Evaluation of the applicability of the quasi-steady-state overheating indicator for offices and schools

Kim Goethals
supervisor: Arnold Janssens

Laboratory of Building Physics, Construction and Services

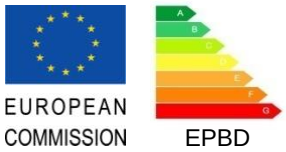
Funded by the Brussels Insititute for Environmental Protection (project IBGE/BIM-EPICOOL)


USE A HINT OF MINT
FIND A COOL PLACE
KEEP THE AIR FLOWING
EUROPEAN COMMISSION
EPBD
KEEP COOL! AT WORK
COOL FEET
COOL AS A CUCUMBER
EAT SPICY
ABR to open first of 25 schools in December
CGBS offers Bible MP3 CDs in Spa
FOR DECADES


USE A TINT OF MINT
FIND A COOL PLACE
EUROPEAN COMMISSION
EPBD
your
KEEP cool! AT WORK
COOL FEET
COOL AS A CUCUMBER
EAT SPICY
ABR to open first of 25 schools in December
CGBS offers Bible MP3 CDs in Sp
David Barrett

Consitutive stimulus of alternative cooling methods badly needed

EU set the EPBD



Common calculation method (EN 13790): preferably quasi-steady-state (instead of BES)

Minimum requirements on energy performance

Summer comfort and cooling underrepresented

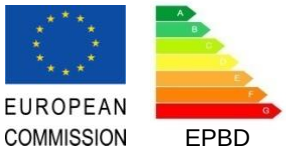
Focus on heating vs increasing cooling demand: e.g. 5 out of 9 EU countries have a (limited) summer analysis

Additional requirement(s) to

- limit the overheating risk
- promote passive cooling

Consitutive stimulus of alternative cooling methods badly needed

EU set the EPBD



Common calculation method (EN 13790): preferably quasi-steady-state (instead of BES)

Minimum requirements on energy performance

Summer comfort and cooling underrepresented

Focus on heating vs increasing cooling demand: e.g. 5 out of 9 EU countries have a (limited) summer analysis

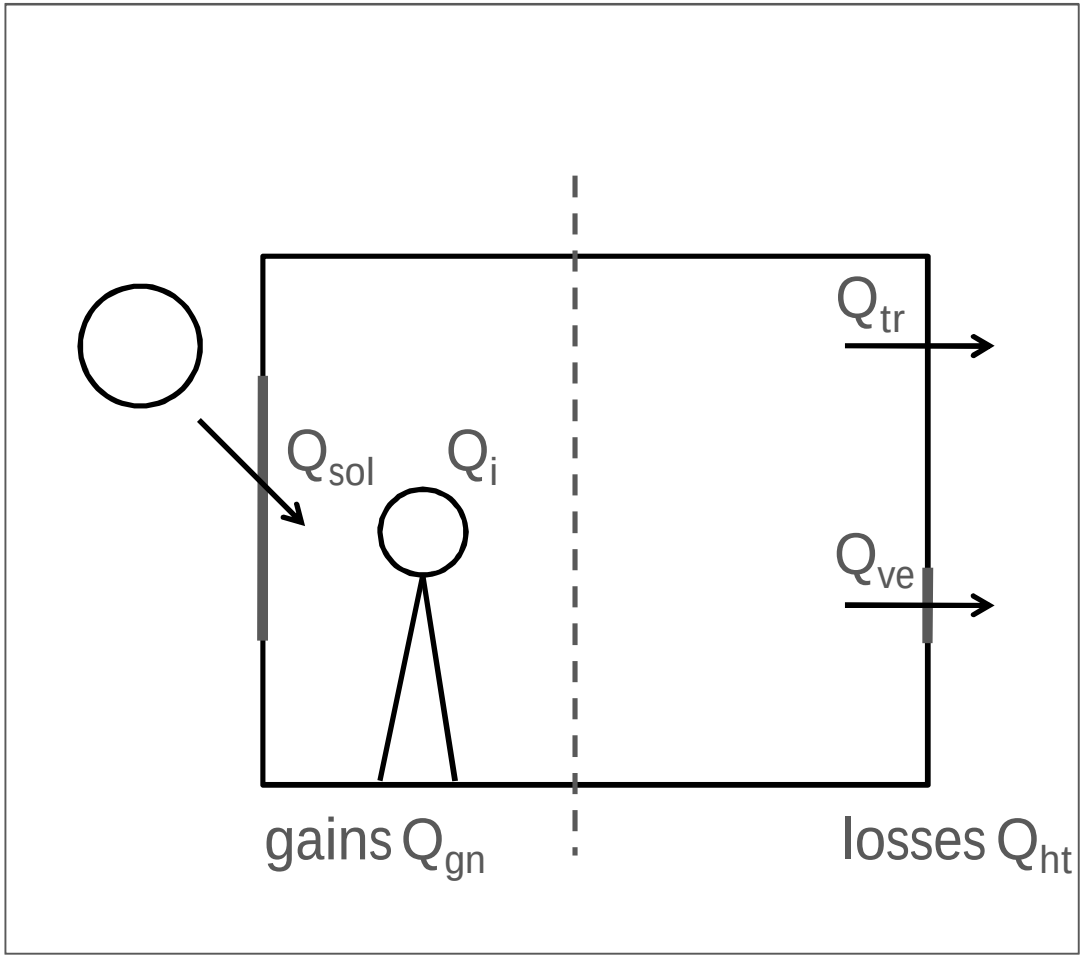
Additional requirement(s) to

- limit the overheating risk
- promote passive cooling

such as an overheating indicator

Quasi-steady-state calculation in a nutshell

Heat balance over long time (month)



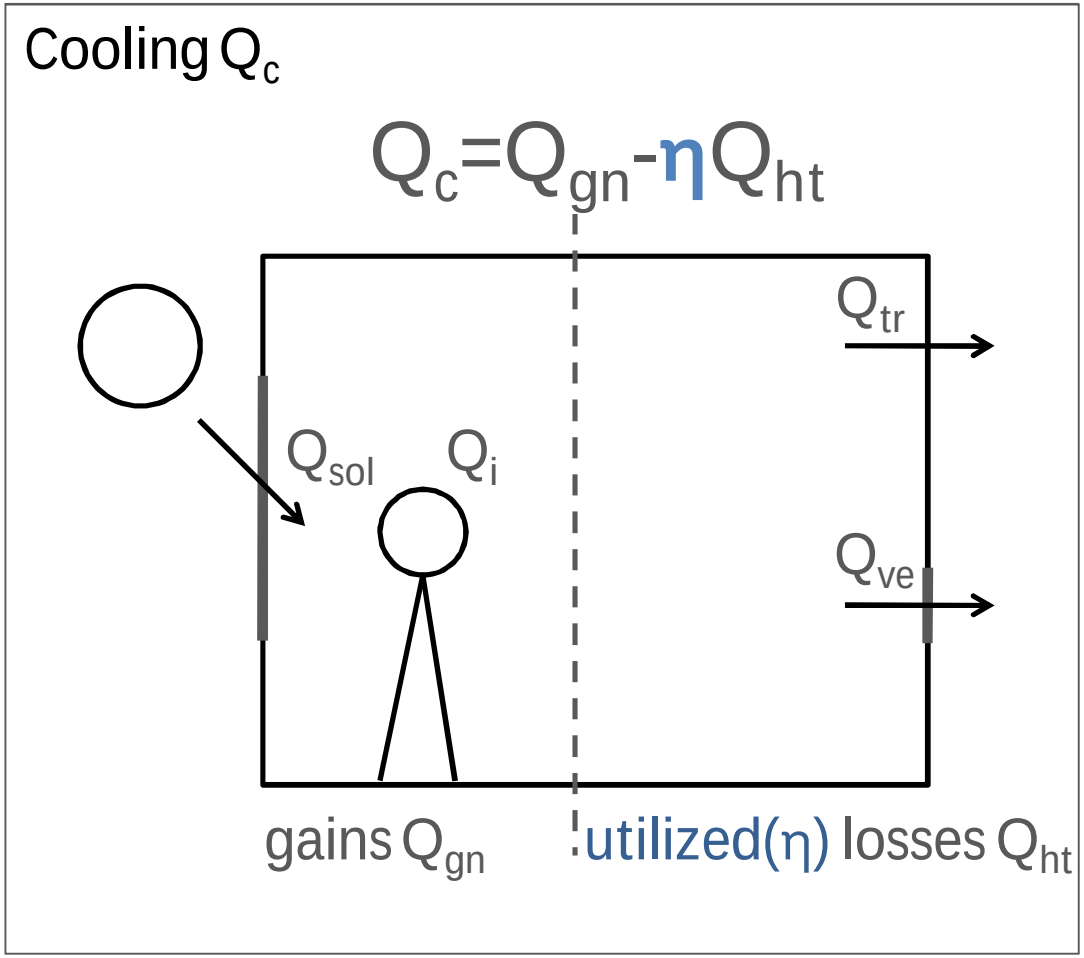
Quasi-steady-state calculation in a nutshell

Heat balance over long time (month)

Utilization factor for dynamic effects

$\eta \sim Q_{ht}/Q_{gn}=1/\gamma_c$

~ thermal mass



Summer analysis: original overheating indicator

Deutscher et al. (2000)

In line with method for heating demand (EN 832, predecessor of EN 13790)

$$Q_{NN} = \sum_{i=1}^{12} \frac{\left(1 - \eta_{H,gn}\right) \cdot Q_{H,gn}}{\left(H_{tr,adj} + H_{ve,adj}\right)}$$

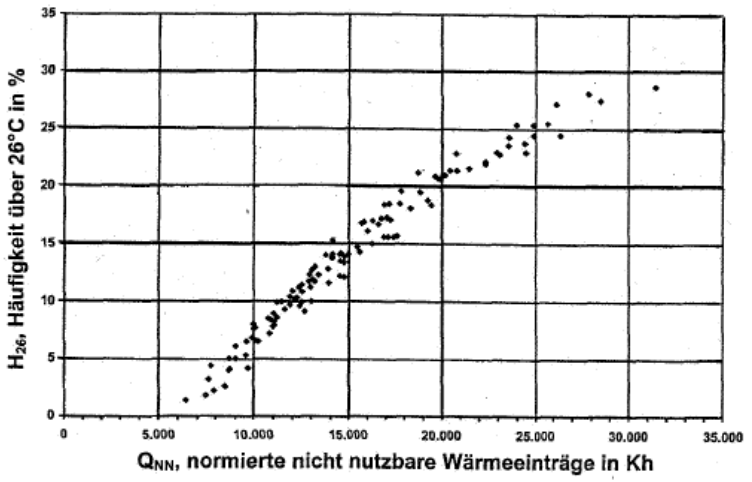


Bild 3. Häufigkeit von Raumtemperaturen über 26 °C in Relation zu den nicht nutzbaren Wärmeeinträgen Q_{NN} (Klimadaten TRY Essen)

Maßgebend für die Grenzwertes $Q_{NN,max}$ die im Bereich von H Bild 4 zeigt die Zusa Ergebnisse der dre regionen für den $H_{\Theta_{Grenz}} < 20\,\%$. Um die reiche der Werte zu neben den Regressior Einzelergebnisse der die Sommer-Klimareg und C (TRY Freiburg) ein deutlicher lineare zwischen $H_{\Theta_{Grenz}}$ und Q Aus den jeweiligen R läßt sich für jede So der $Q_{NN,max}$-Wert für mitteln (Tabelle 4). Ein zu bewertendes C Vorgaben des somr schutzes, wenn der u dingungen" ermittelte weiligen Grenzwert überschreitet:

Summer analysis: original overheating indicator

Deutscher et al. (2000)

In line with method for heating demand (EN 832, predecessor of EN 13790)

Excess

Gains

$$Q_{NN} = \sum_{i=1}^{12} \frac{(1 - \eta_{H,gn}) \cdot Q_{H,gn}}{(H_{tr,adj} + H_{ve,adj})}$$

Normalization

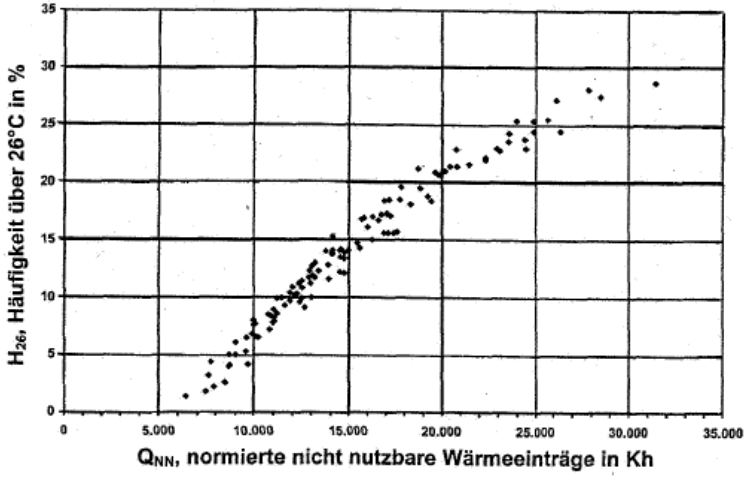


Bild 3. Häufigkeit von Raumtemperaturen über 26 °C in Relation zu den nicht nutzbaren Wärmeeinträgen Q_{NN} (Klimadaten TRY Essen)

Maßgebend für die Grenzwertes $Q_{NN,max}$ die im Bereich von H Bild 4 zeigt die Zusa Ergebnisse der dre regionen für den $H_{\vartheta_{Grenz}} < 20\,\%$. Um die reiche der Werte zu neben den Regressior Einzelergebnisse der die Sommer-Klimareg und C (TRY Freiburg) ein deutlicher lineare zwischen $H_{\vartheta_{Grenz}}$ und Q Aus den jeweiligen R läßt sich für jede So der $Q_{NN,max}$-Wert für mitteln (Tabelle 4). Ein zu bewertendes C Vorgaben des somr schutzes, wenn der u dingungen" ermittelte weiligen Grenzwert überschreitet:

Summer analysis: Flanders' adoption

Flanders (Belgium)

$$I_{overh} = \sum_{i=1}^{12} \frac{(1 - \eta_{H,gn}) \cdot Q_{H,gn}}{(H_{tr,adj} + H_{ve,adj})}$$

Input and calculation parameters of heating

$\theta_{int} = 18°C$ (instead of 20°C)

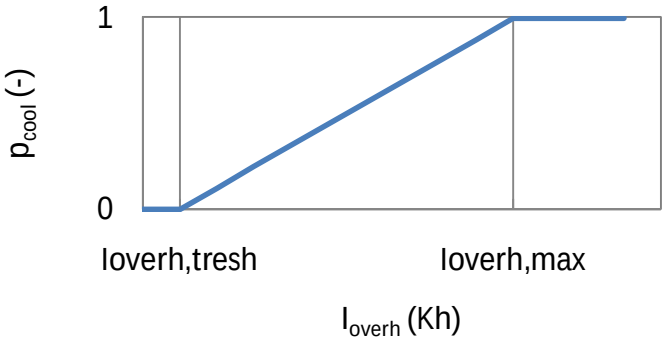
$n = 1.0h^{-1}$ (instead of 0.7h^{-1} or 3.0h^{-1})

Limited applicability

Dwellings

Fictitious cooling

Penalizes the instalment of mechanical cooling afterwards



Summer analysis:
revised overheating indicator

Proposal

$$I_{overh} = \sum_{t=1}^{12} \frac{(1 - \eta_{C,gn}) \cdot Q_{C,gn}}{(H_{tr,adj} + H_{ve,adj,ext} + H_{ve,adj,hyg})}$$

Input and calculation parameters of cooling

$\mathbf{e.g.}\ \boldsymbol{\theta_{int}} = \mathbf{23°C}$

Additional heat transfer coefficients

Passive cooling techniques
(e.g. windows, increased mechanical ventilation during daytime, night cooling)

Upper and lower bounds

Reusing fictitious cooling

Extended applicability

Dwellings + offices, schools

Summer analysis:
revised overheating indicator

Proposal

$$I_{overh} = \sum_{i=1}^{12} \frac{(1 - \eta_{C,gn}) \cdot Q_{C,gn}}{(H_{tr,adj} + H_{ve,adj,ext} + H_{ve,adj,hyg})}$$

Input and calculation parameters of cooling

$\mathbf{e.g.}\ \boldsymbol{\theta_{int} = 23°C}$

Additional heat transfer coefficients

Passive cooling techniques
(e.g. windows, increased mechanical ventilation during daytime, night cooling)

Upper and lower bounds

Reusing fictitious cooling

Extended applicability

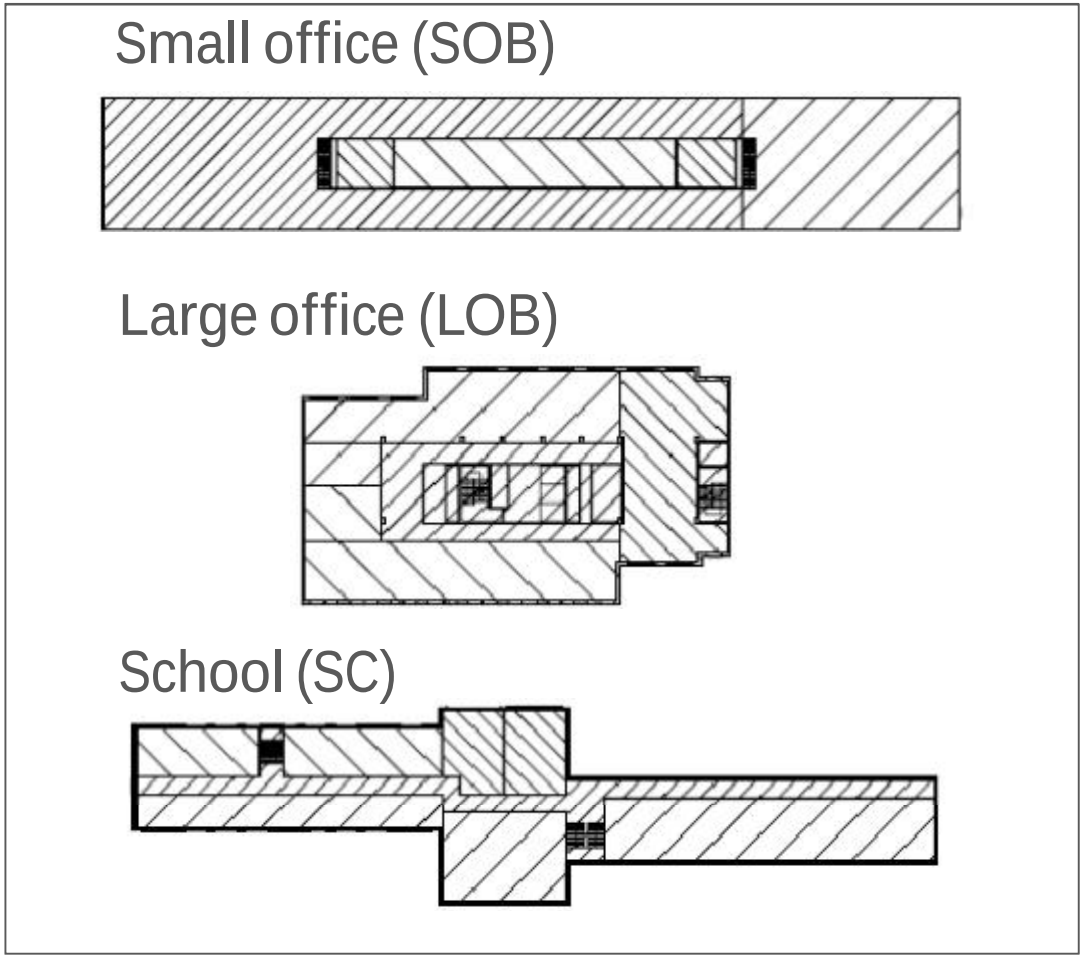
Dwellings + offices, schools

Dynamic simulations of three non-residential buildings

>1 building zone (concurring in EPB and TRNSYS)

3 quality levels (ACCeptable, GOOd, VERy good)

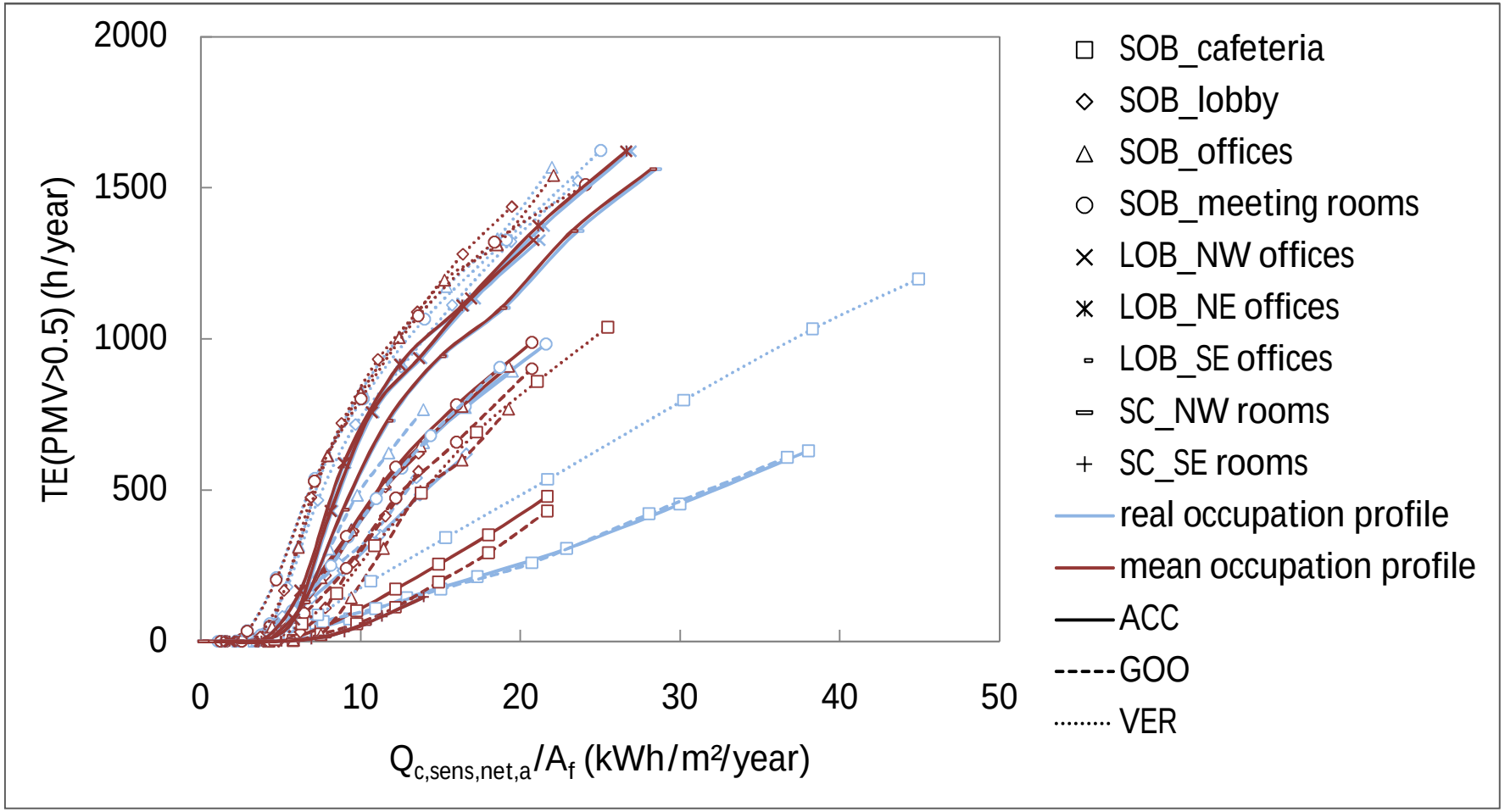
8 x 2 levels of internal loads (real, mean)



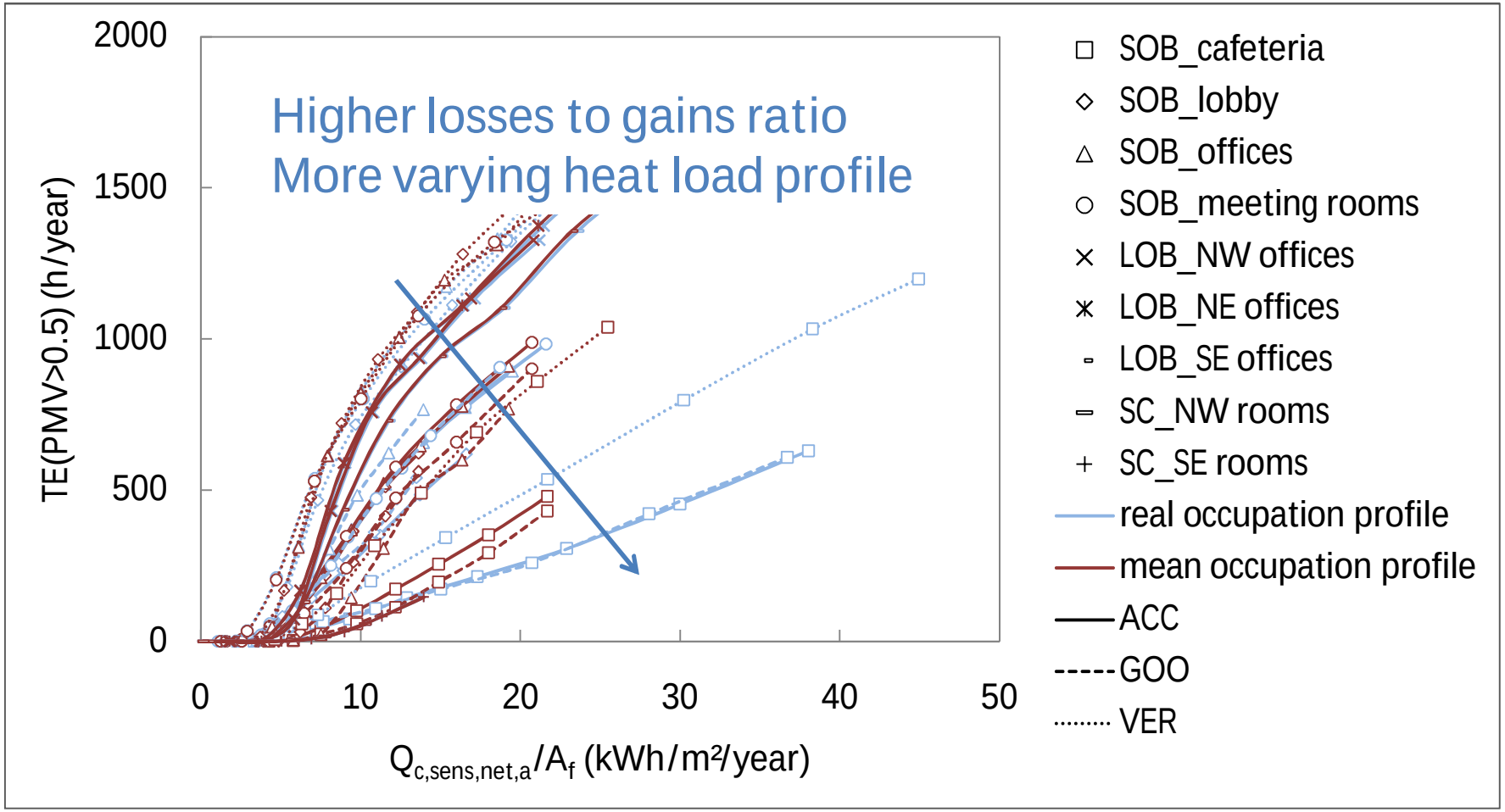
Comfort assessment based on dynamic simulations

Discomfort when…	Number of hours for which a PMV-value larger than 0.5 applies, exceeds 100h/year or TE(PMV>0.5)>100h/year (ISSO, 2004)
ASIEPI suggests adaptive comfort	Higher tolerance when users are allowed to adapt to the building's environment
EPBD for compliance control	Safe approximation: PMV only takes into account a varying clothing resistance

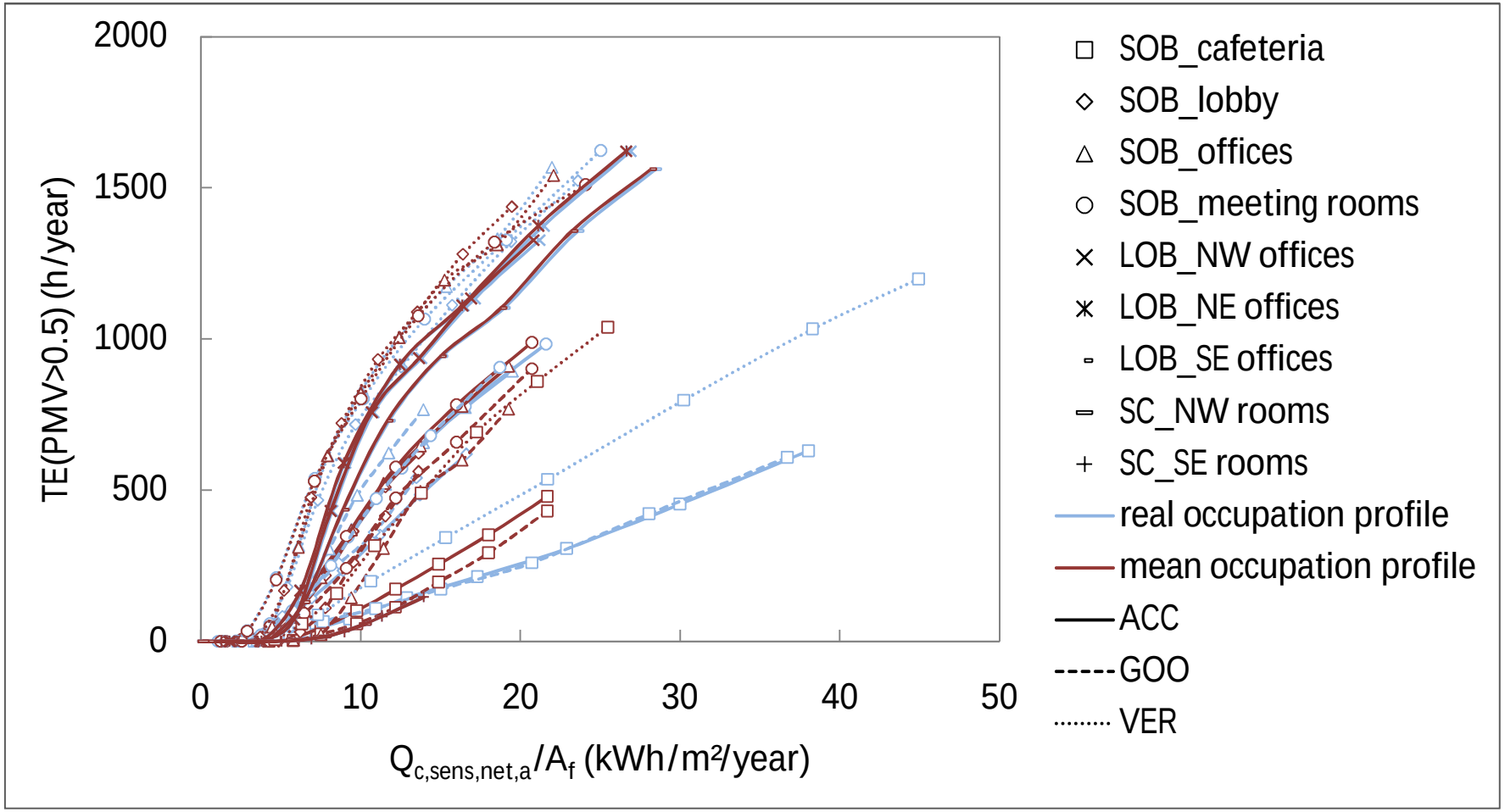
Input and calculation parameters used for cooling as a reference



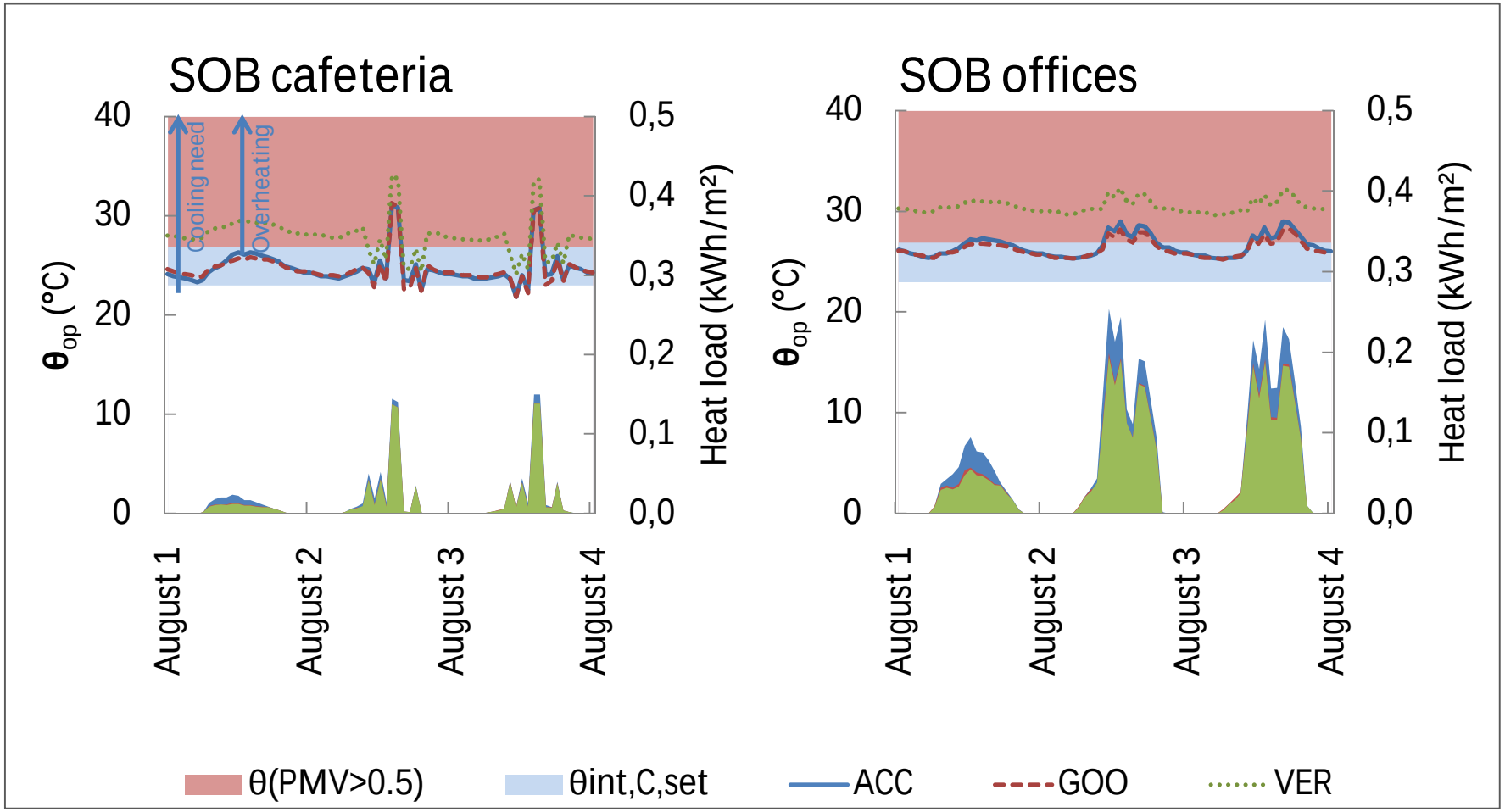
Input and calculation parameters used for cooling as a reference



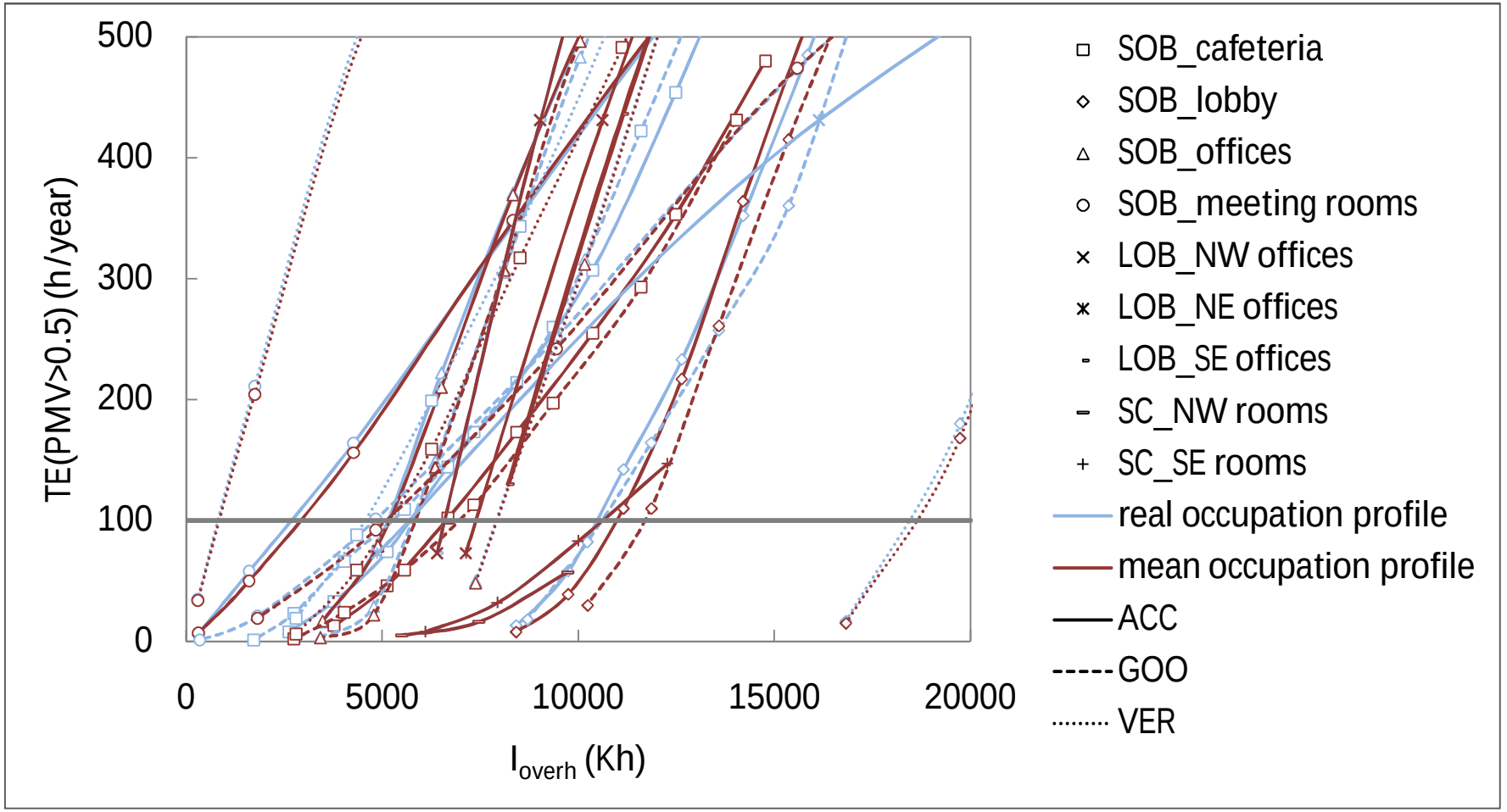
Input and calculation parameters used for cooling as a reference



Impact of occupation profiles



Overheating indicator applicable to offices and schools ...

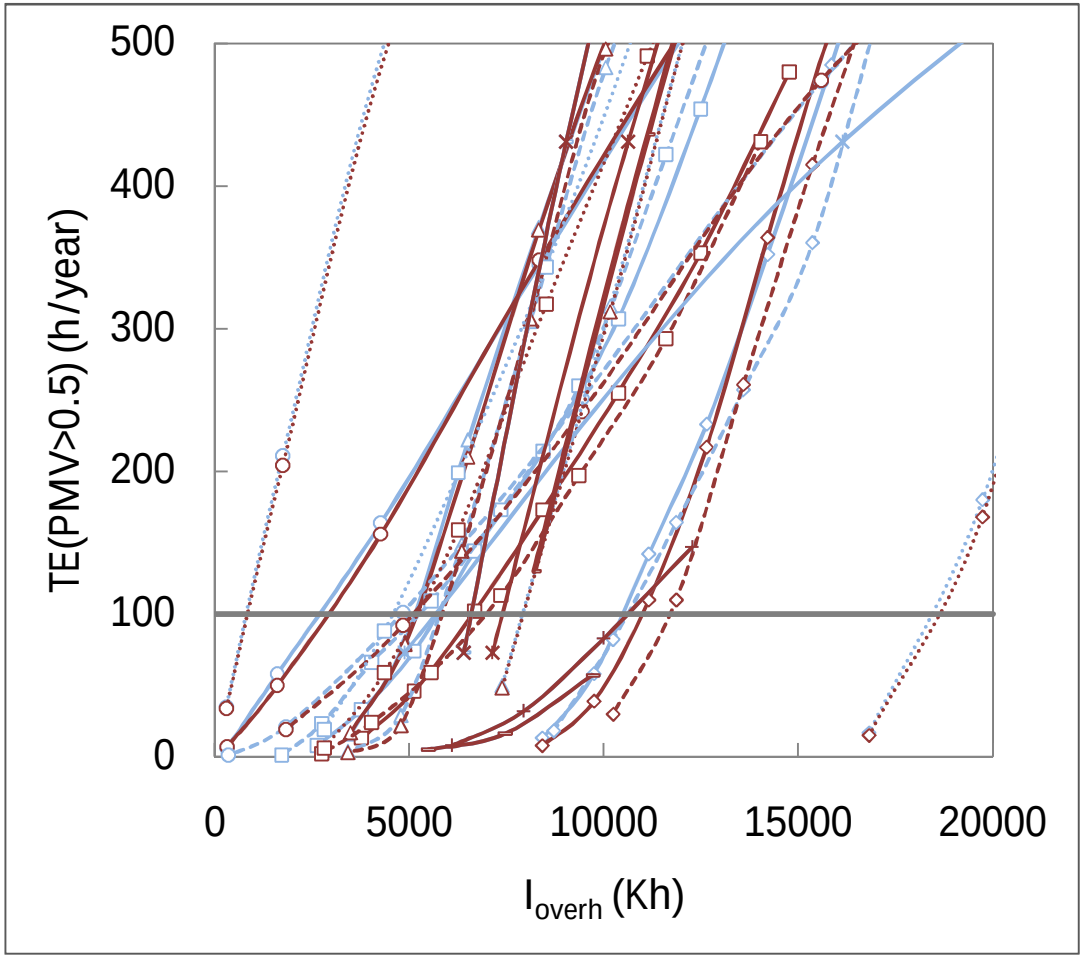


… but shows differing relations

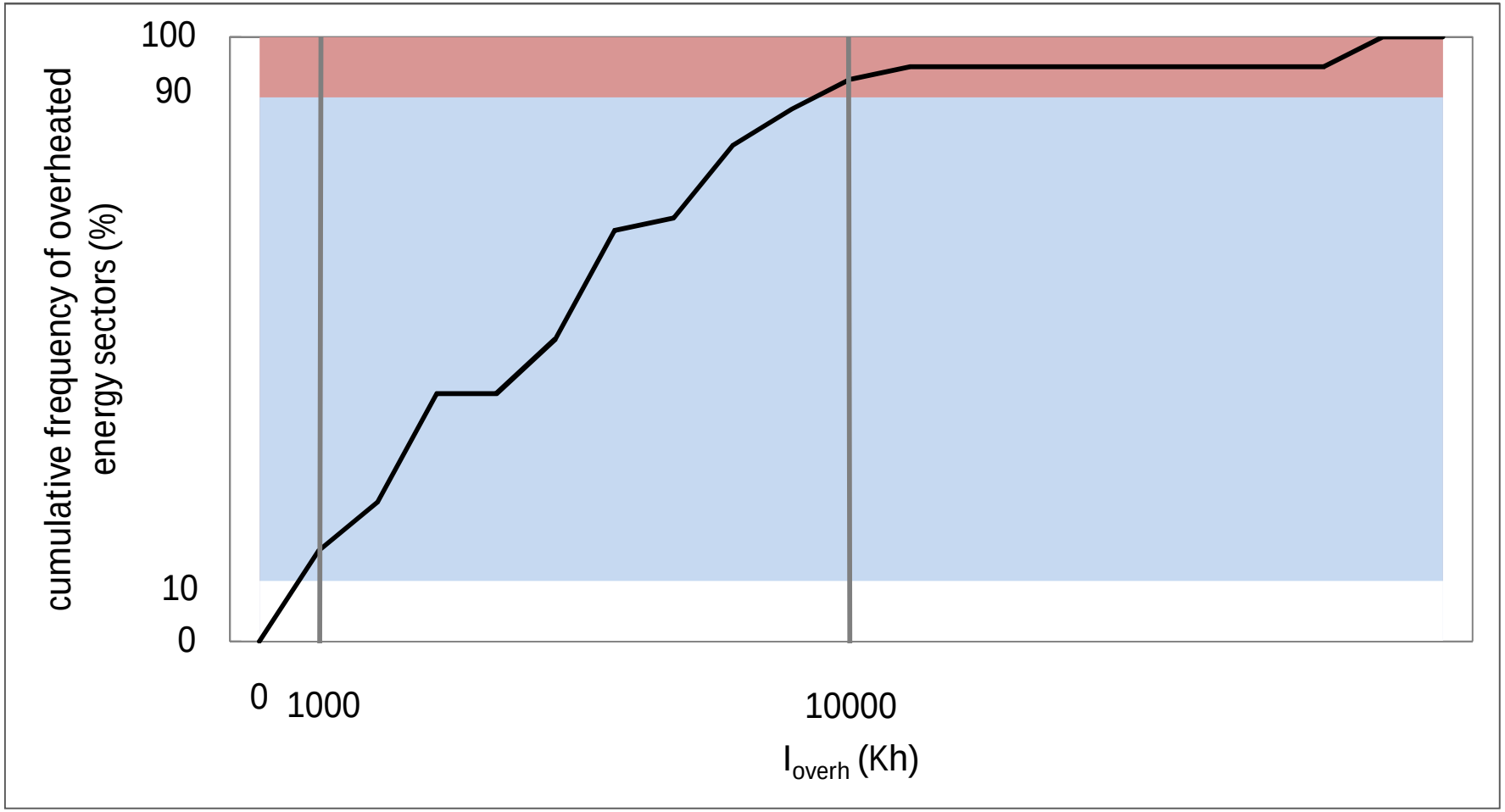
Heat load profiles

Period of excess gains <> occupation period

Fixed indoor temperature <> thermal mass



Lower and upper bounds useful to implement fictitious cooling



Revised overheating indicator is suited

Calculation parameters used for cooling	More logic
Large spread	Introduction of fictitious cooling
Promote passive cooling techniques	Opening windows during daytime (Goethals and Janssens, 2010a) Increased mechanical ventilation during daytime (Goethals and Janssens, 2010b) Night ventilation (Breesch et al., 2011)

Evaluation of the applicability of the quasi-steady-state overheating indicator for offices and schools

UNIVERSITEIT GENT

*Kim Goethals and Arnold Janssens

kim.goethals@ugent.be