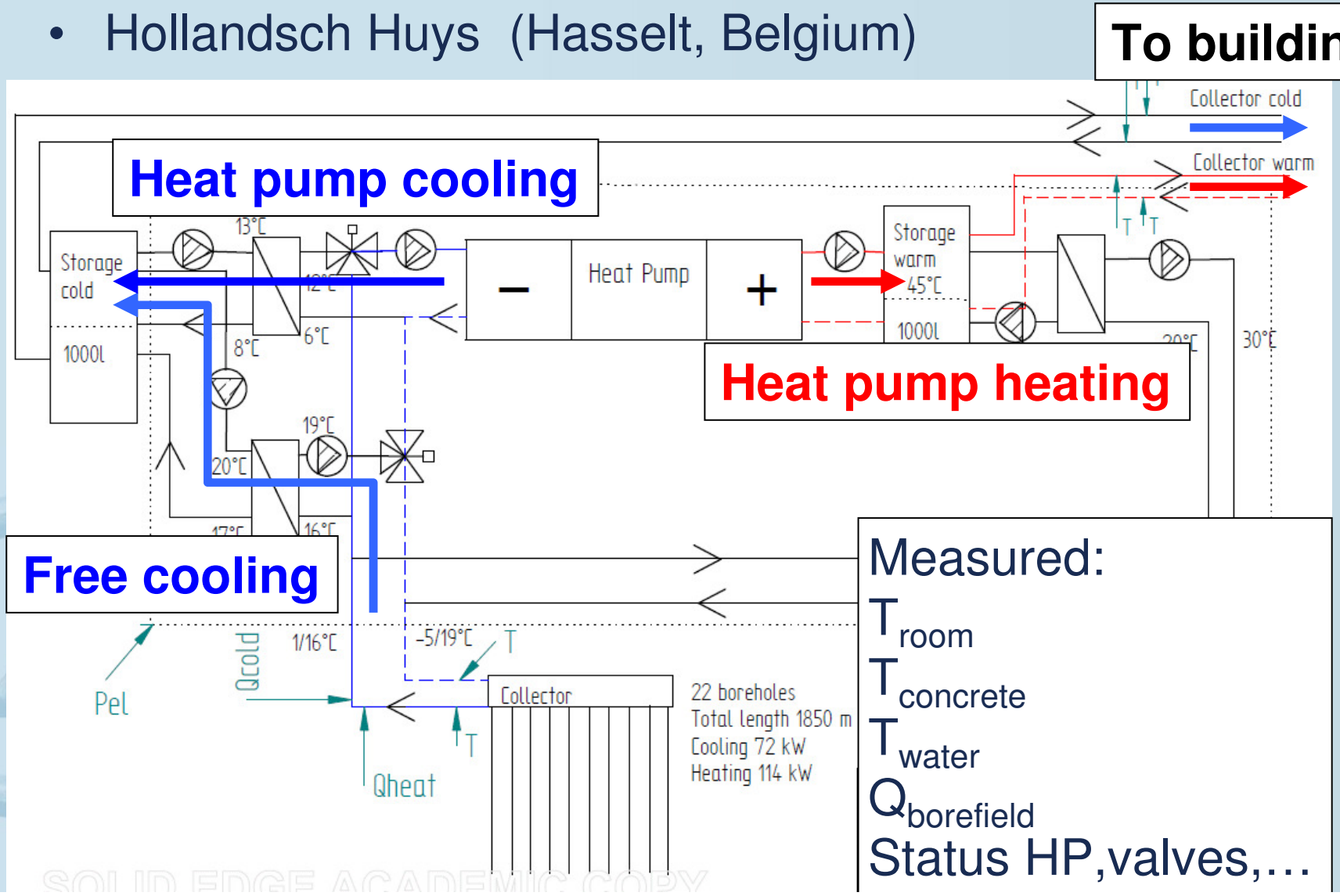




- 3 office floors + apartment
- 4000m² office space

Case studies

- Hollandsch Huys (Hasselt, Belgium)

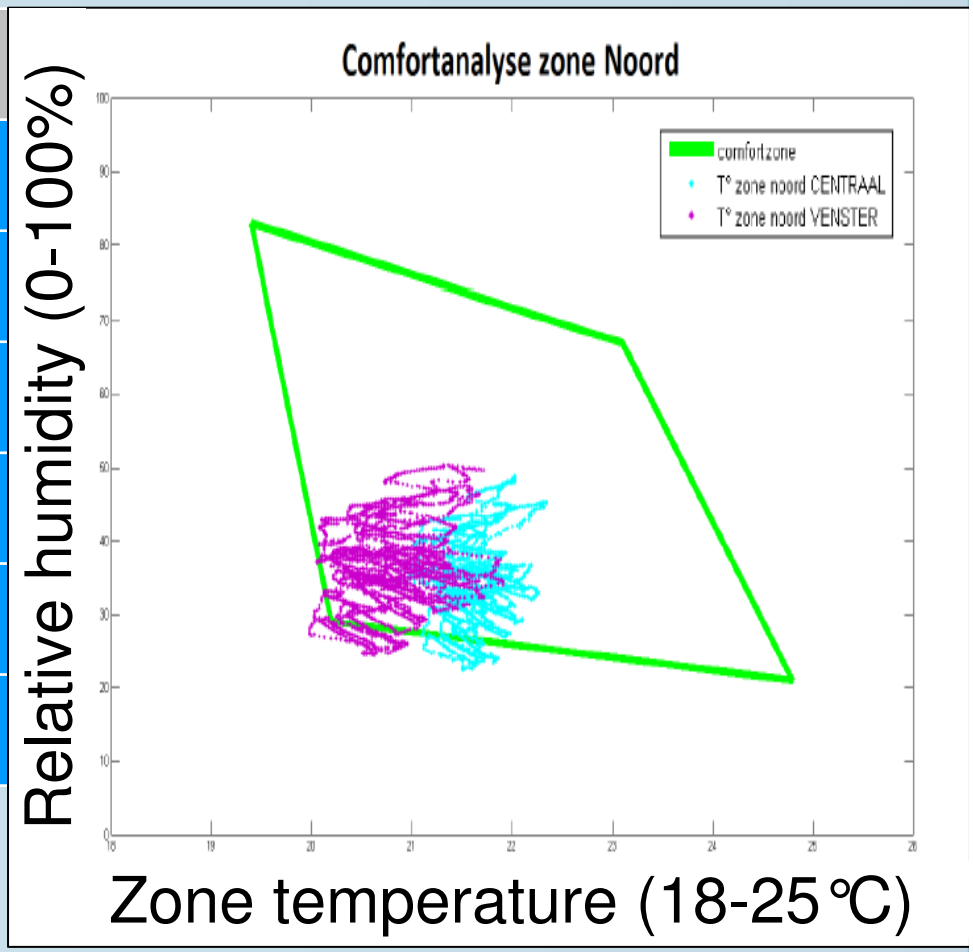


SOLID EDGE ACADEMIC COPY

Case studies

- Hollandsch Huys (Hasselt, Belgium)

Energy balance	
SPF tot	4.7
SPF heating tot	3.5
EER cooling tot	13.3
Heating energy	36 kWh/m²
Cooling energy	17 kWh/m²
Electrical energy	11 kWh/m²



Case studies

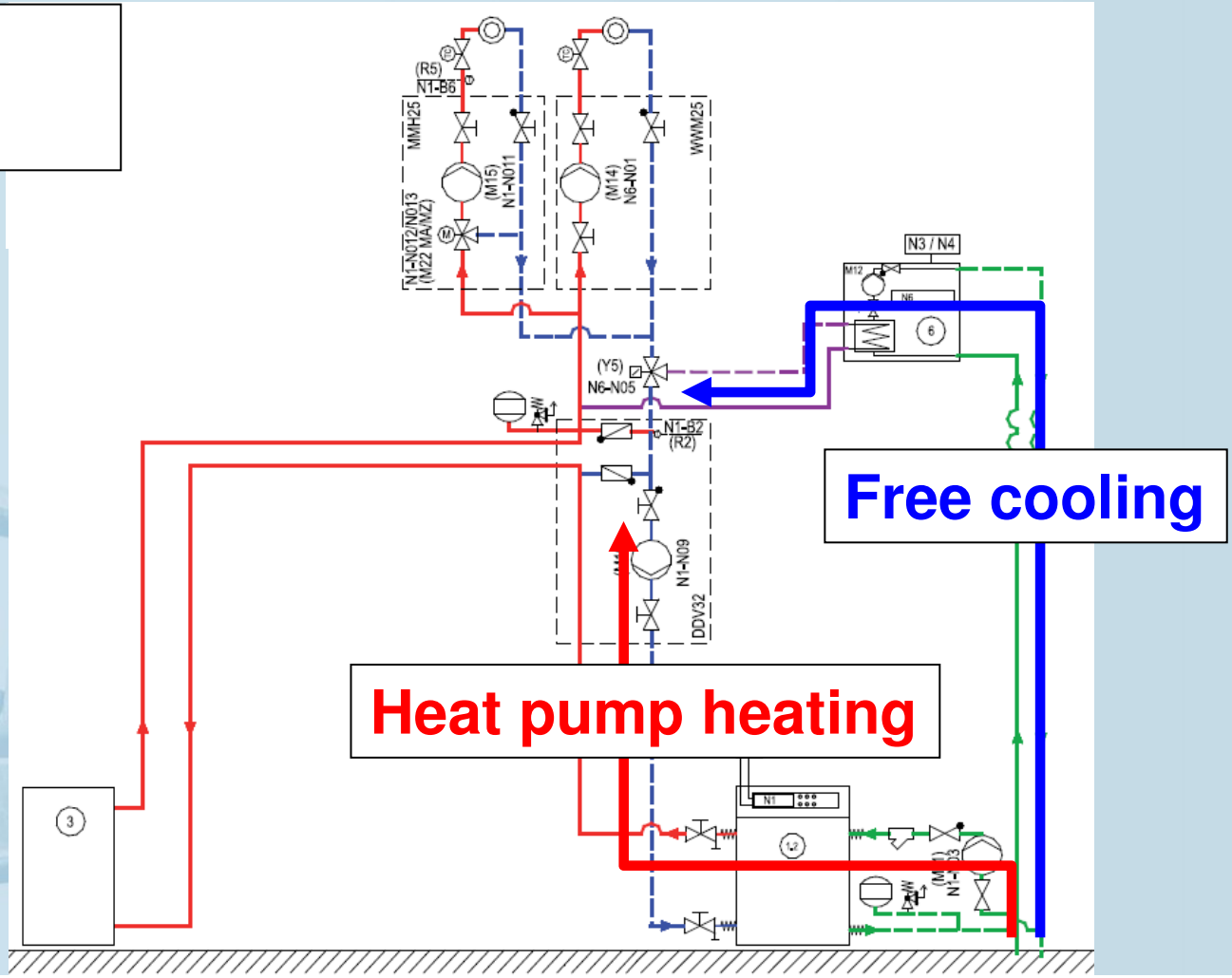
- Office building (Wellen, Belgium)
  - 2 floors
  - Heated cellar
  - 600 m²



Case studies

- Office building (Wellen, Belgium)

Measured:
everything…



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Thank you for your attention!

