

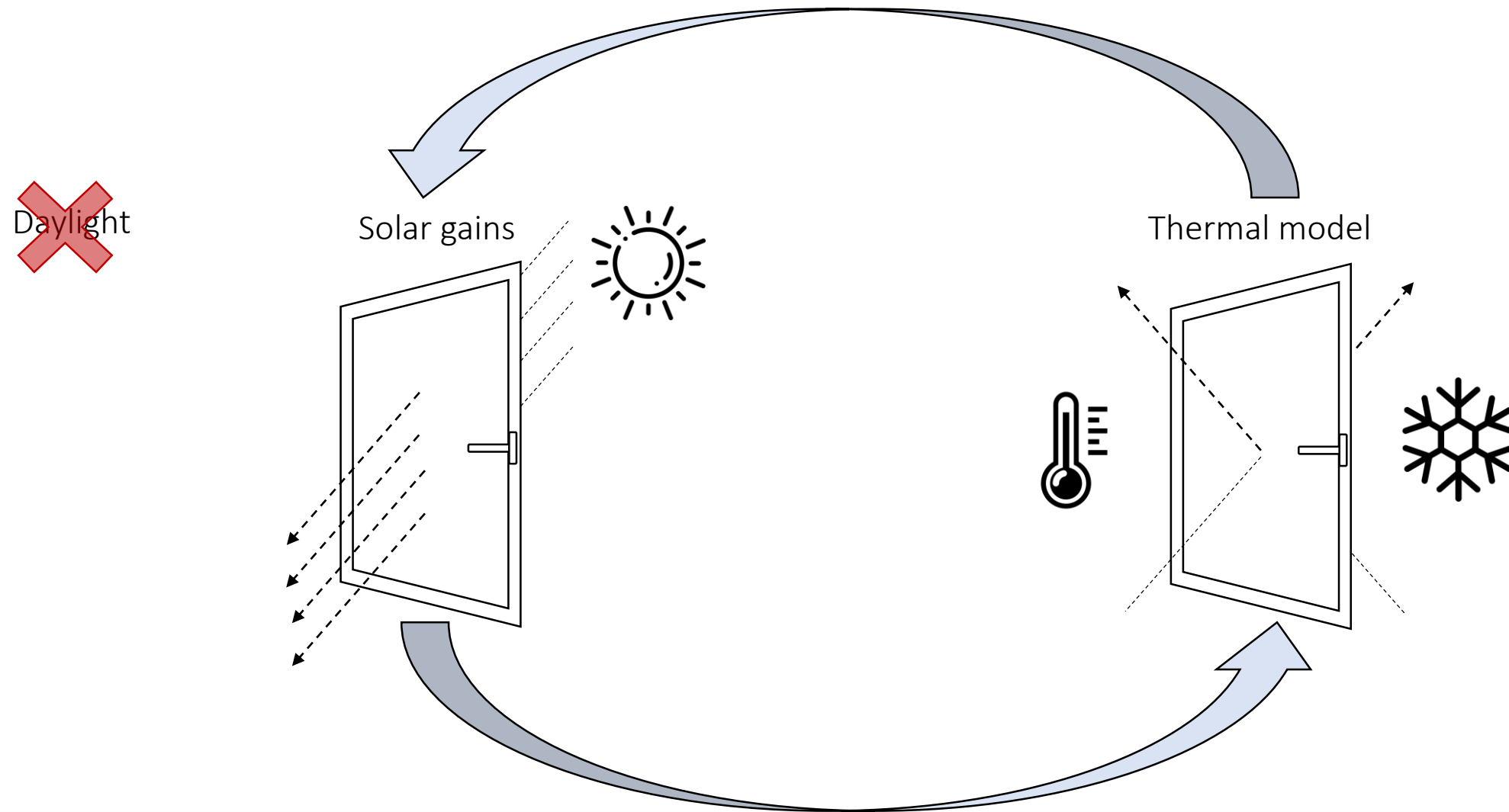


Window model

Mara MAGNI, Elisa VENTURI, Fabian OCHS - Carnot User Meeting 2022

The University of Innsbruck was founded in 1669 and is one of Austria's oldest universities. Today, with over 28.000 students and 5.000 staff, it is western Austria's largest institution of higher education and research. **For further information visit: www.uibk.ac.at.**

Case study

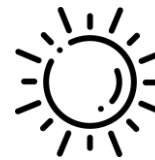
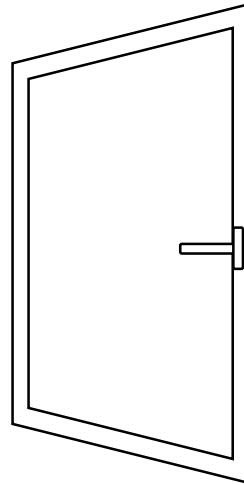


Case study

Analysis of different window models considering:

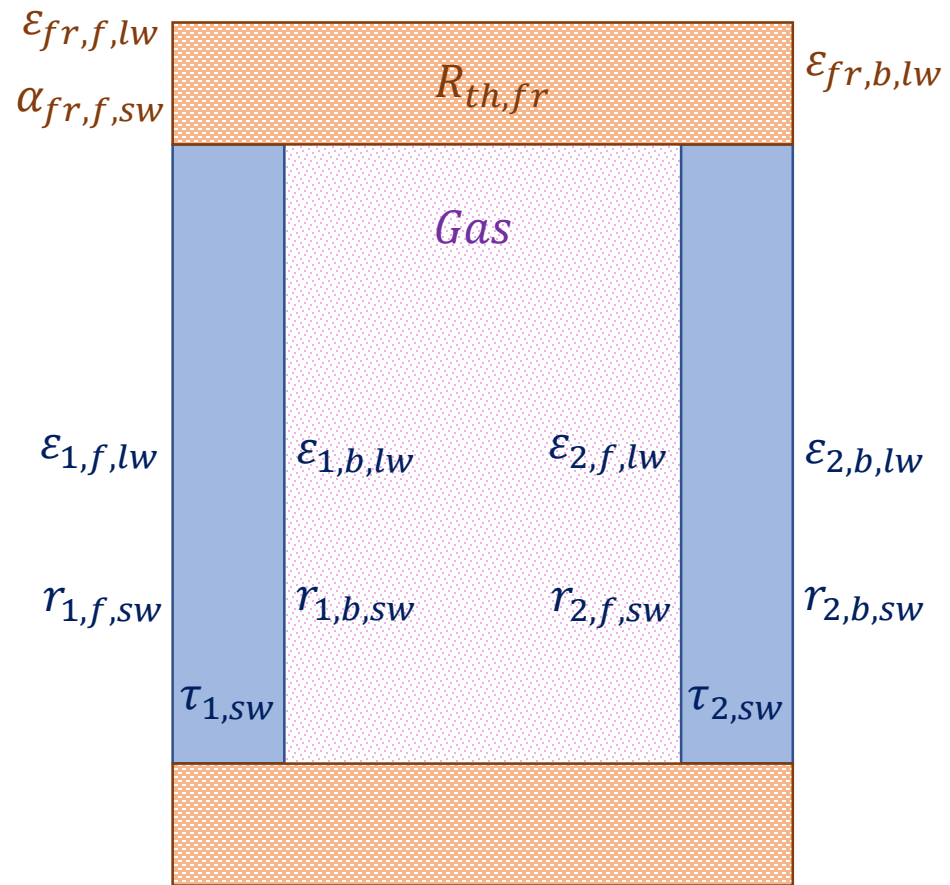
- Constant Internal boundary conditions;
- Weather of Stockholm;
- Double glazed window

$\vartheta_a = 22^{\circ}\text{C}$
 $\vartheta_{\text{rad}} = 22^{\circ}\text{C}$

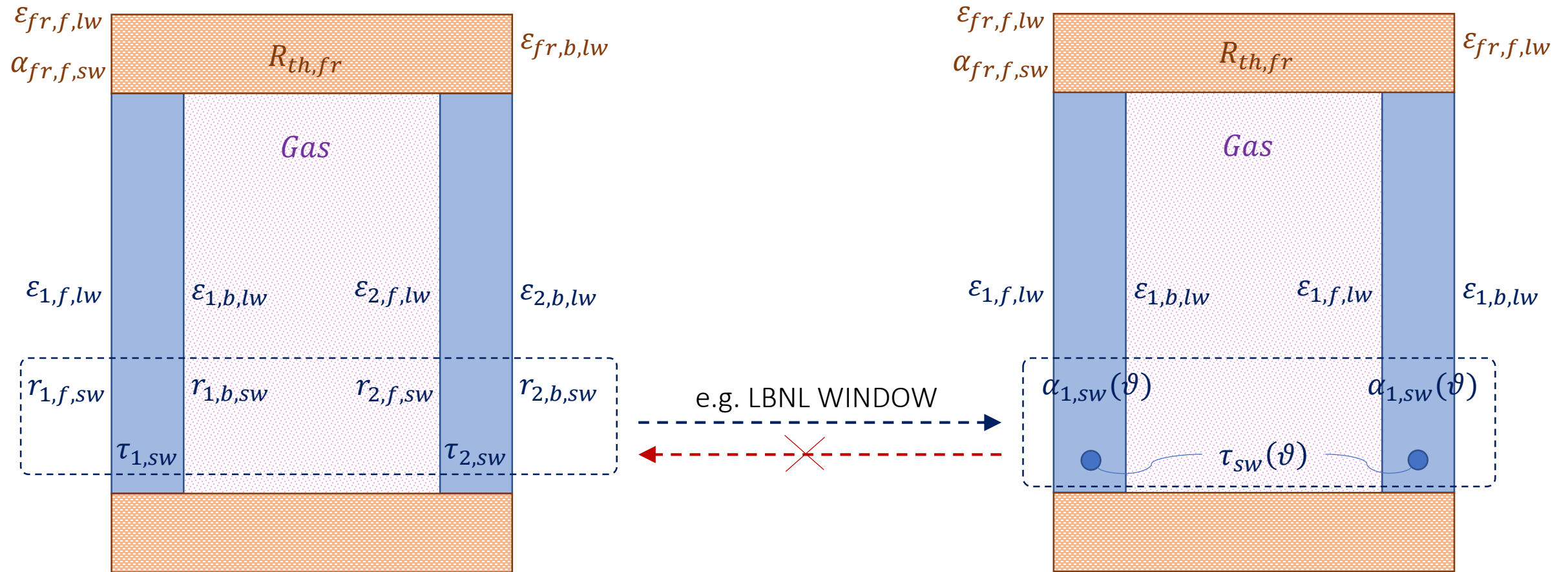


TMY Stockholm

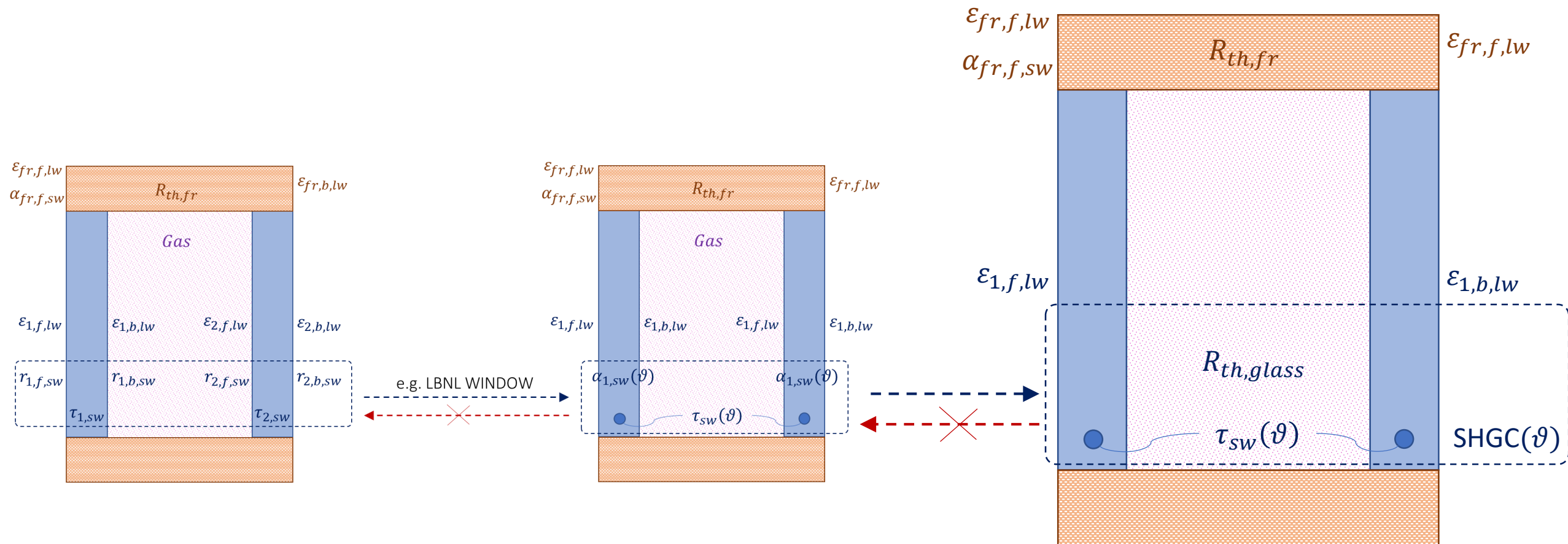
Window models



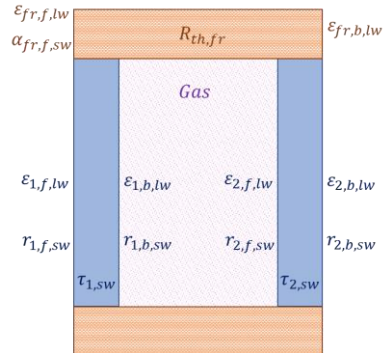
Window models



Window models

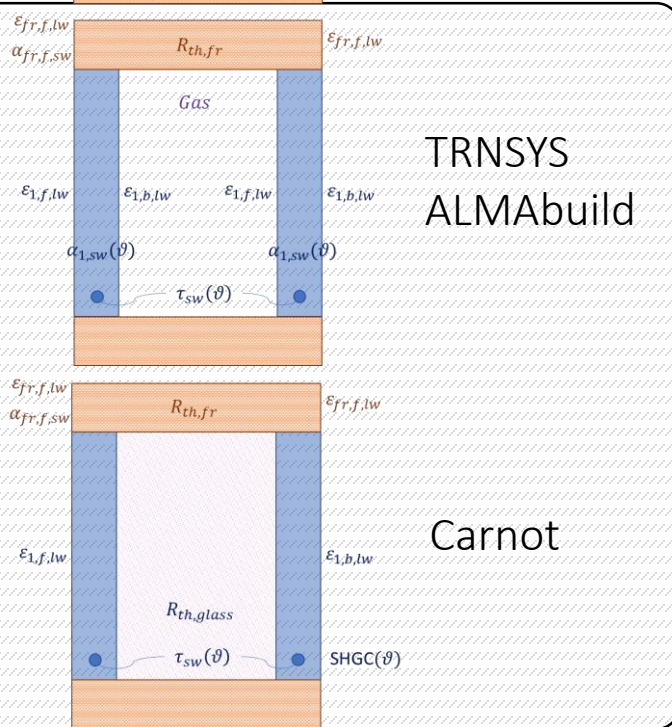


Window models



EnergyPlus,
Modelica,
IDA ICE

Increasing level of
detail and of required
inputs



TRNSYS
ALMABuild

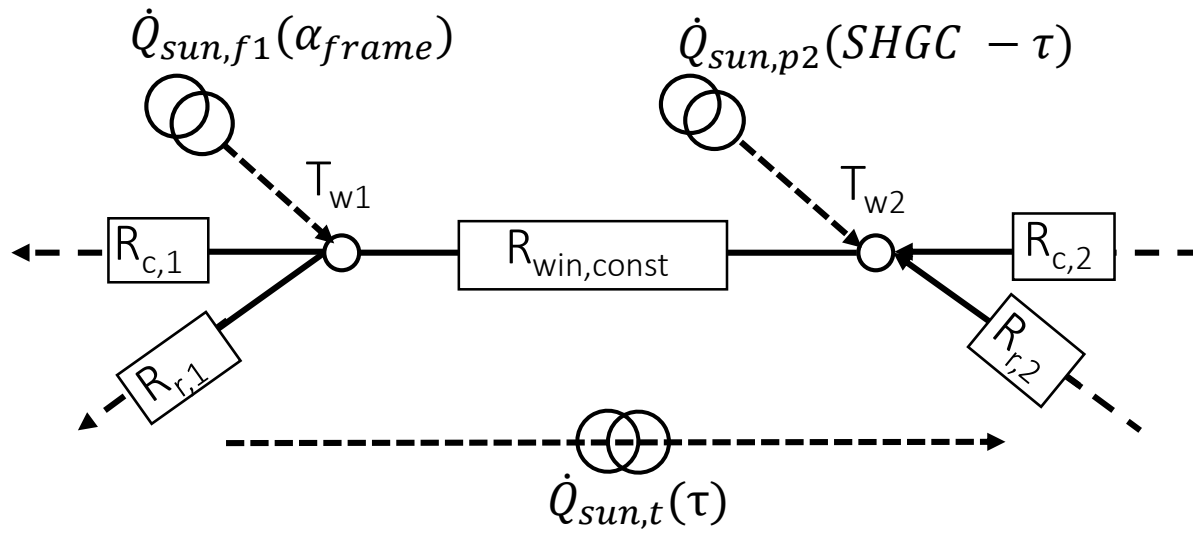
Carnot

If detailed input are
available it is possible
to derive from these
the lumped inputs
needed in the more
simplified models

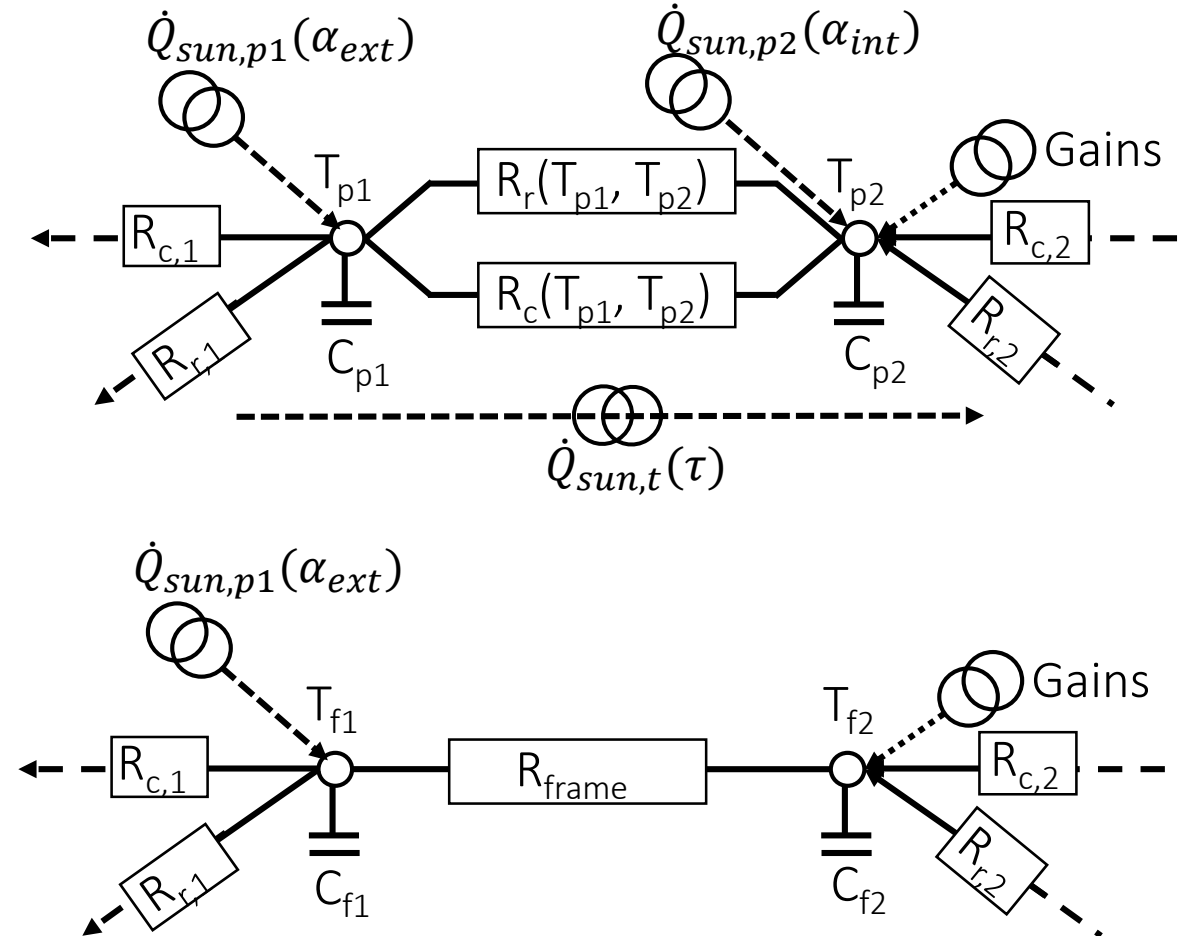
Derive detailed inputs
from simplified it is
“not” possible

Window models

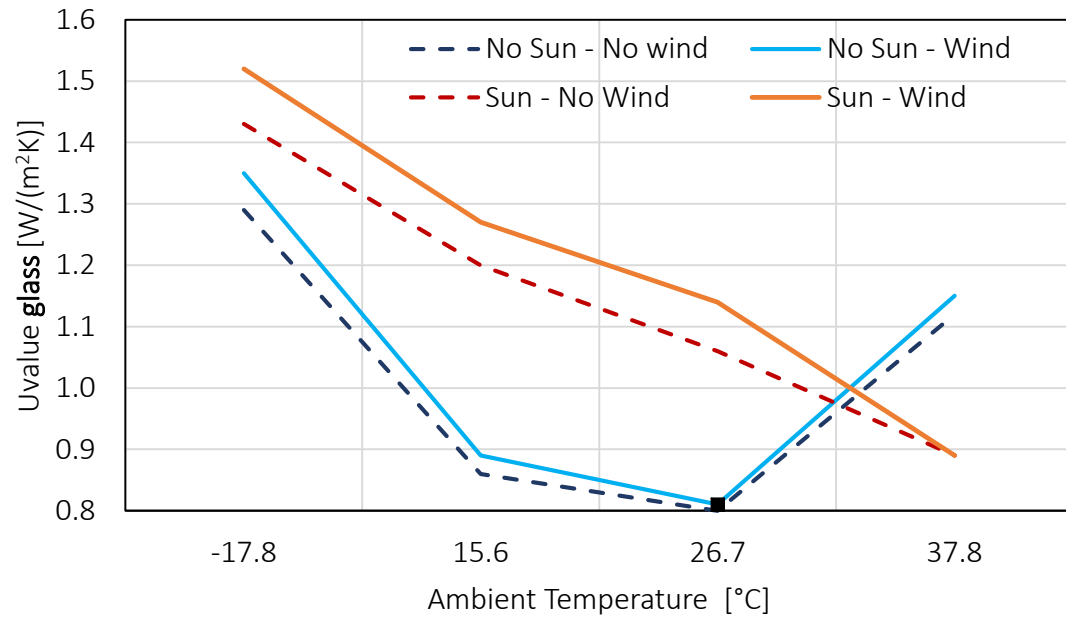
Carnot



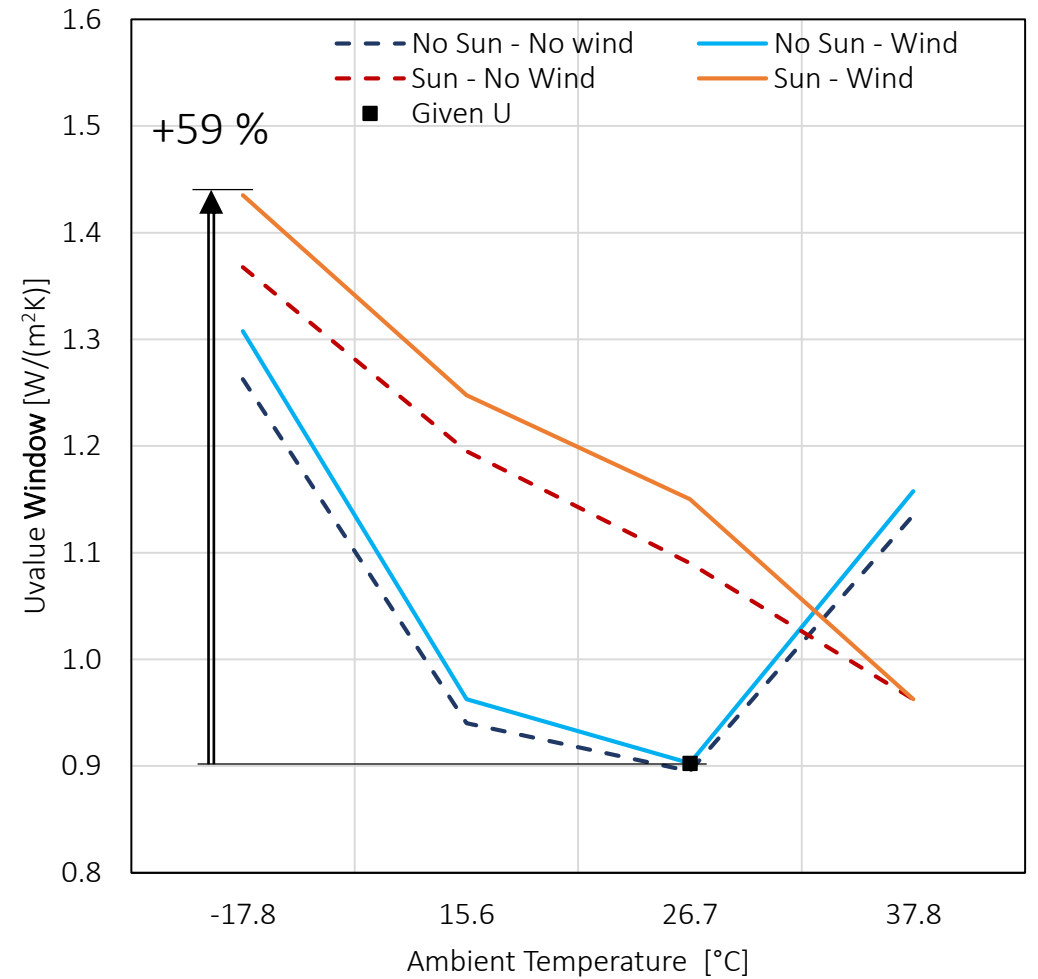
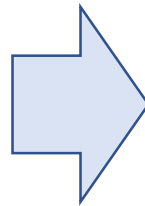
ALMABuild



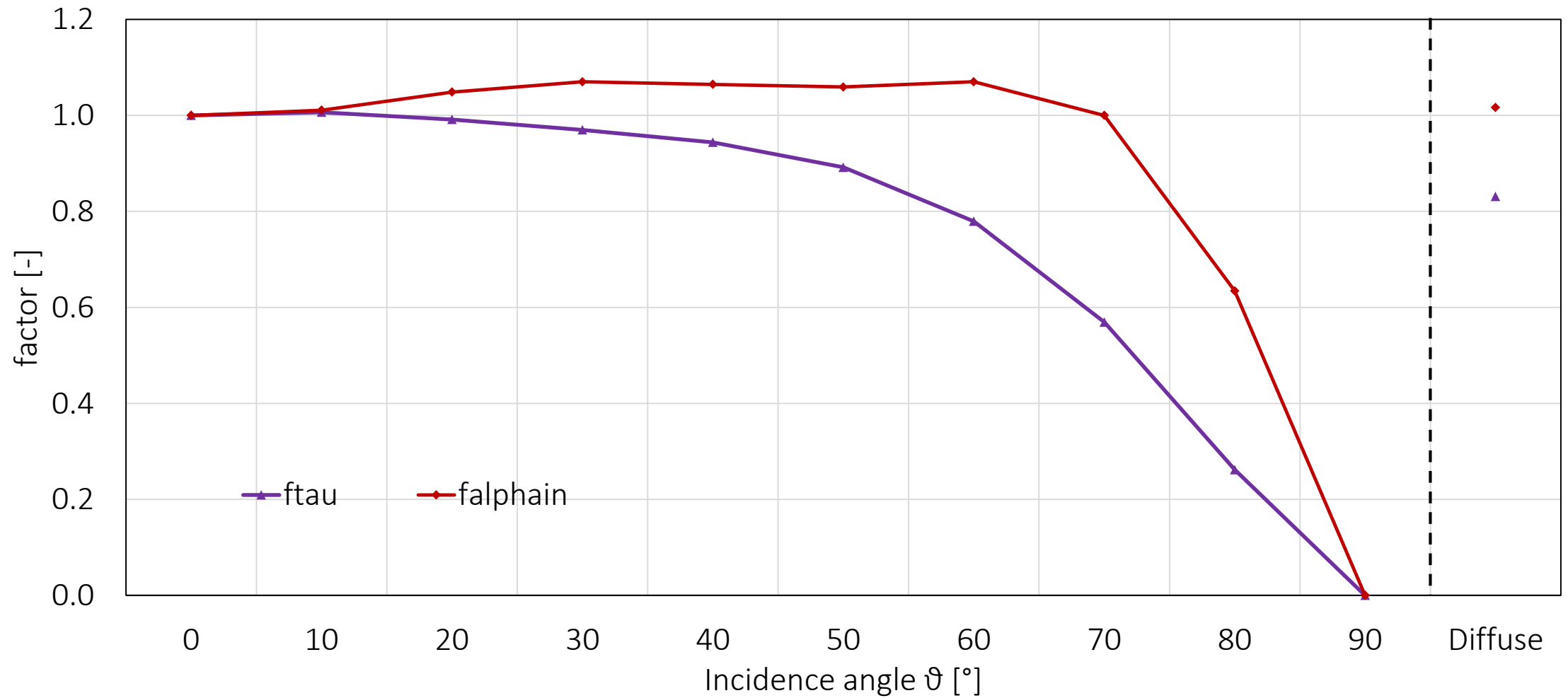
Window U value



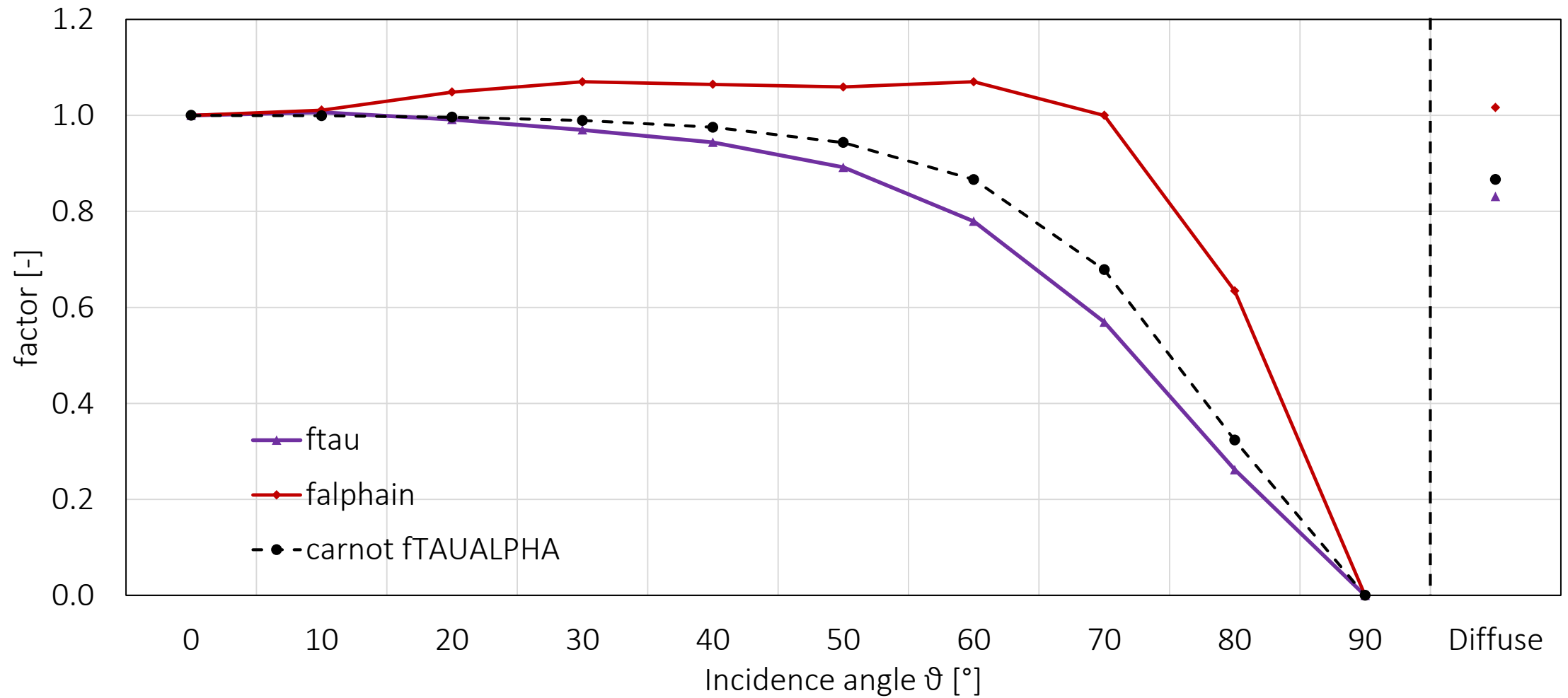
$U_{\text{frame}} = 1.18 \text{ [W/(m}^2\text{K)]}$



Solar absorption and transmission factors



Solar absorption and transmission factors



Objective of the analysis

Assess the influence (on the results' accuracy) of:

- the constant thermal resistance;
- the model of the solar gains.

Cases

| | | |
|--|---|--|
| | <p>Case 1: No sun</p> | <p>Case 4: No sun, Rwin,const calibrated</p> |
| | <p>Case 2: With sun, no solar absorption</p> | <p>Case 5: With sun, no solar absorption, Rwin,const calibrated</p> |
| | <p>Case 3: With sun and solar absorption</p> | <p>Case 6: With sun and solar absorption, Rwin,const, SHGC and Tau calibrated</p> |

Cases

A carnot window model with a separated balance for the frame and glass has been tested.

Case 1: No sun

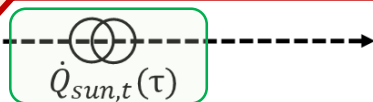
Case 4: No sun,
 $R_{win,const}$ calibrated

Case 2: With sun, no solar absorption

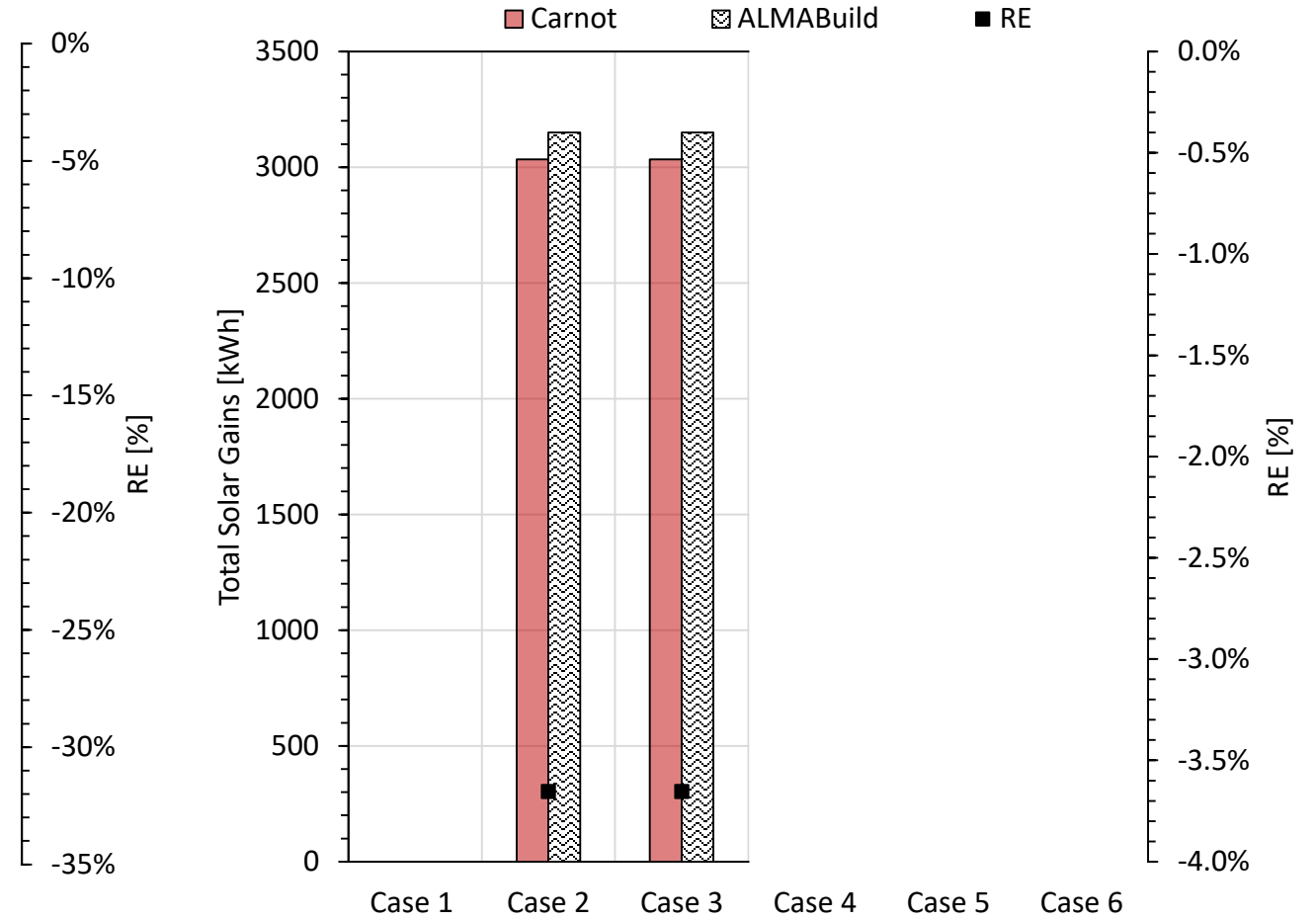
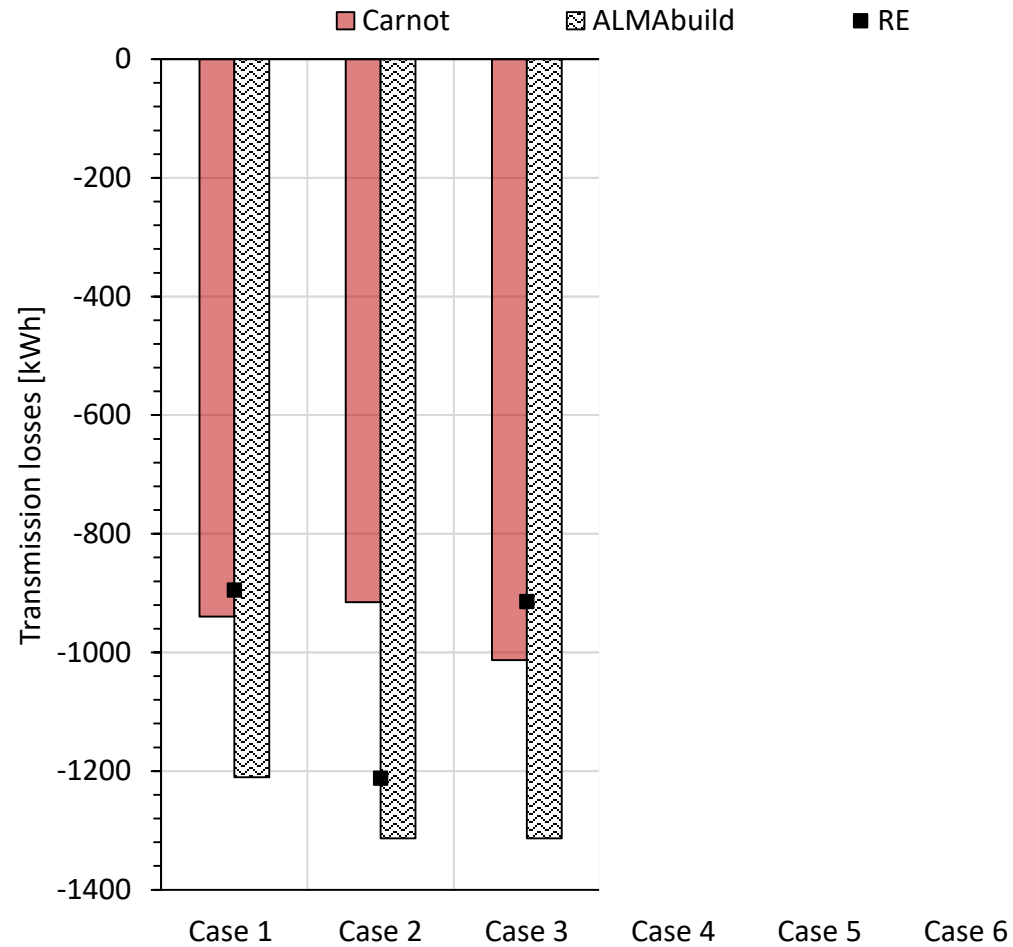
Case 5: With sun, no solar absorption,
 $R_{win,const}$ calibrated

Case 3: With sun and solar absorption

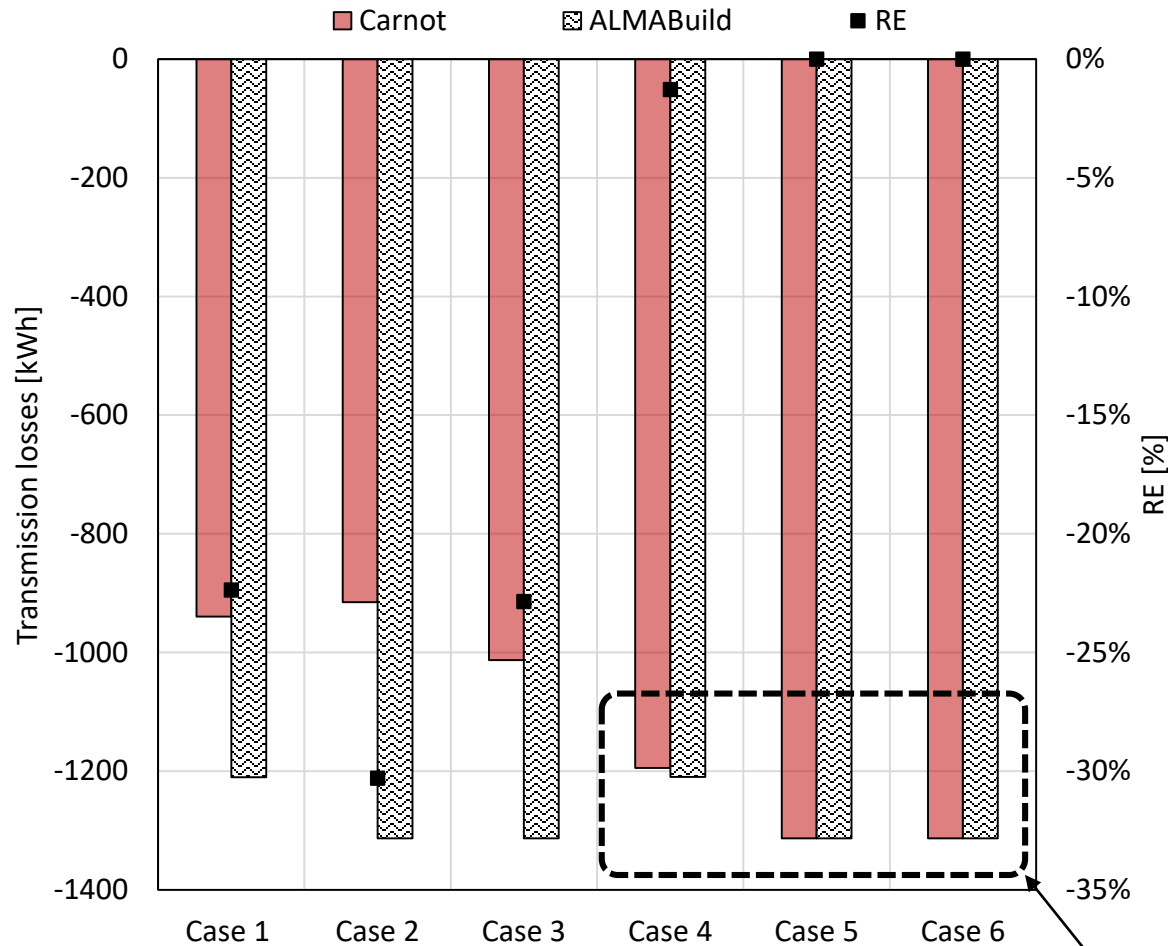
In case 6 a slightly modified model of carnot has been used where different LuT for absorption and transmission were applied.



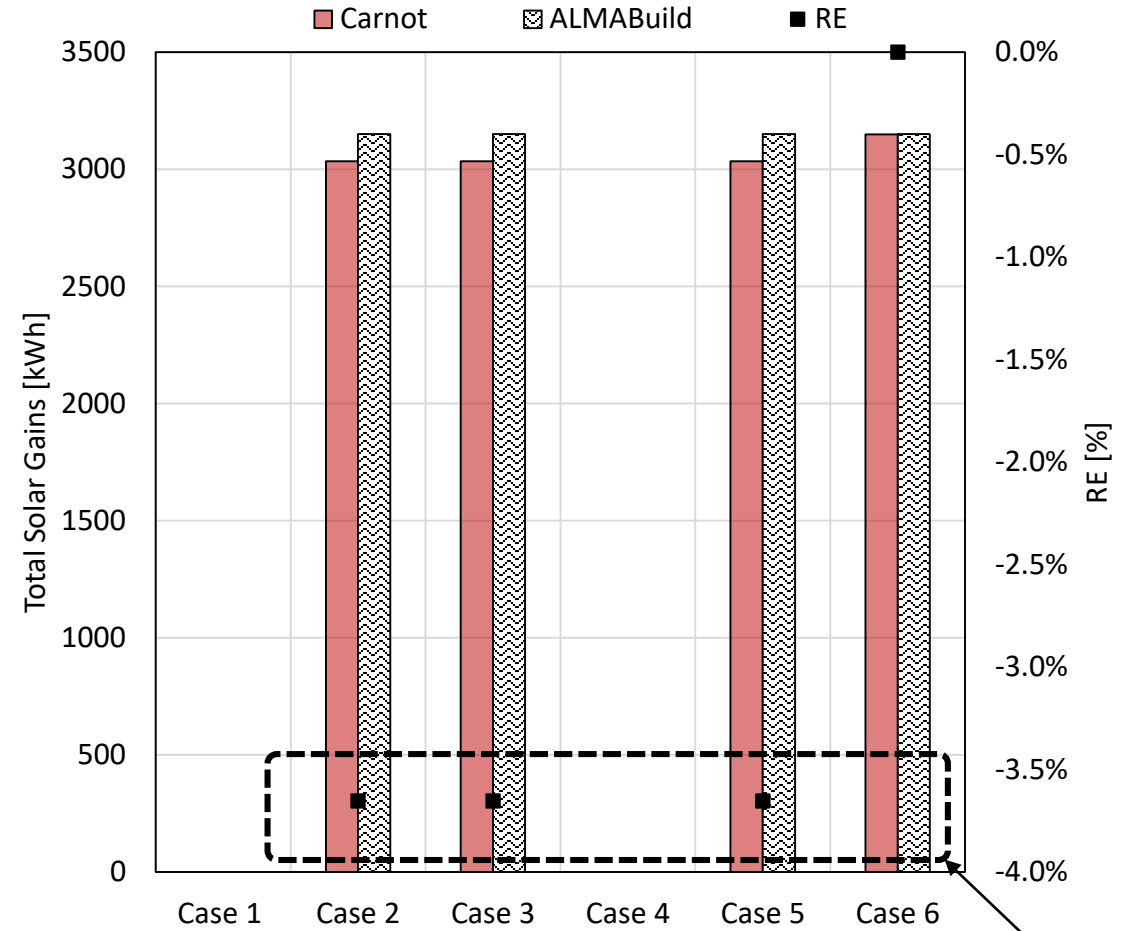
Results - Annual



Results - Annual

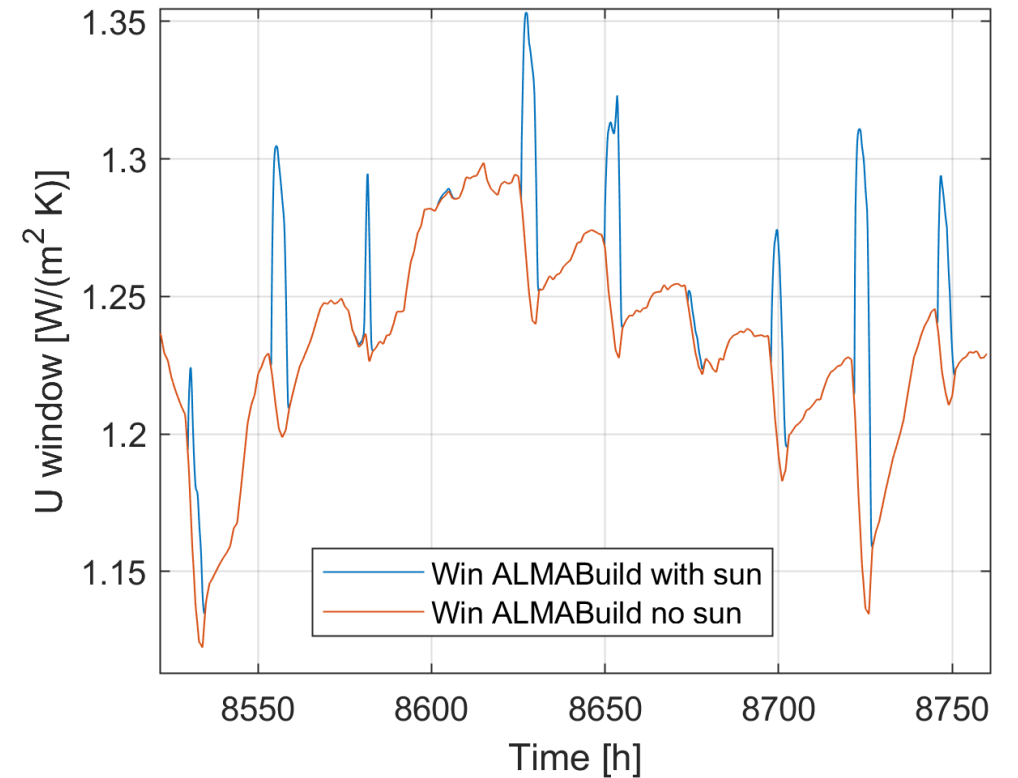
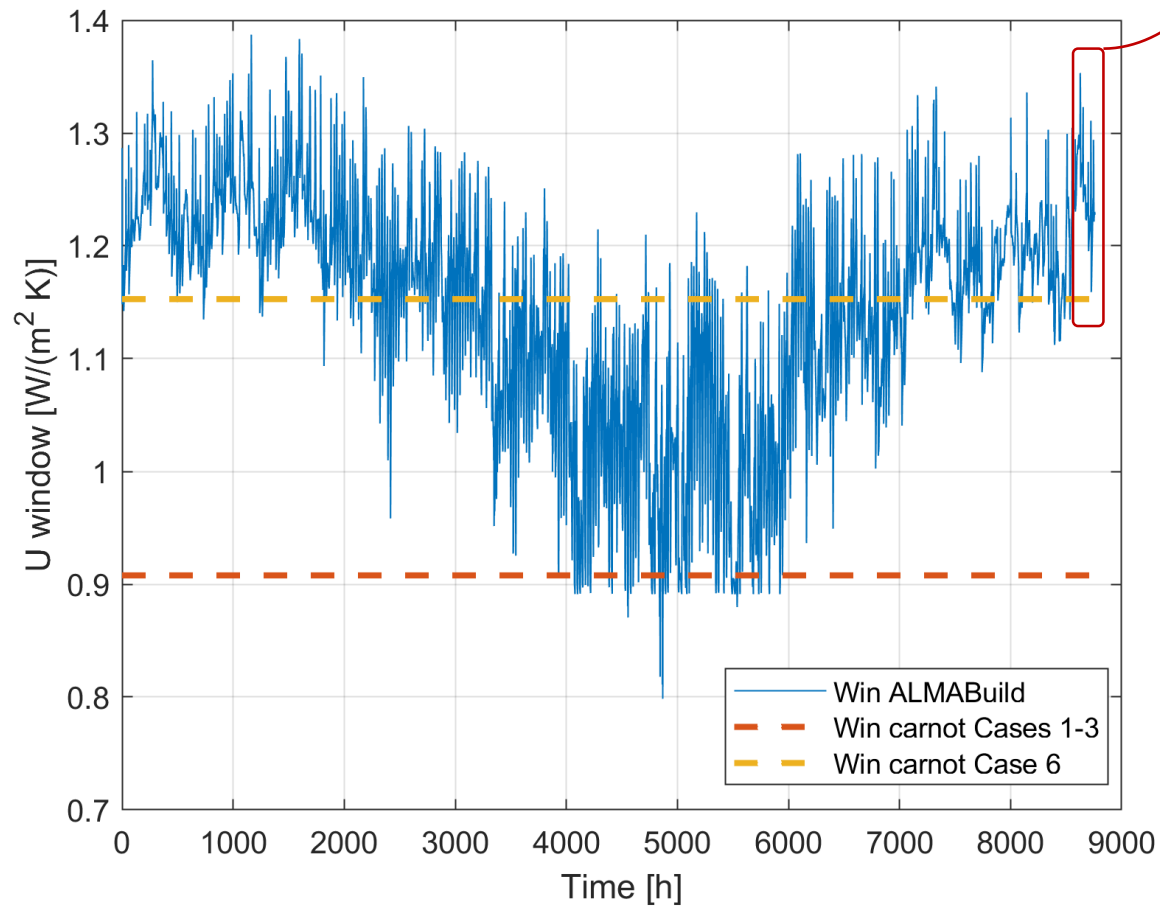


Transmission losses dependent on the solar gains!

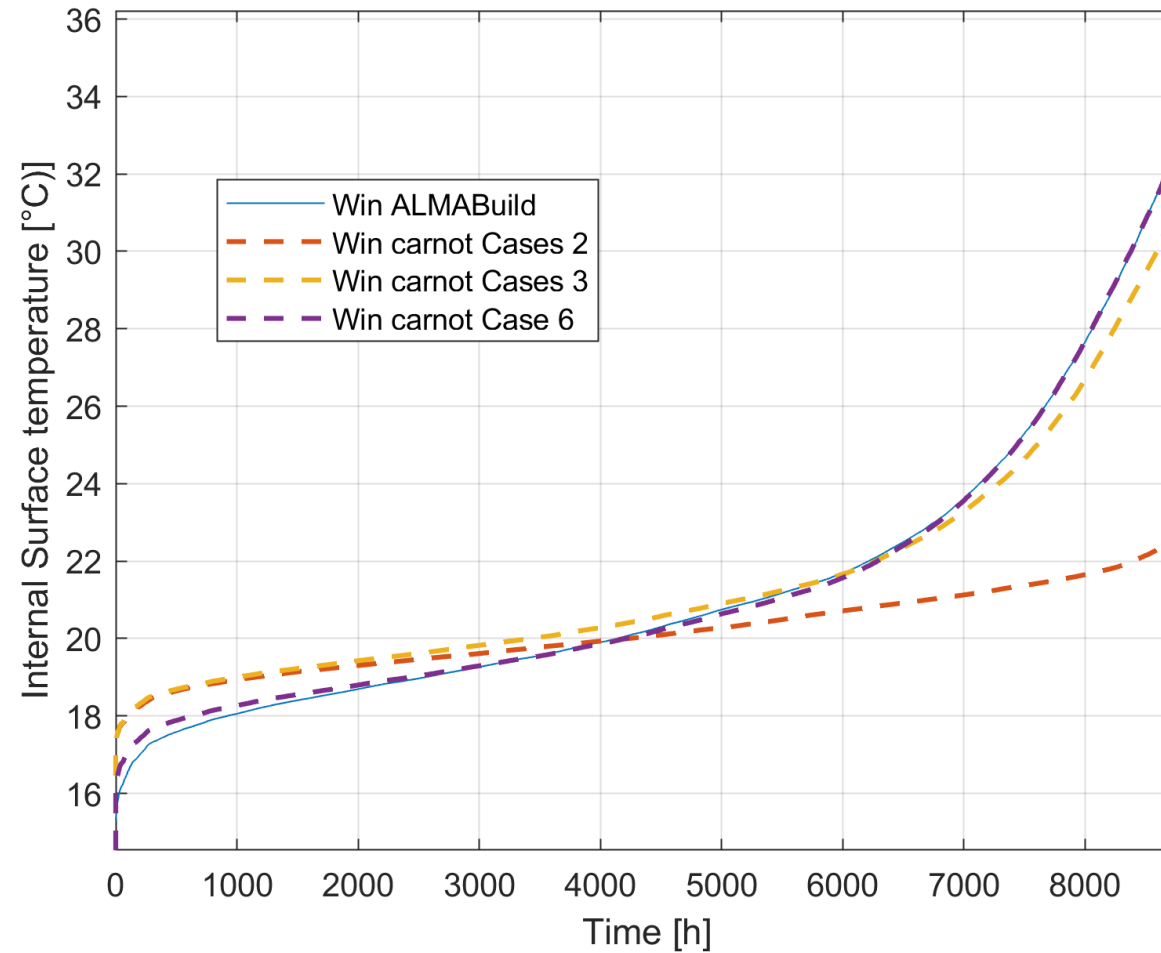


Small relative error does not mean small influence!
It must be related to the thermal balance of the zone

Results - Uvalue



Results – Internal surface temperature



Conclusions and outlook

Transmission losses

- When no detailed data are available it is difficult to use a complex window model;
 - Anyway, also using the simple window model with a “wrong” Uvalue could lead to high inaccuracy;
- The development of a pre-processing for the calculation of the correct Uvalue would be highly beneficial for the carnot window model
- Considering one lumped node for frame and glass (**thus one average surface temperature**) influences the calculation of the convective and radiative exchange

Solar gains

- Using the g-value or the transmission factor + absorption in the internal pane only marginally influence the total heat flux of the carnot window model. The internal surface temperature will be of course different.
- When optical angular data are available the carnot model would be improved by using two lookup tables for the correction factors for the absorption and transmission coefficients.



Thank you for your attention!

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