

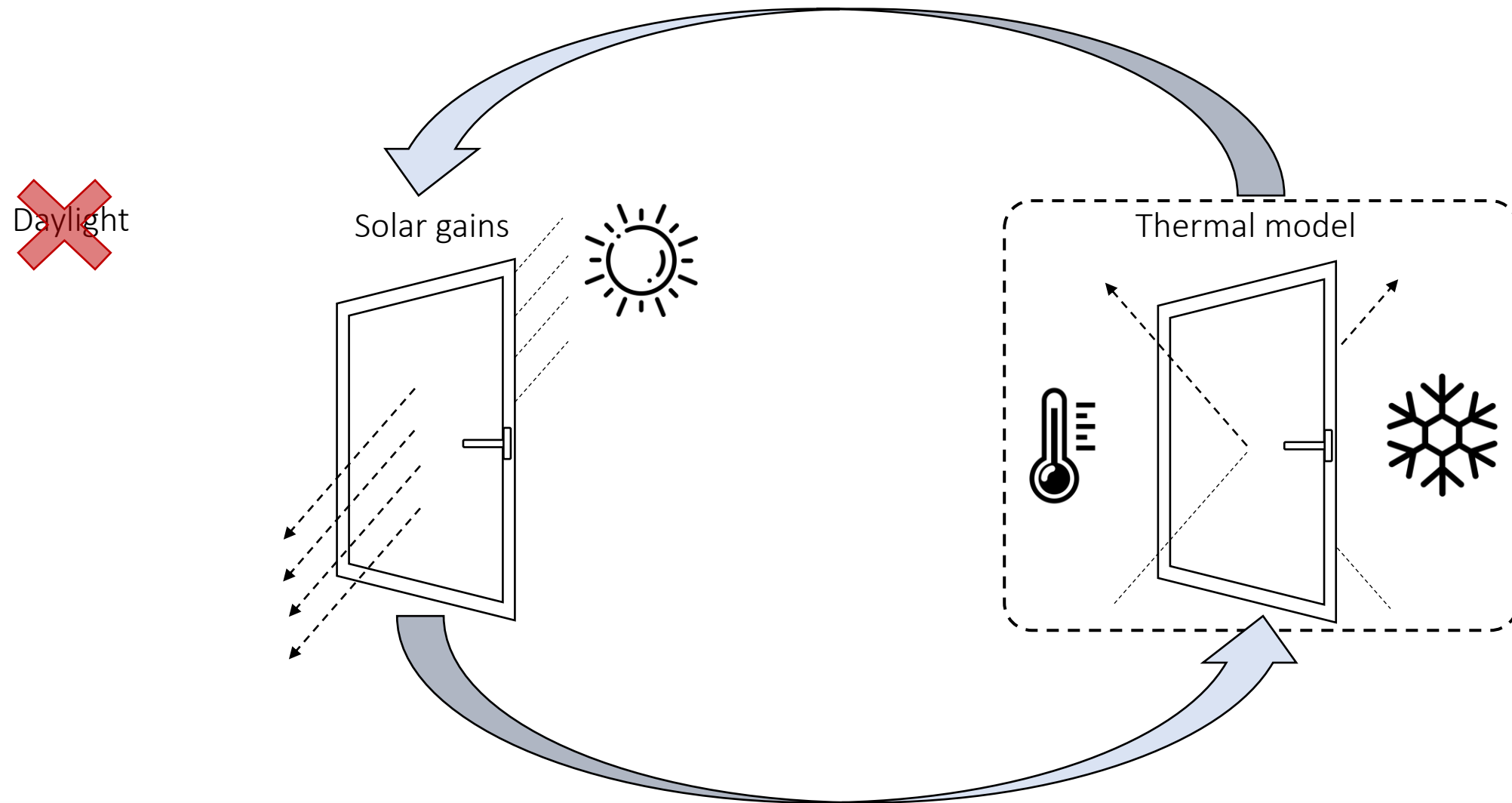


Improved Carnot Window Model Based on the WINDOW Database

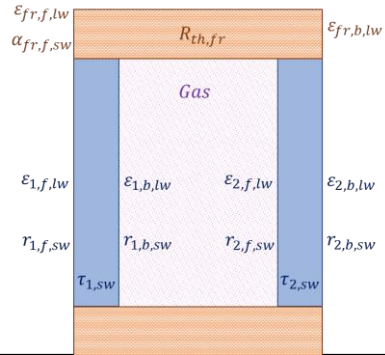
Mara MAGNI, Elisa VENTURI, Fabian OCHS - Carnot User Meeting 2023

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.**

Introduction: Window models

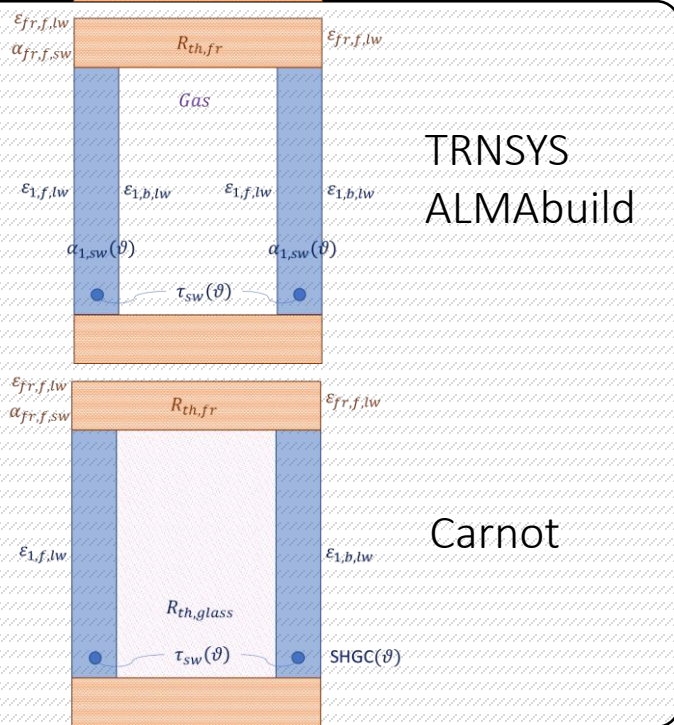


Introduction: Window models



EnergyPlus,
Modelica,
IDA ICE

Increasing level of
detail and of required
inputs



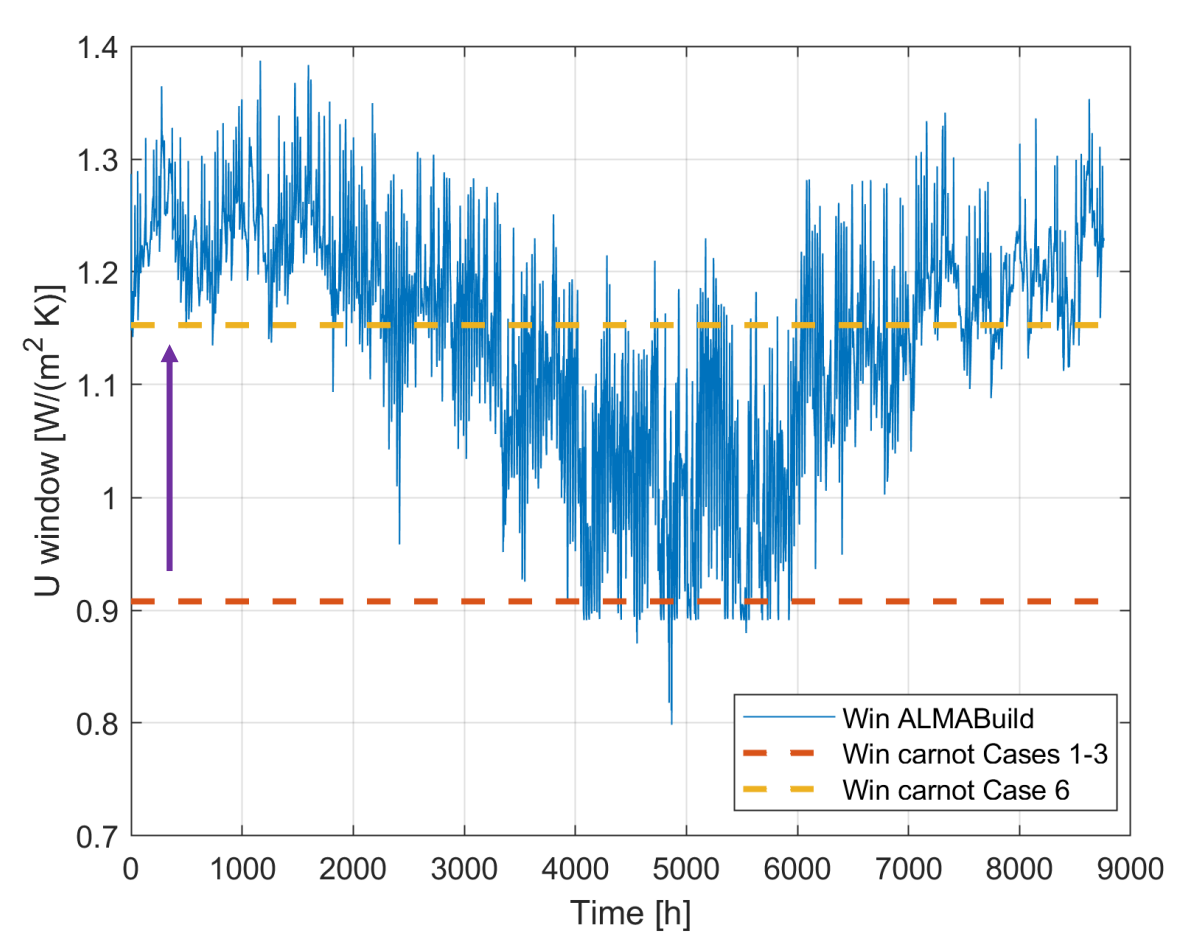
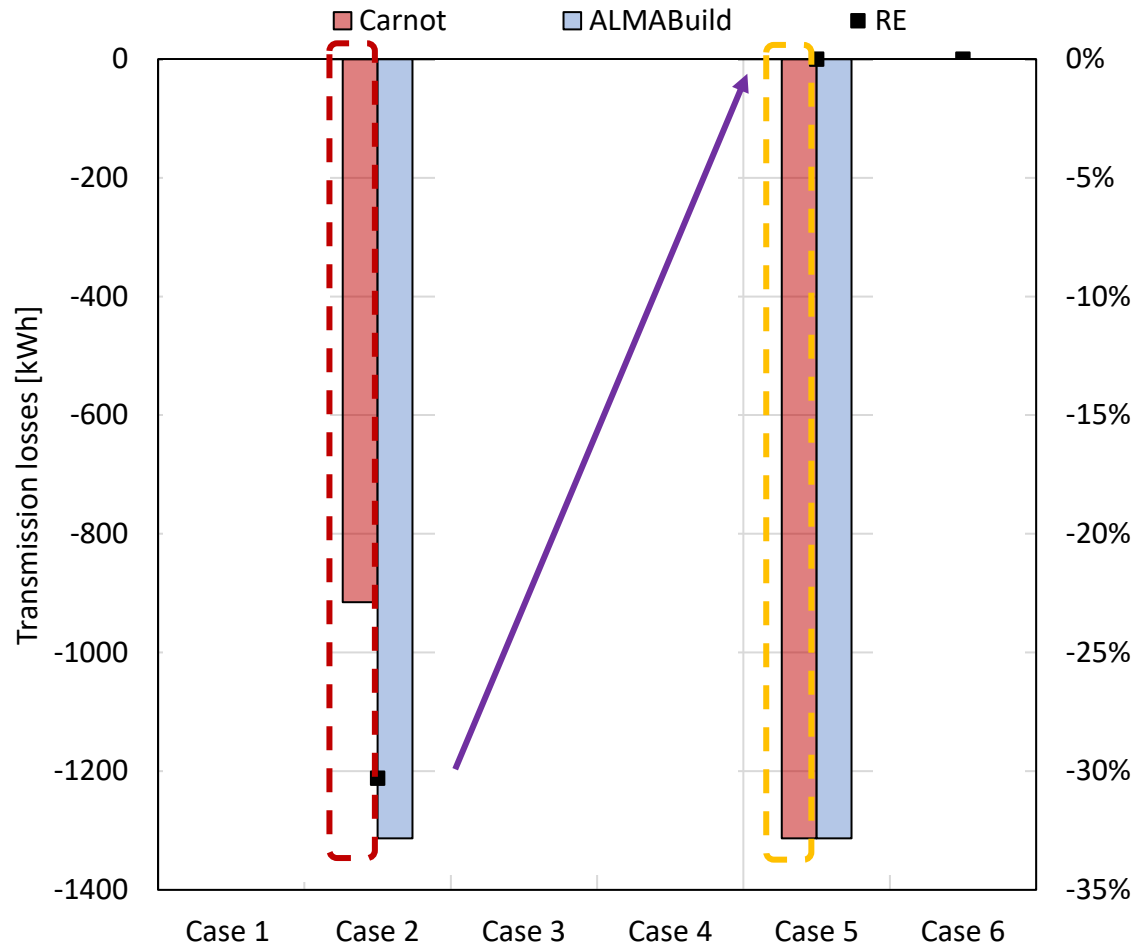
TRNSYS
ALMABuild

Carnot

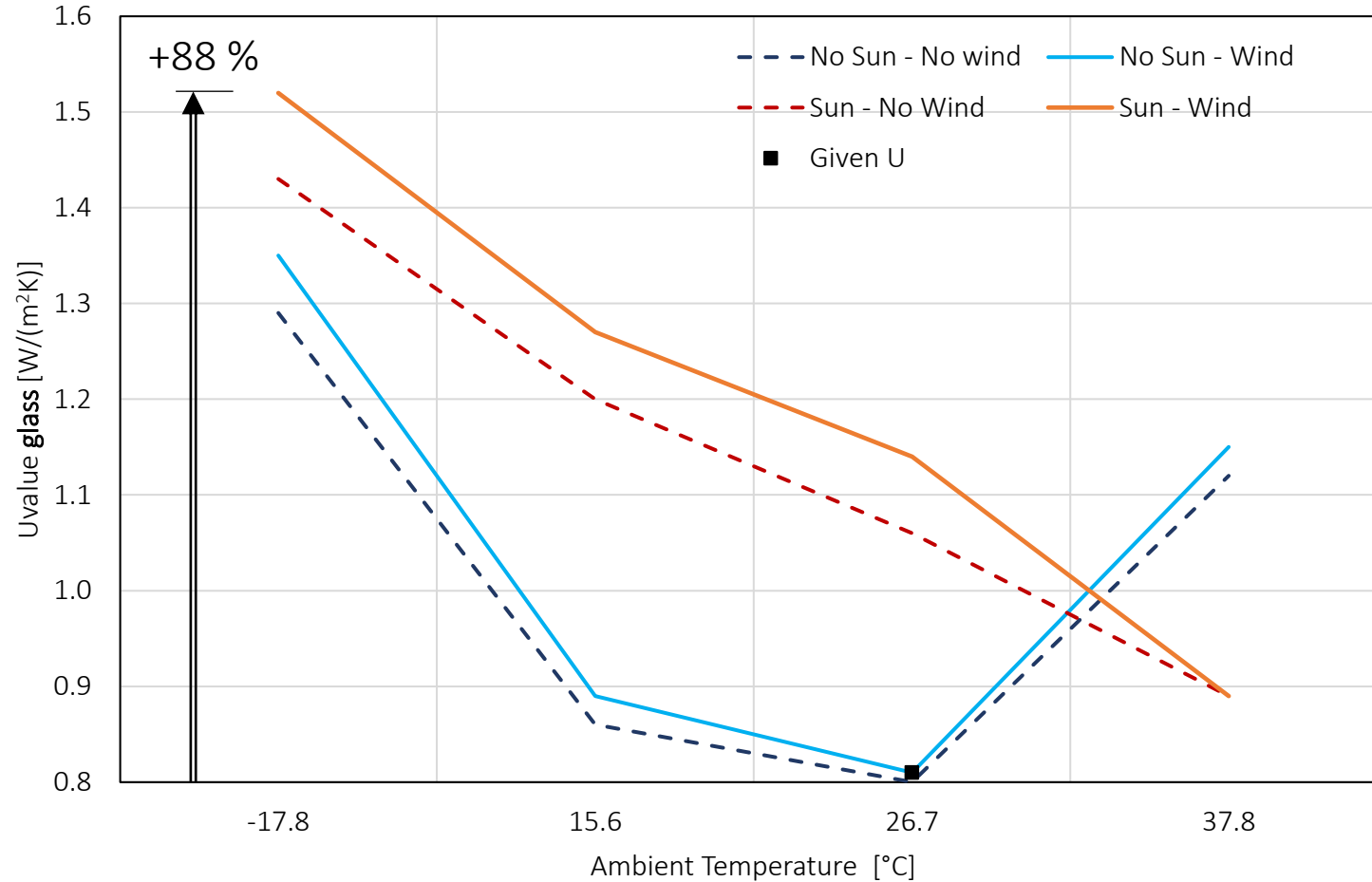
If detailed input are
available it is possible
to derive from these
the lumped inputs
needed in the more
simplified models

Derive detailed inputs
from simplified it is
"not" possible

Results (Carnot User Meeting 2022) - Annual



Introduction: Window U value



Method:



1. Window Library from TRNSYS (W74-lib.dat, W4-lib.dat)

	Internal	External
Emis Front (Internal)	0.84	0.06
Emis Back (External)	0.84	0.84

	Temperature [°C]		
	-17.8	15.6	26.7
			37.8

Solar (W/m2)	WdSpd (m/s)	Uvalue [W/m2/K]			
0	0	1.29	0.86	0.8	1.12
0	6.71	1.35	0.89	0.81	1.15
783	0	1.43	1.2	1.06	0.89
783	6.71	1.52	1.27	1.14	0.89

	Gap	Thick	Cond	dCond	Vis	dVis	Dens	dDens	Pr	dPr	
Krypton	16.0	0.00860	2.800	2.280	7.500	3.740	-0.0137	0.660	0.00002		
Angle	0	10	20	30	40	50	60	70	80	90	Hemis
Tsol	0.462	0.465	0.458	0.448	0.436	0.412	0.360	0.263	0.121	0.000	0.384
Abs1	0.114	0.114	0.116	0.120	0.125	0.132	0.139	0.139	0.139	0.000	0.128
Abs2	0.186	0.188	0.195	0.199	0.198	0.197	0.199	0.186	0.118	0.000	0.189
Rfsol	0.237	0.232	0.231	0.233	0.241	0.260	0.303	0.406	0.614	1.000	0.289
Rbsol	0.179	0.172	0.170	0.173	0.183	0.202	0.239	0.328	0.542	0.999	0.227
Tvis	0.749	0.754	0.743	0.730	0.711	0.674	0.589	0.428	0.200	0.000	0.626
Rfvis	0.121	0.115	0.114	0.118	0.132	0.163	0.228	0.376	0.649	1.000	0.203
Rbvis	0.109	0.102	0.099	0.102	0.115	0.140	0.188	0.296	0.529	0.999	0.170
SHGC	0.632	0.636	0.635	0.629	0.616	0.592	0.542	0.434	0.232	0.000	0.557

➔ 54 Double pane windows

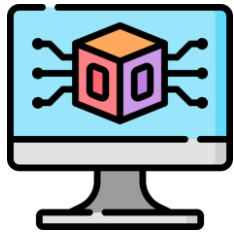
Method:



1. Window Library from TRNSYS (W74-lib.dat, W4-lib.dat)



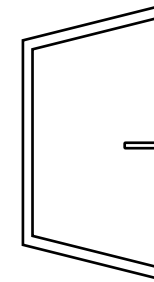
2. Analyse the data of the library (for double pane windows) to derive a correction factor of the U value (assuming to know the SHGC and the position of the low emissivity layer)



3. Simulate all the analysed windows with ALMABuild, Carnot standard and Carnot modified models

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

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



TMY Stockholm



TMY Rome

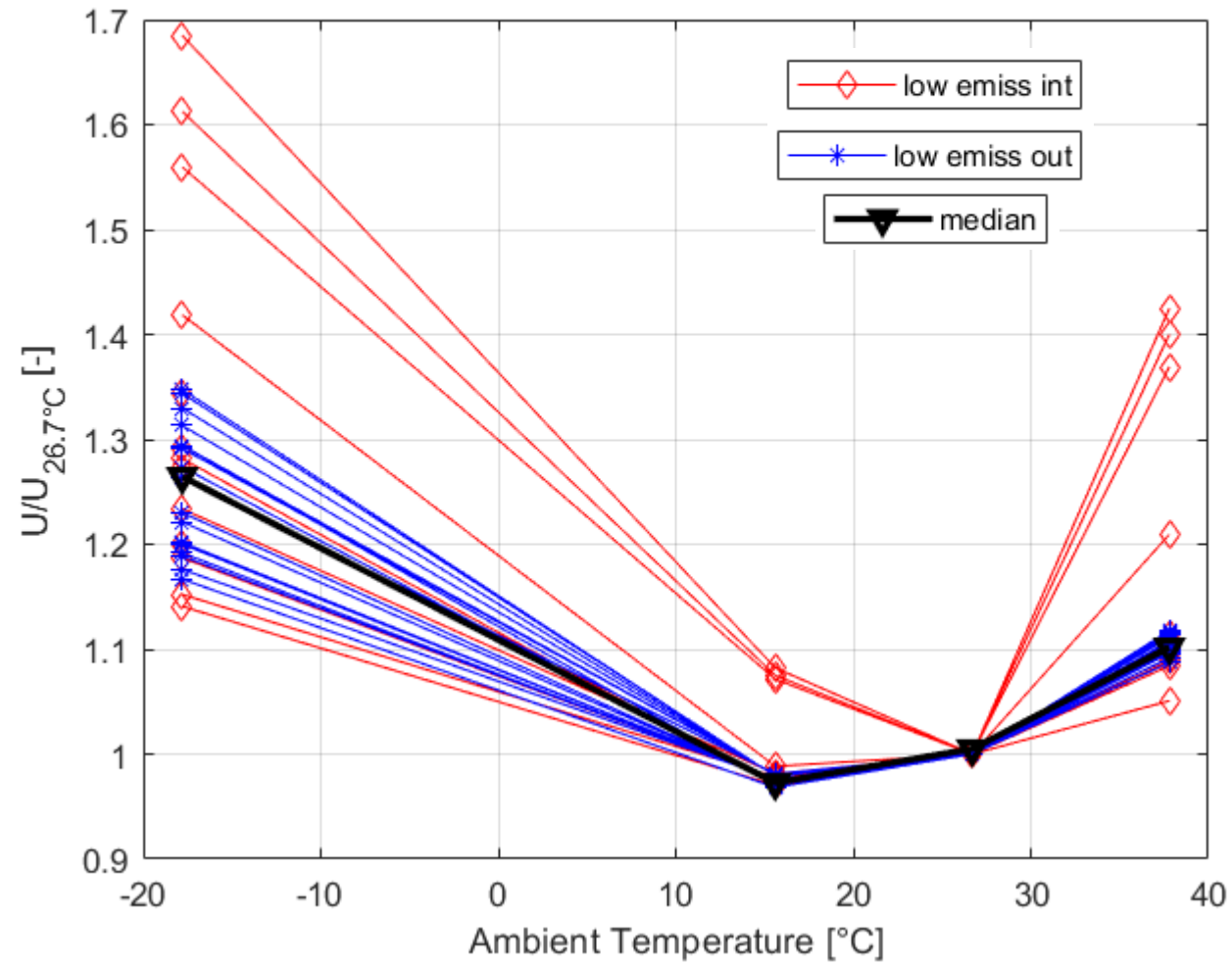
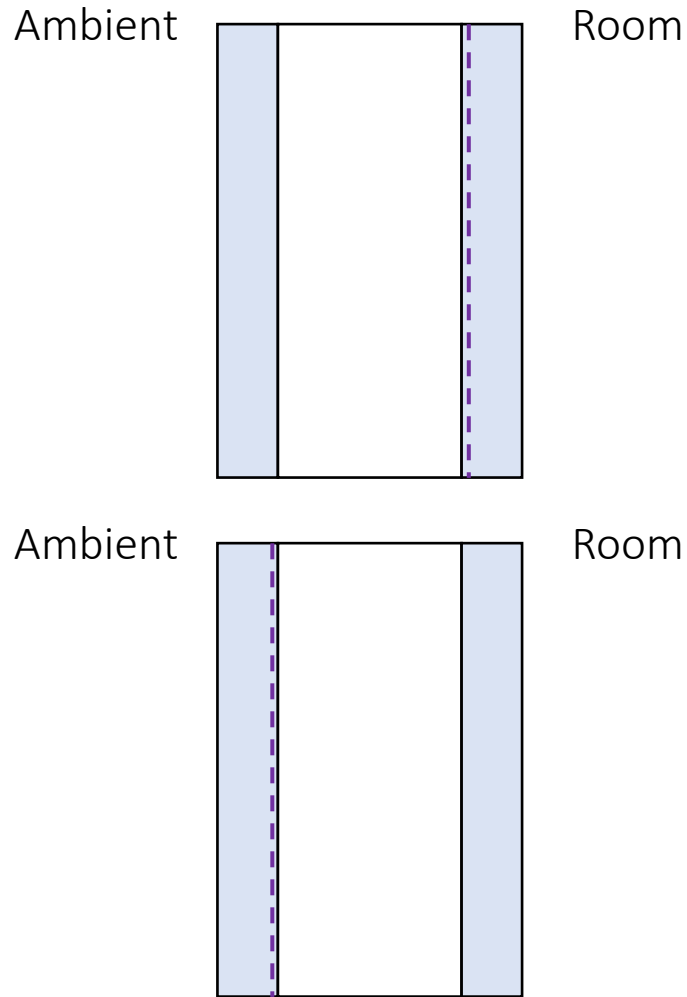


4. Compare the results and evaluate the benefit

Results: Analysis of the Window library



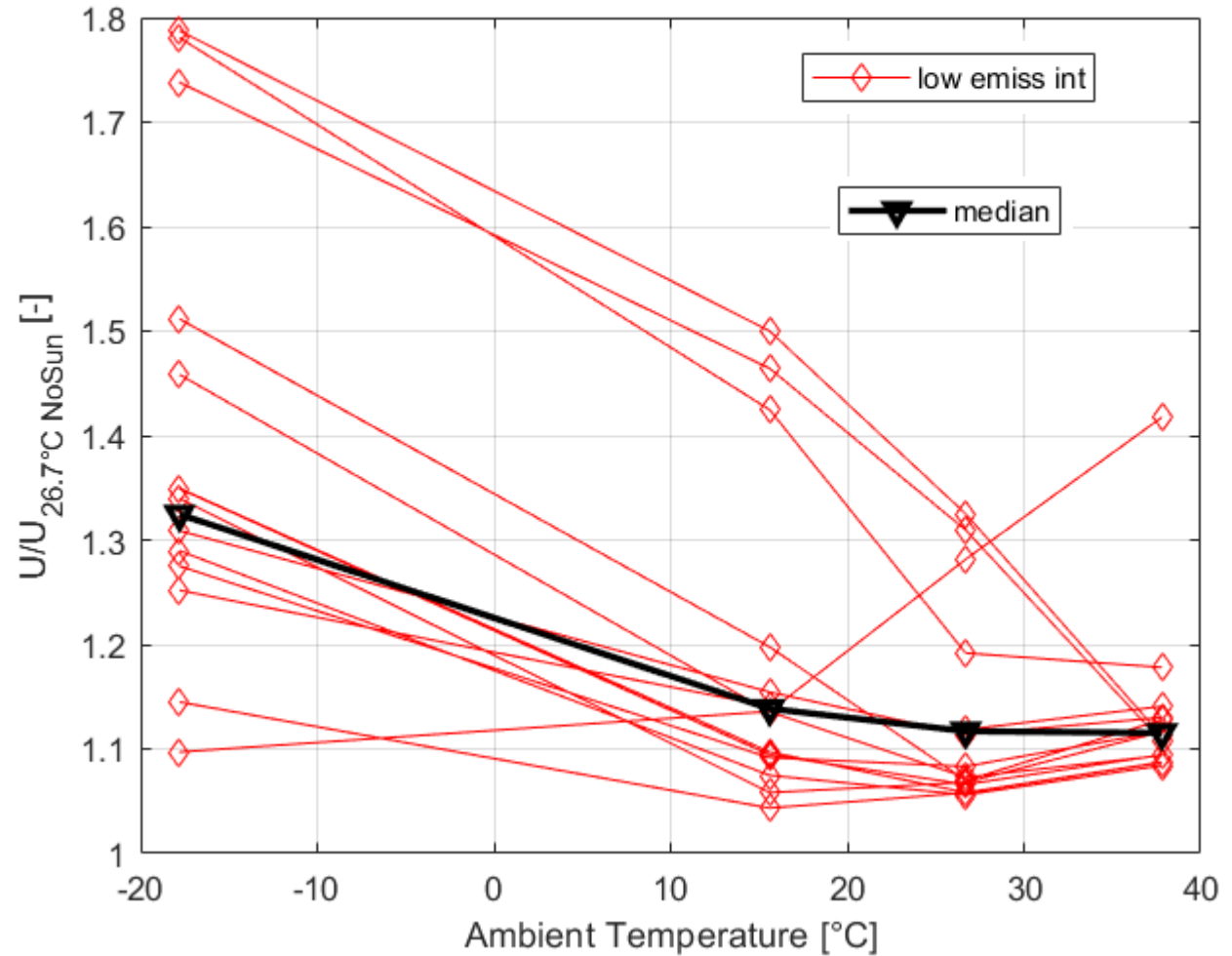
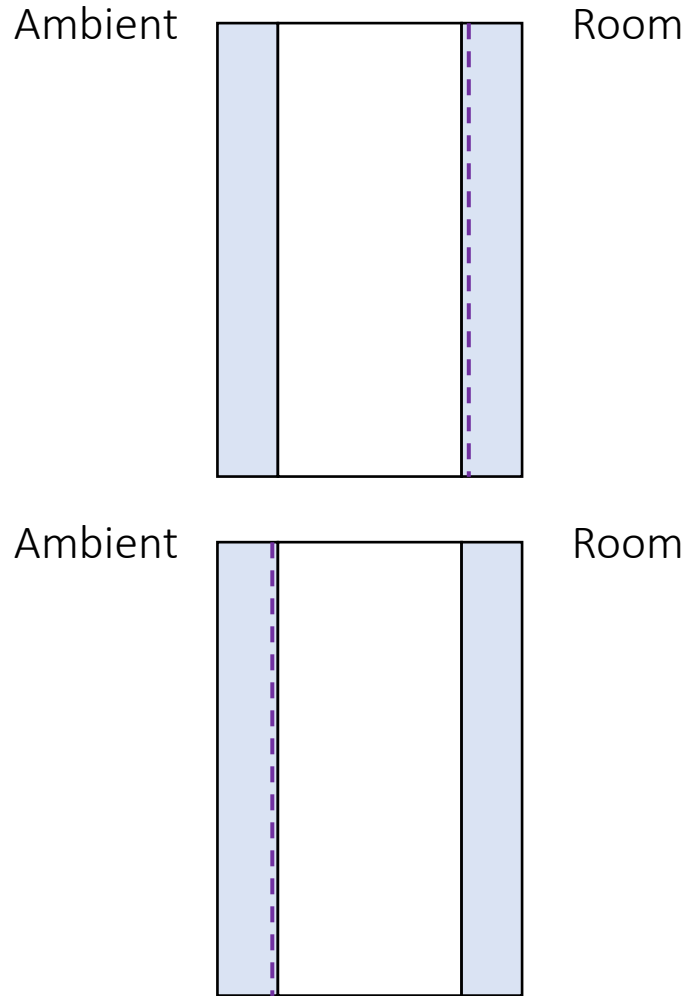
No Sun



Results: Analysis of the Window library

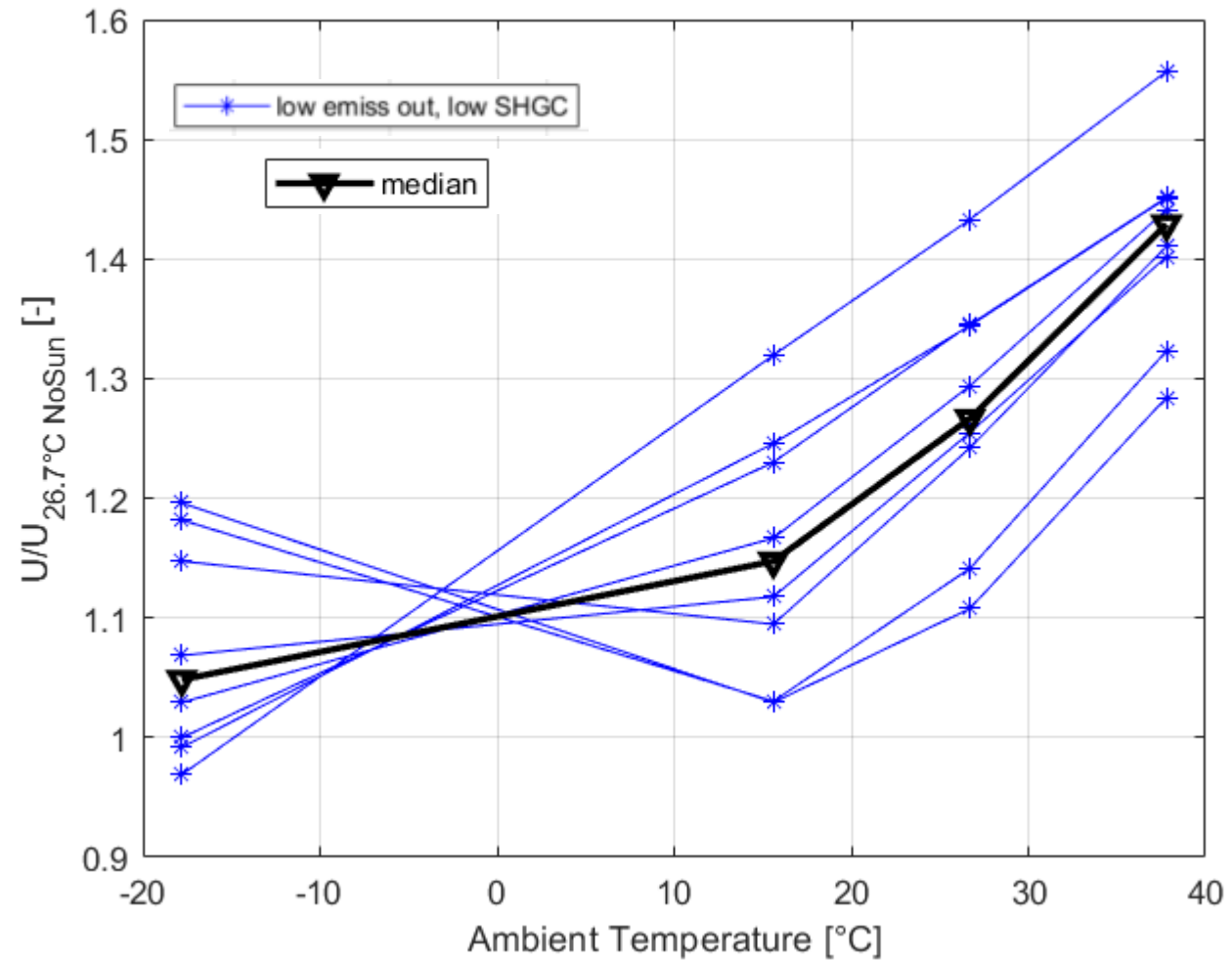
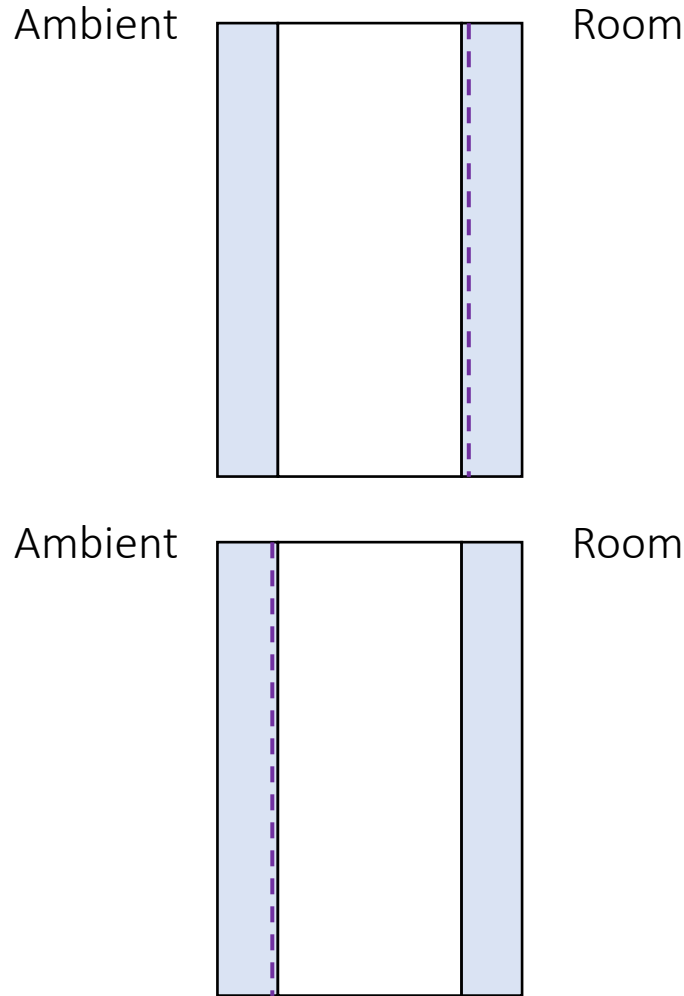


With Sun



Results: Analysis of the Window library

With Sun

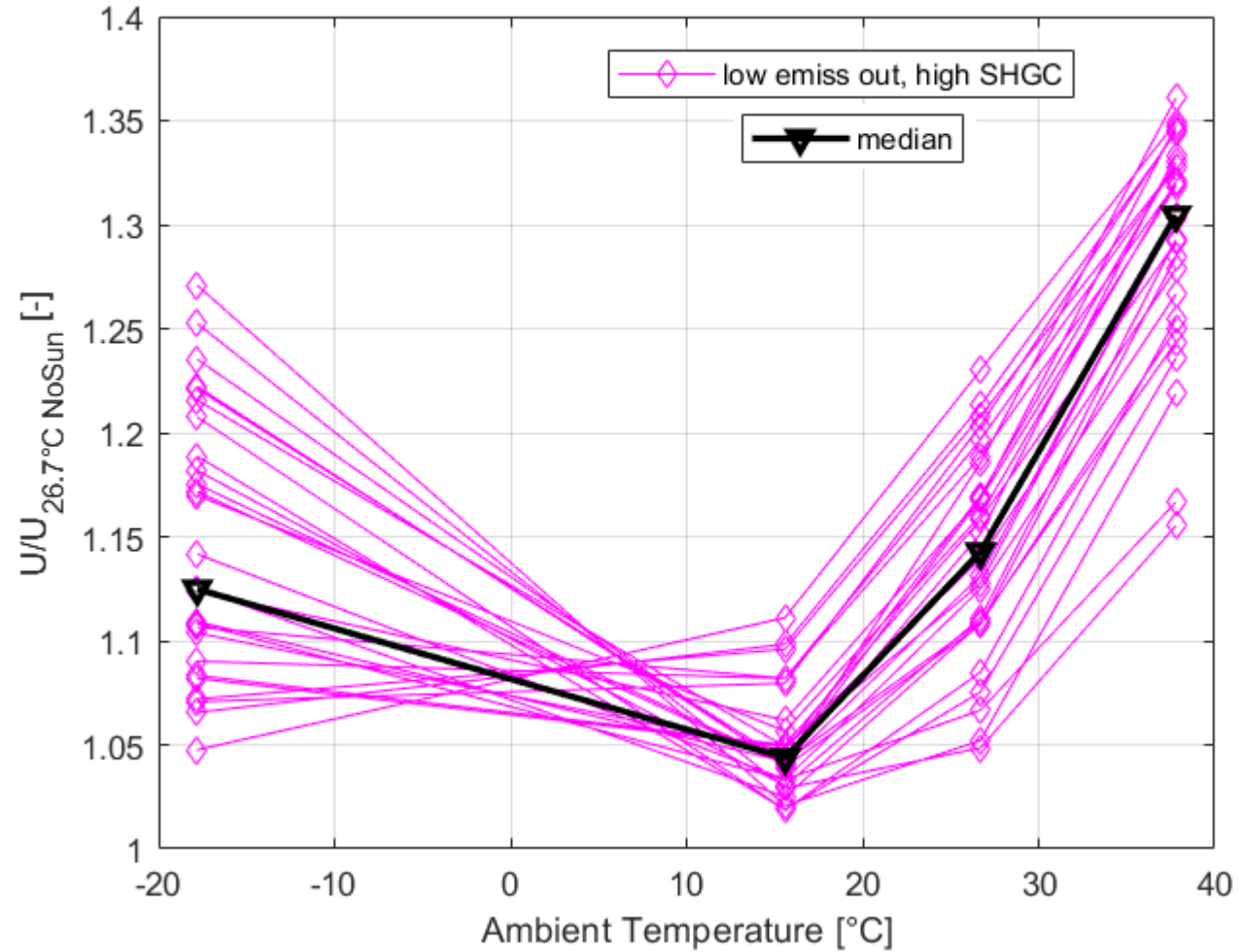
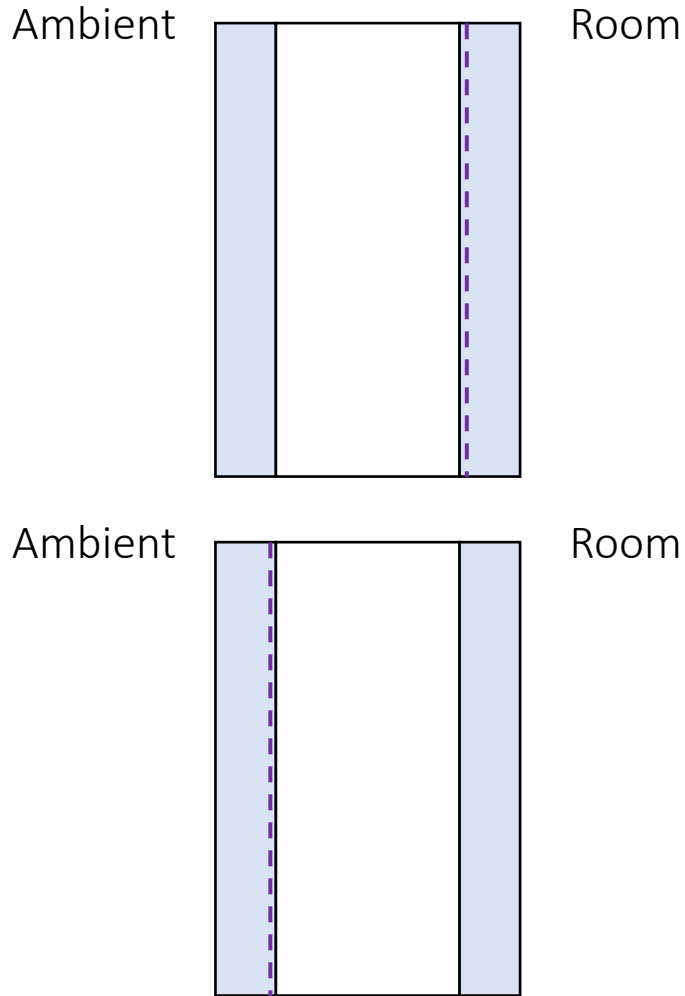


low SHGC < 0.29

Results: Analysis of the Window library

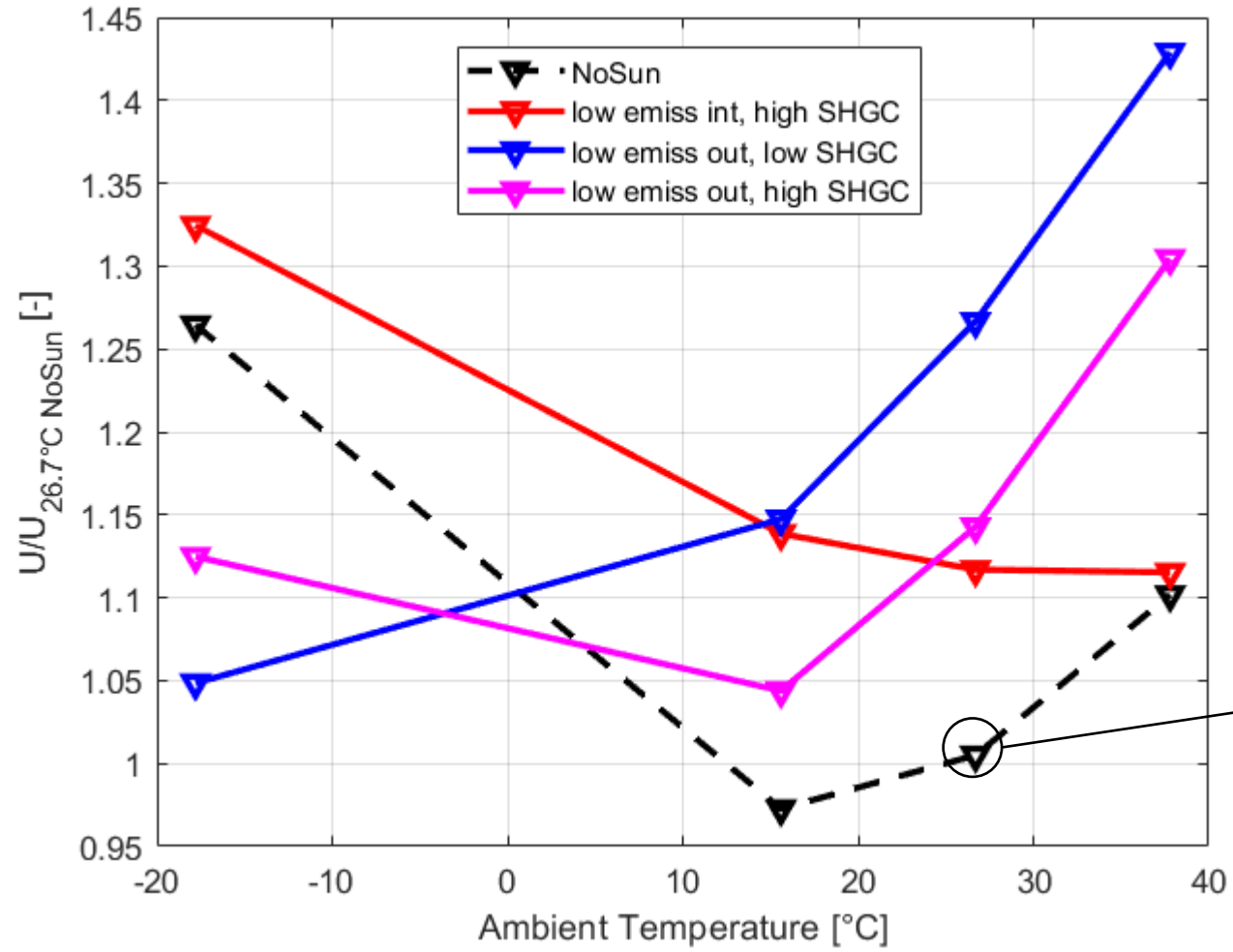
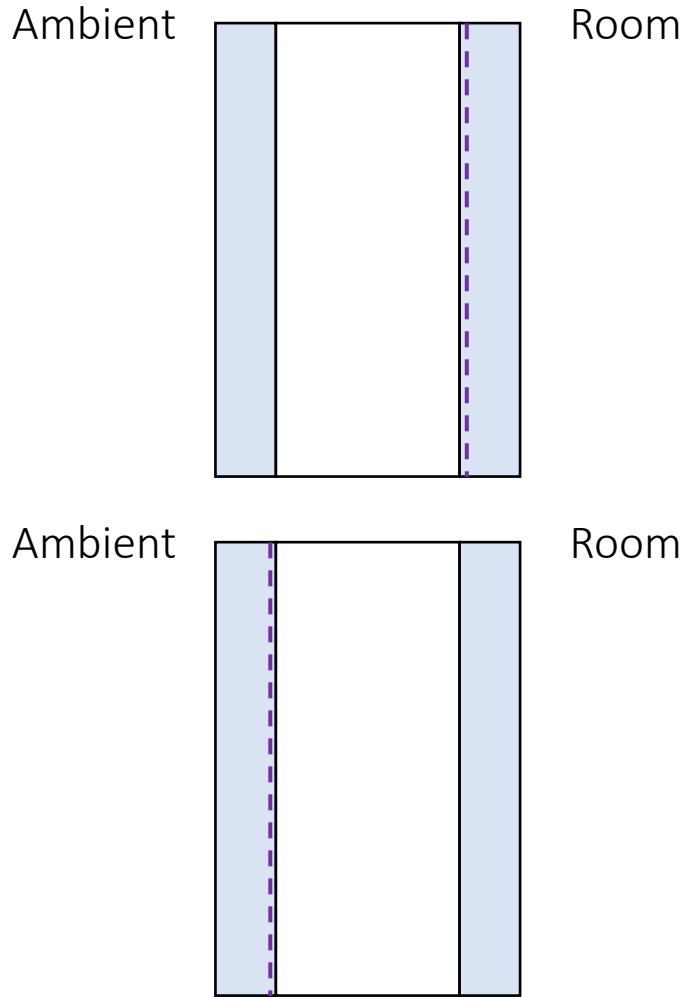


With Sun



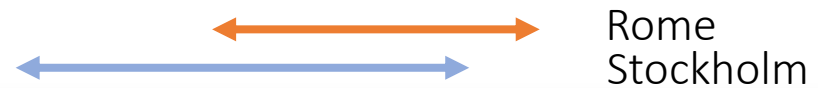
high SHGC ≥ 0.29

Results: U value correction factors



low SHGC < 0.29
high SHGC ≥ 0.29

U = 0.73-1.38
[W/(m²K)]

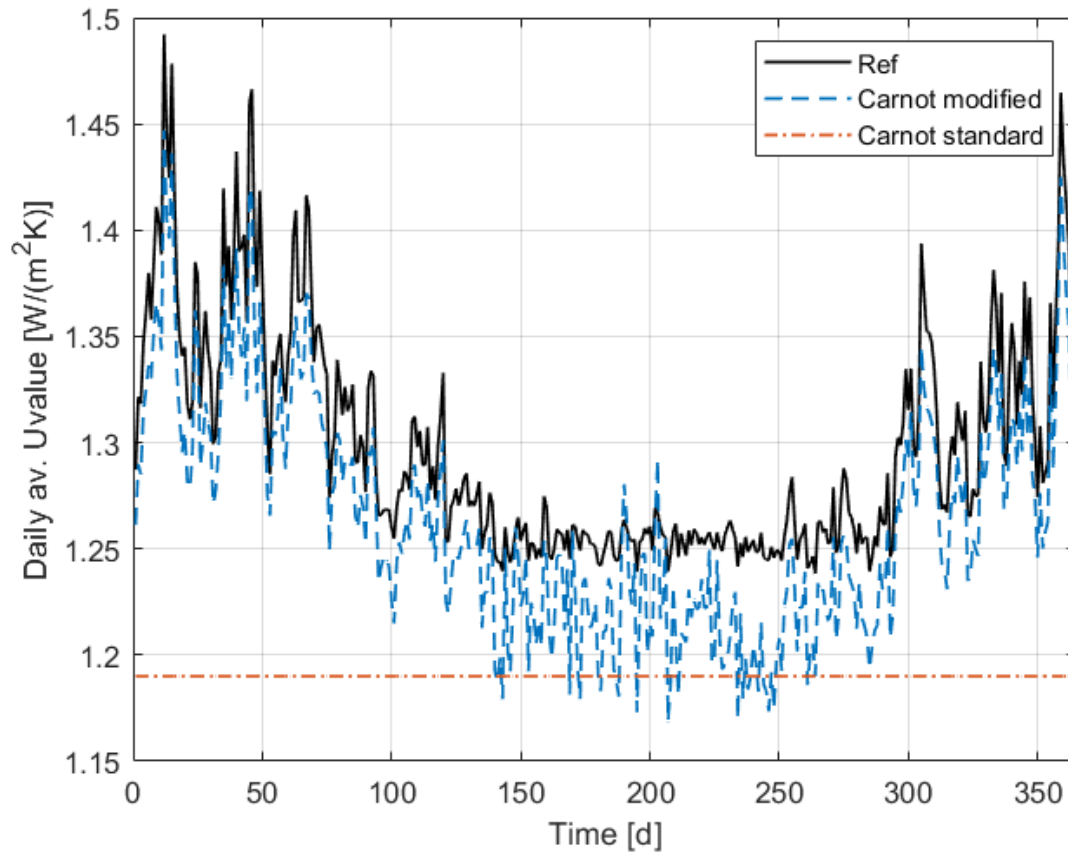


Results: U value

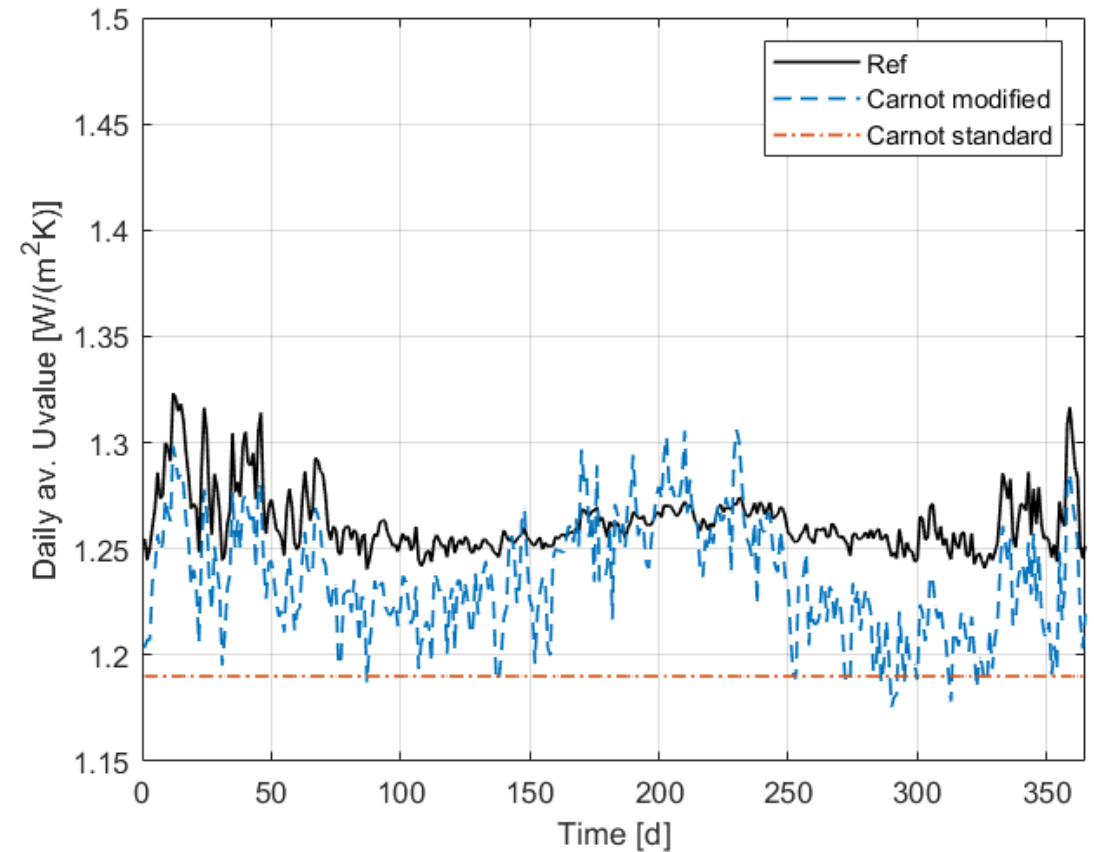
Window Type: Low emiss out and high SHGC



Stockholm



Rome

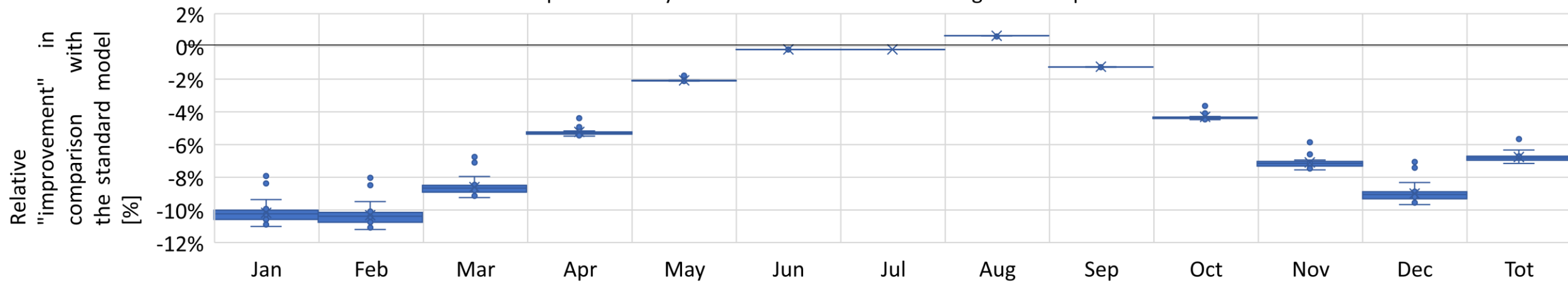
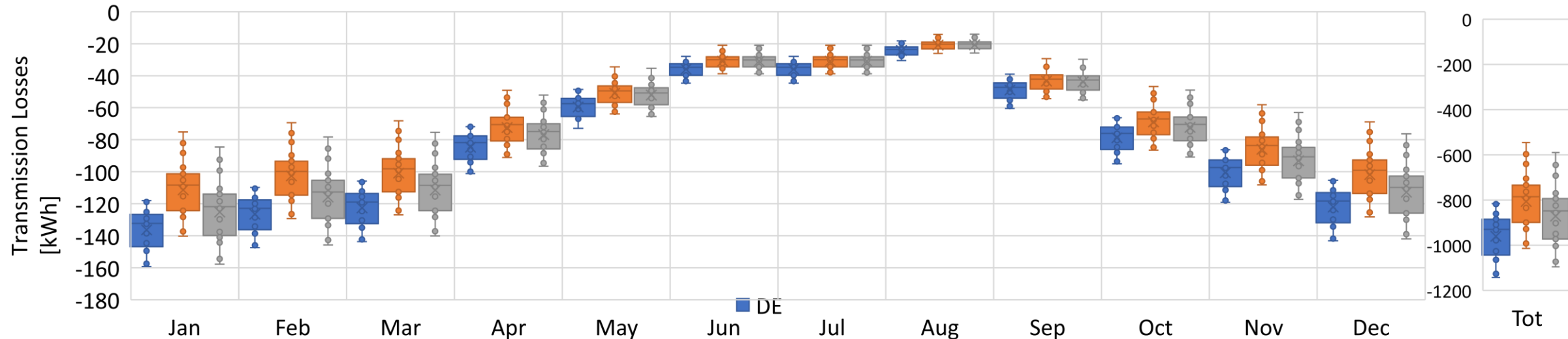




Results: Transmission Losses

Stockholm - No solar Irradiation

Ref Carnot standard Carnot modified

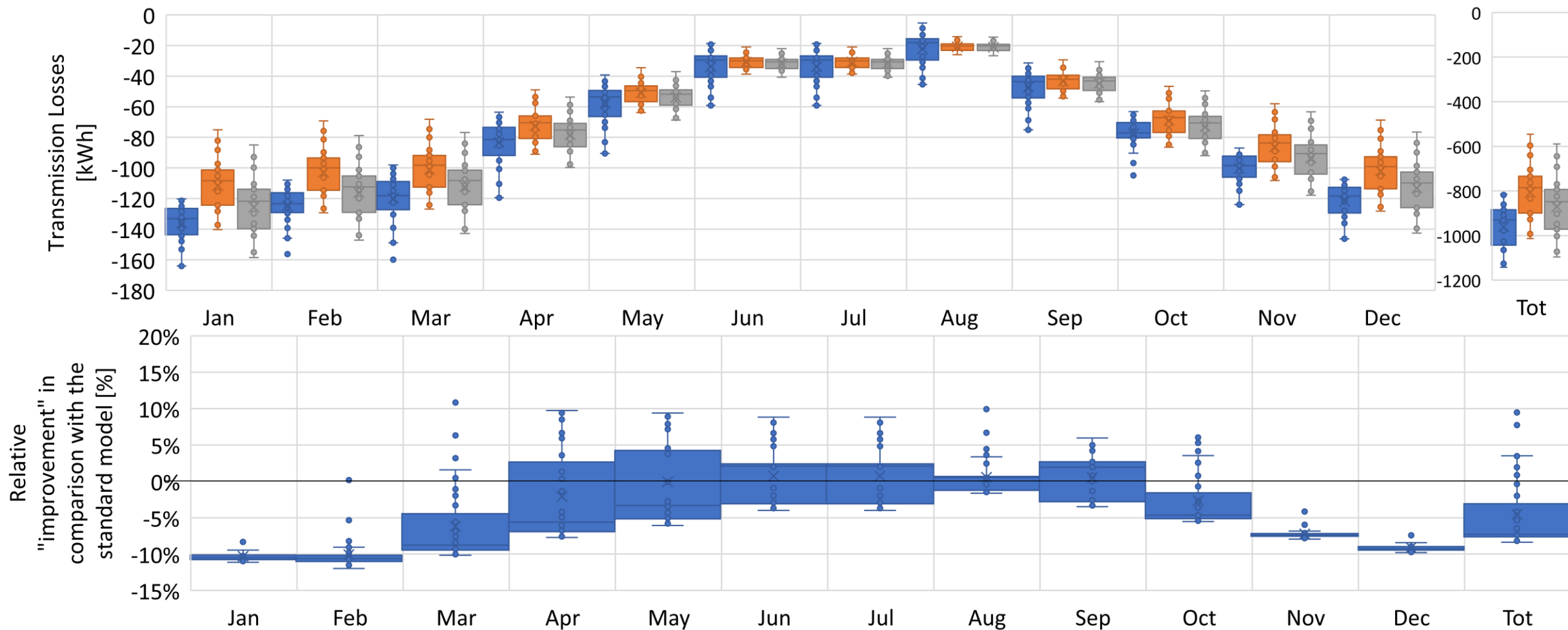




Results: Transmission Losses

Stockholm – With Solar Irradiation

■ Ref ■ Carnot standard ■ Carnot modified

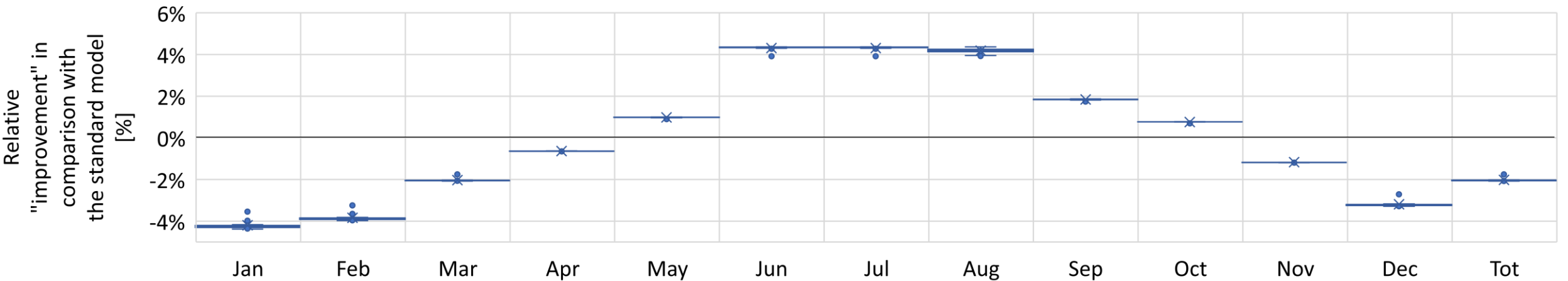
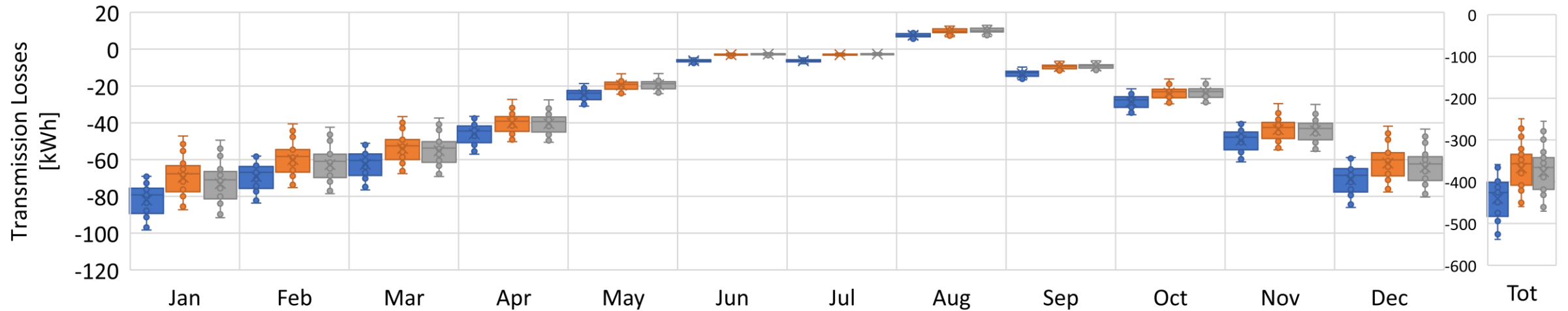




Results: Transmission Losses

Rome - No solar Irradiation

■ Ref ■ Carnot standard ■ Carnot modified

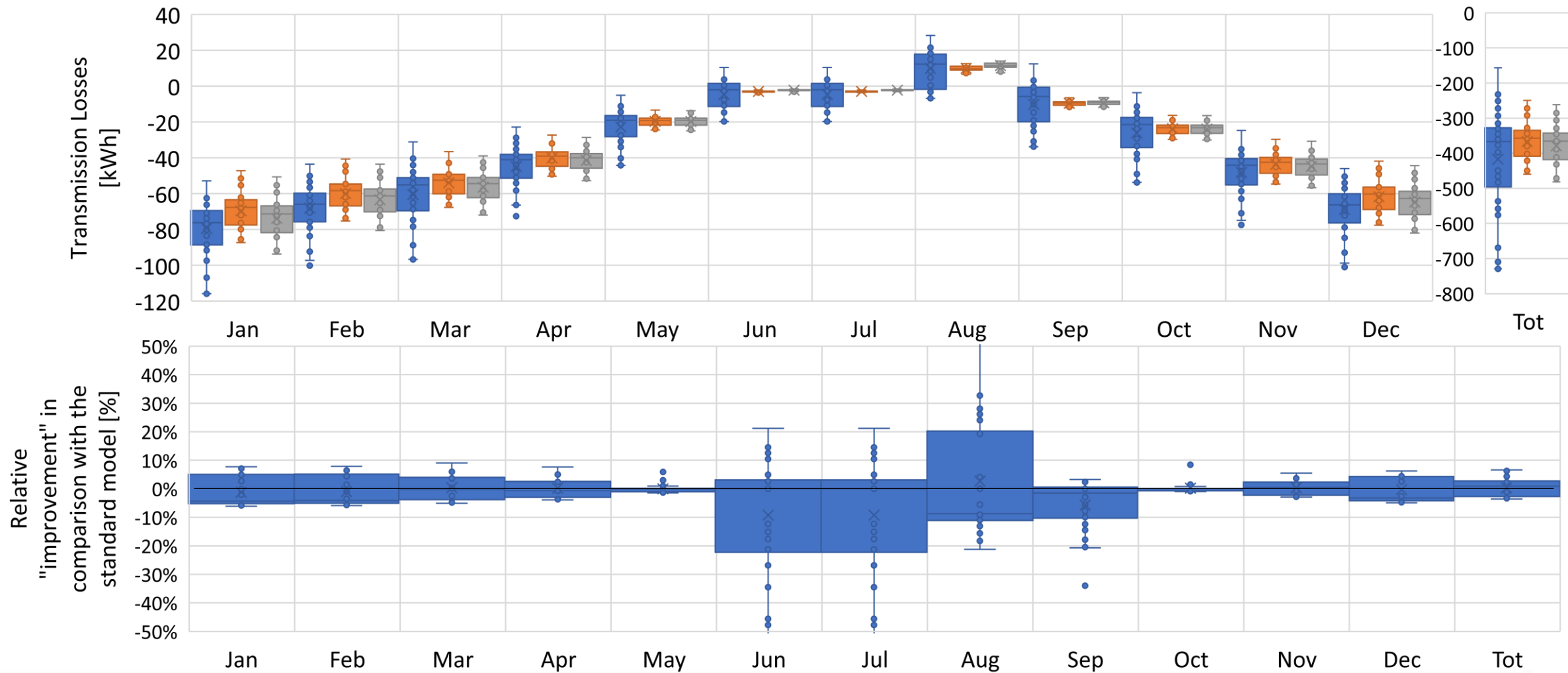




Results: Transmission Losses

Rome – With Solar Irradiation

■ Ref ■ Carnot standard ■ Carnot modified





Conclusions and Outlook

- The proposed method allow to improve the calculation of the transmission losses in winter and for cold climate
- Further work is required to improve the results during the summer period and/or in warm climate
- This method can be extended to improve also the calculation of the solar gains with the simplified window model

Thank you for your attention!

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Acknowledgment

RENplusHOMES

Renewable ENergy-based Positive Homes