CARNOT USER TAG

Überblick der Aktivitäten an der UIBK

FHNW, Muttenz, 16.01.2013

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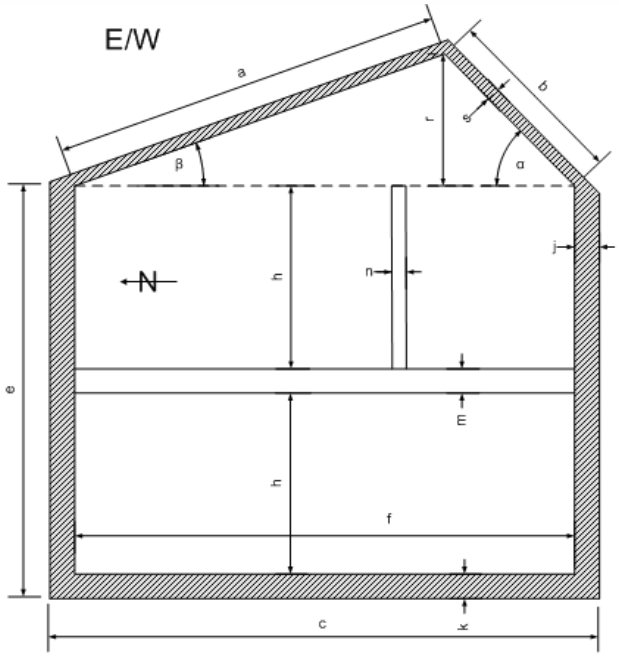
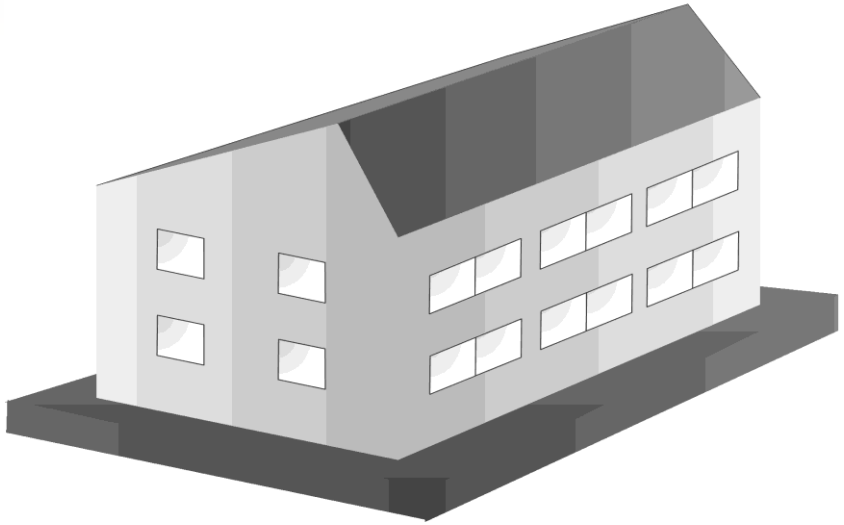
Aktivitäten

- Gebäudemodel(le)
  - (TABS vs. Radiator)
  - (Klima)-;)
- Erdreich-Wärmeübertrager
  - horizontal
  - vertikal
- Wärmepumpen-Berechnungsmodell („cross-validiert“ mit CARNOT)
- Hygrothermische Wand
- PV vs. ST für MFH
- Vergleich SolarAktivhaus und Passivhaus (TRNSYS + CARNOT)

Referenzgebäude IEA T44 (SFH15)



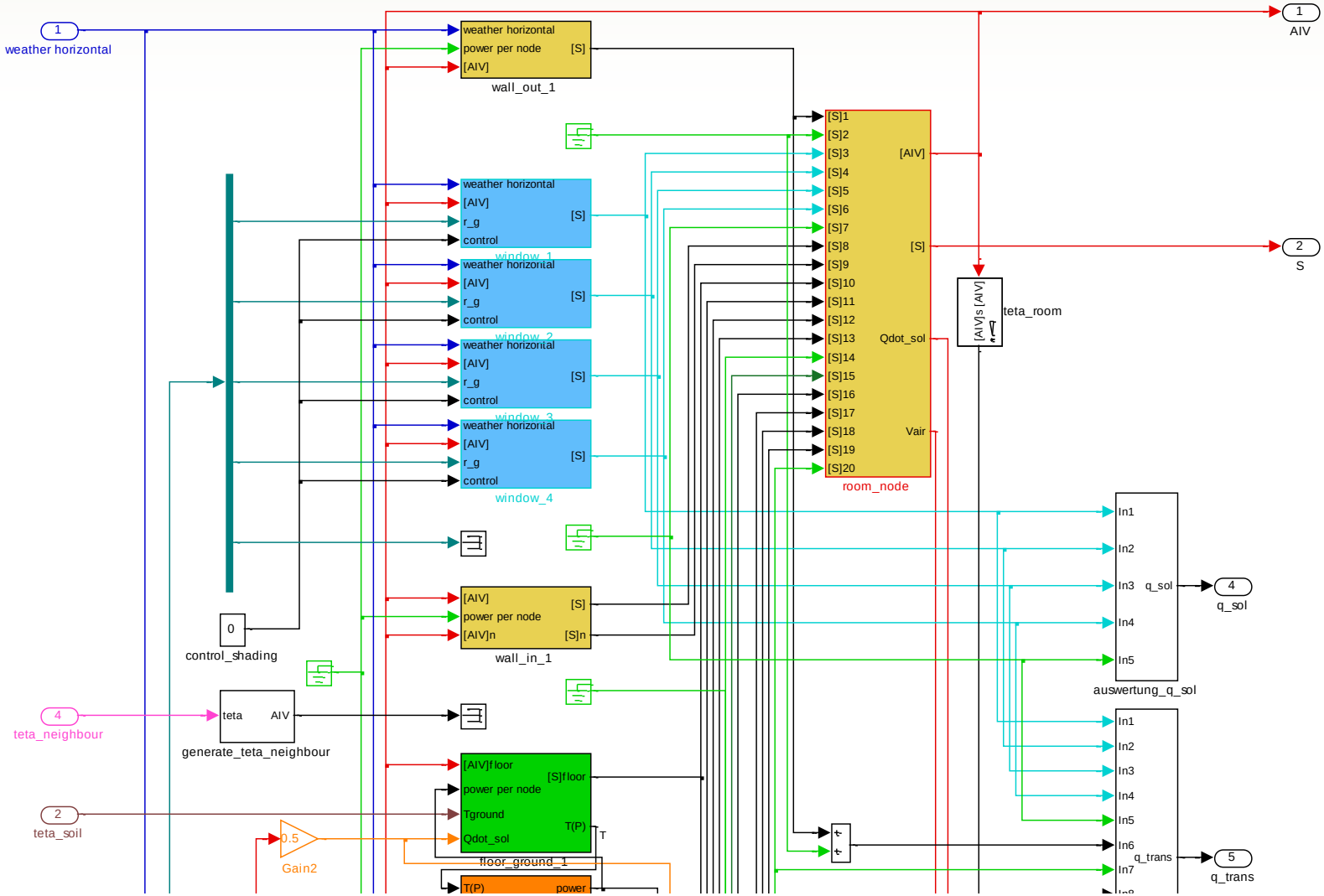
View of the E/W section of the building



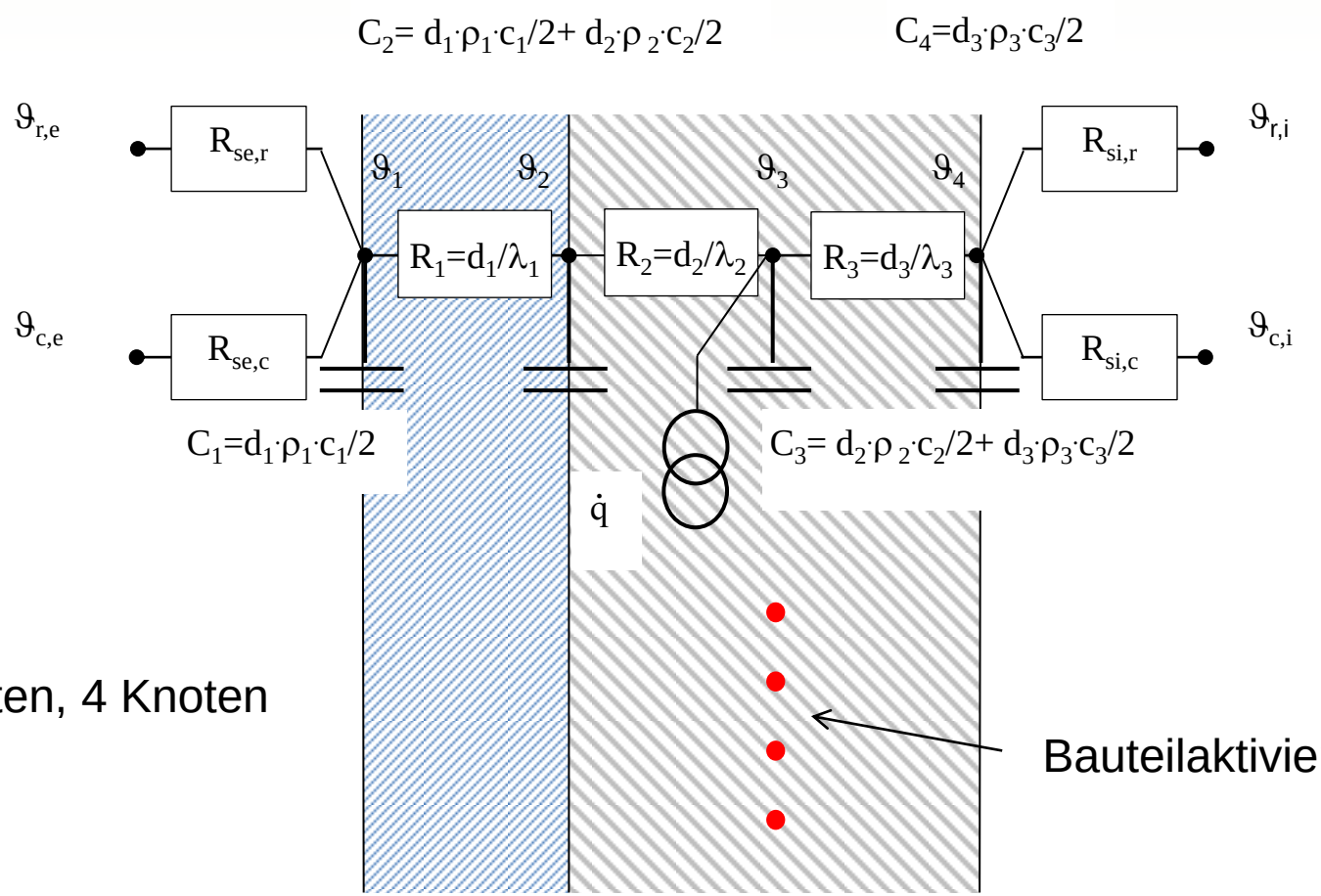
Simple view of the house (showing South and West facades)

part	a	b	f	g	h	m	n	r	α	β
measure	5.46 m	2.64 m	7 m	10 m	2.6 m	0.4 m	0.2 m	1.87 m	45°	20°

„complex building model“



Wandmodell „complex building model“

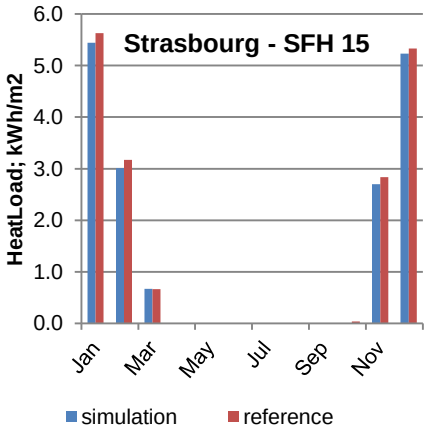


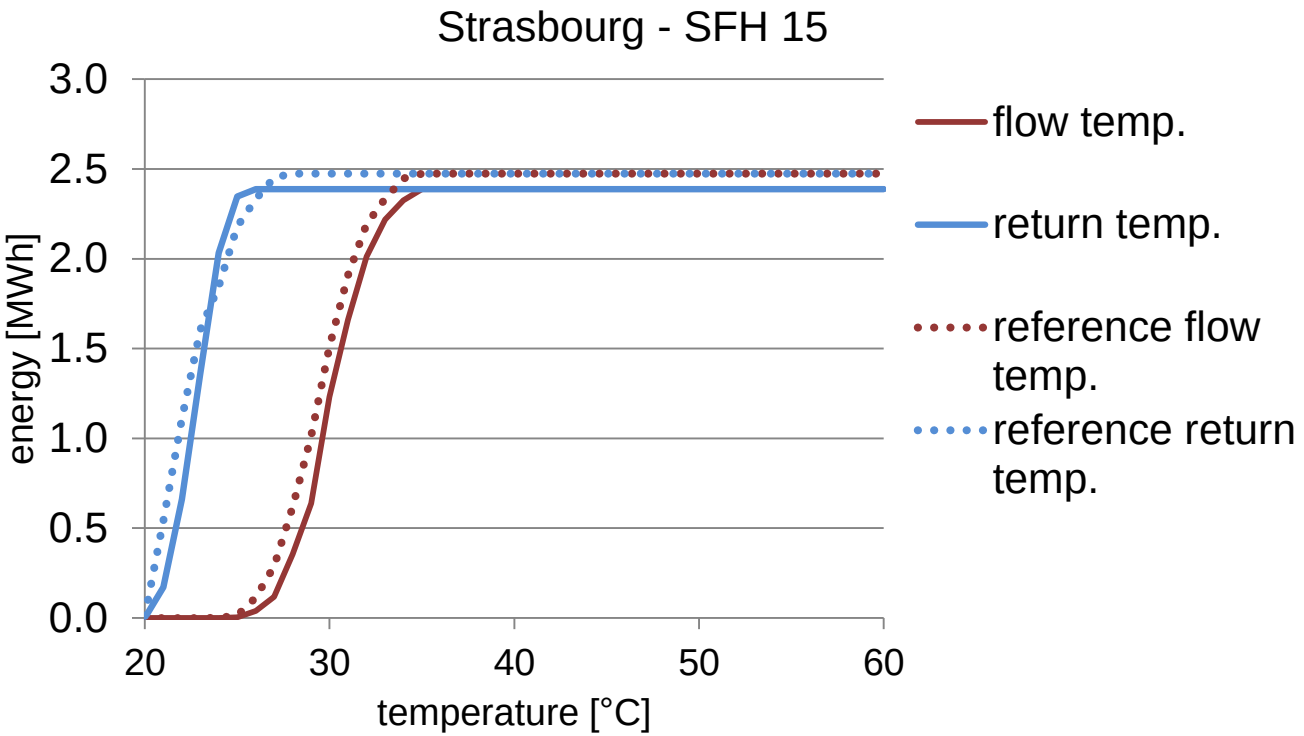
Bsp.:
2 Schichten, 4 Knoten

Bauteilaktivierung

Vergleich Carnot – Trnsys (reference)

Standort: Strasbourg





Vergleich Carnot – Trnsys (reference)

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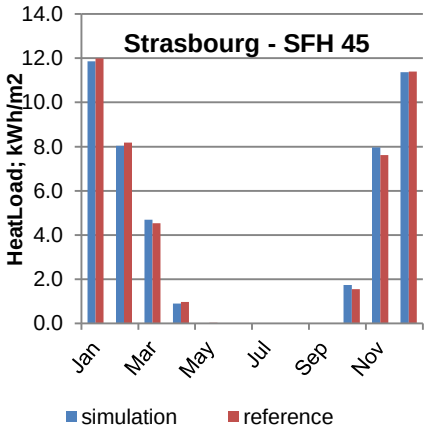
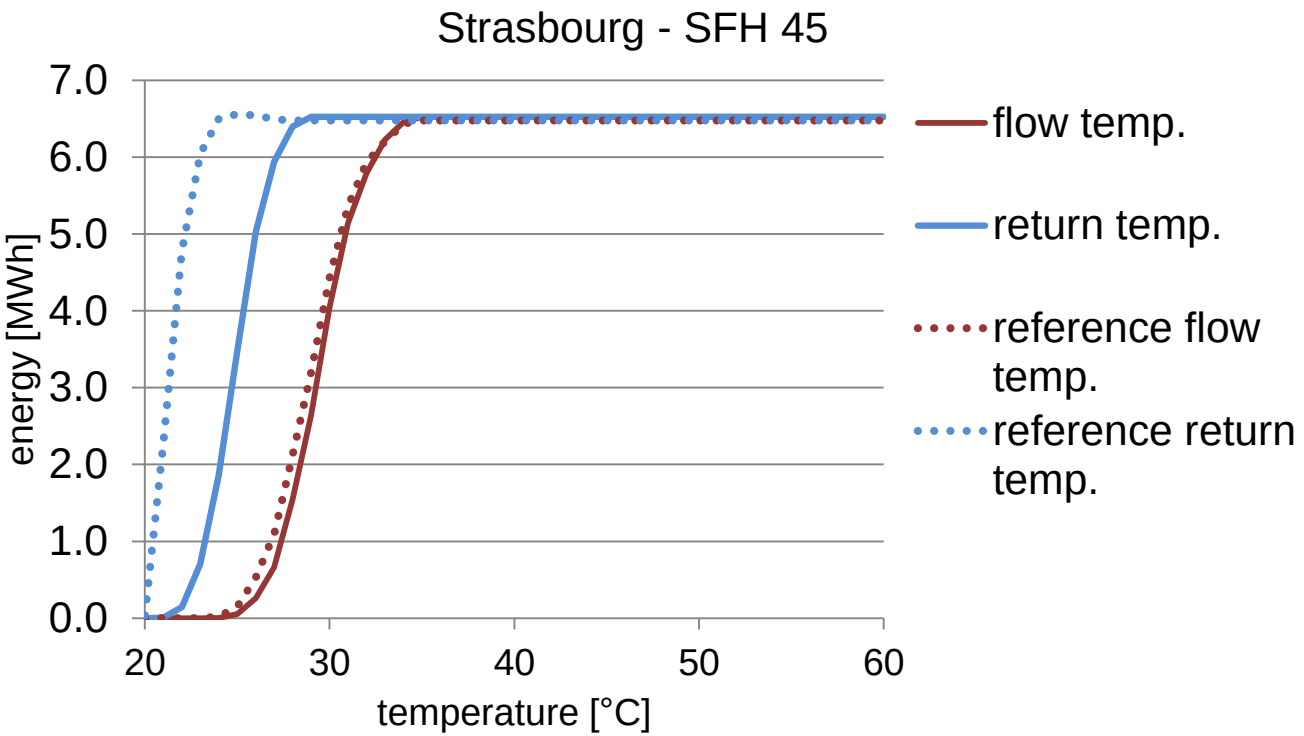
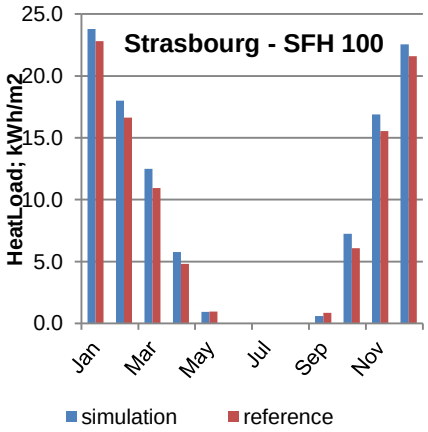
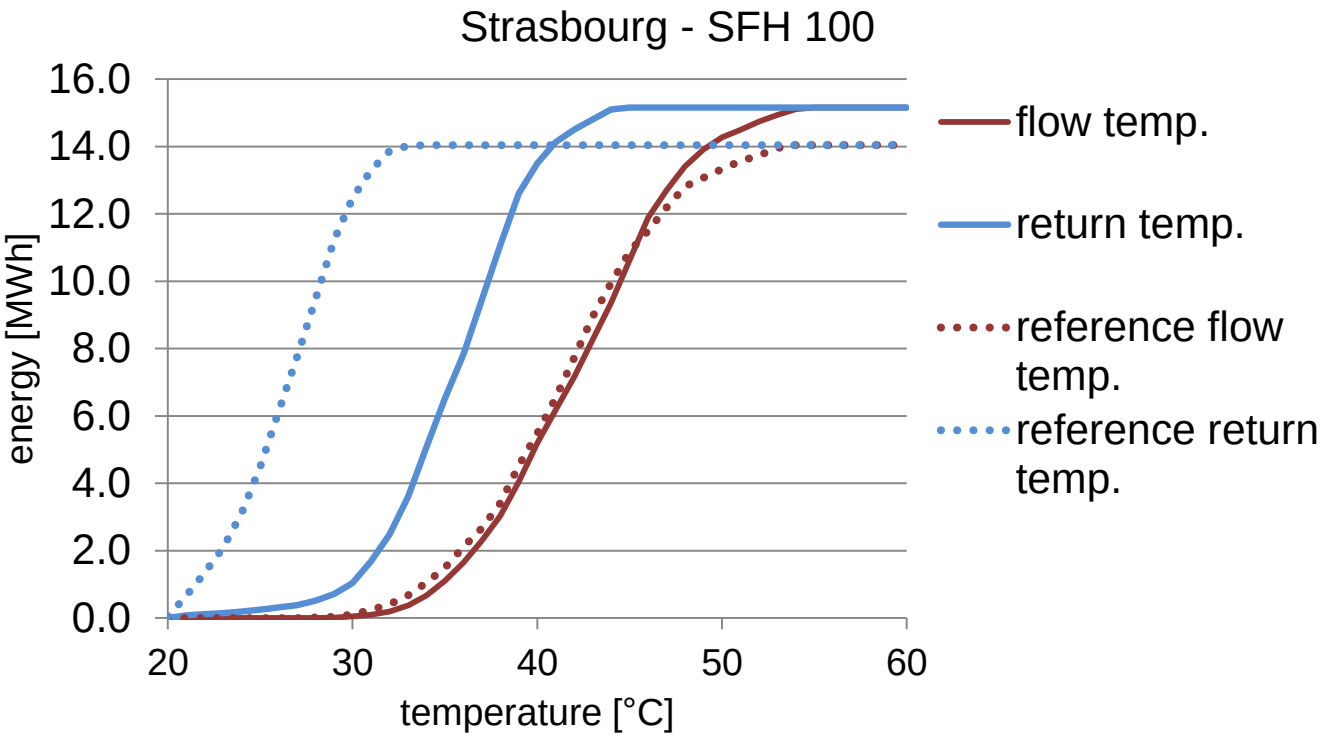




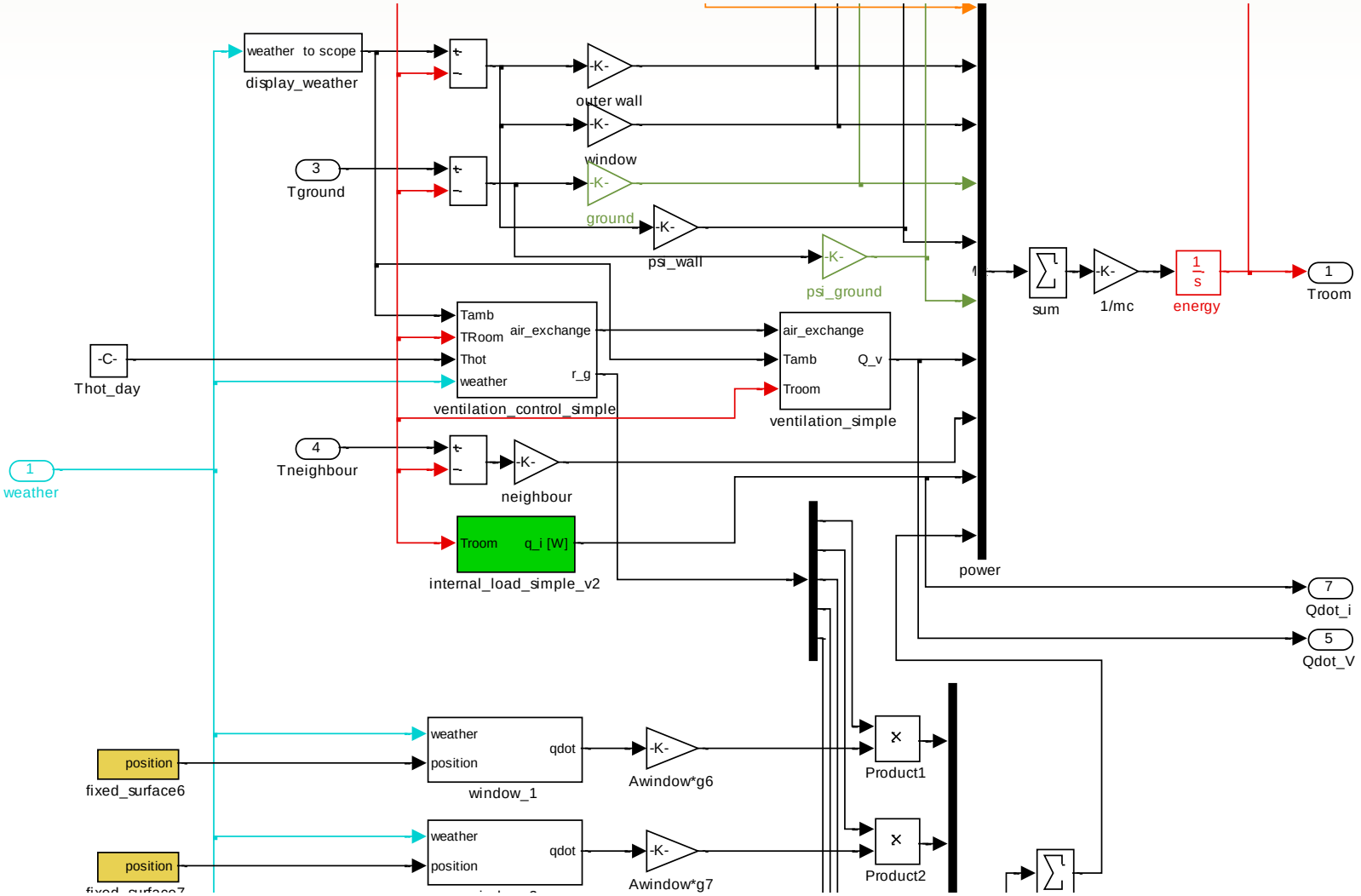
Vergleich Carnot – Trnsys (reference)

Standort: Strasbourg





„simple building model“



simple vs. complex building model

Vereinfachungen

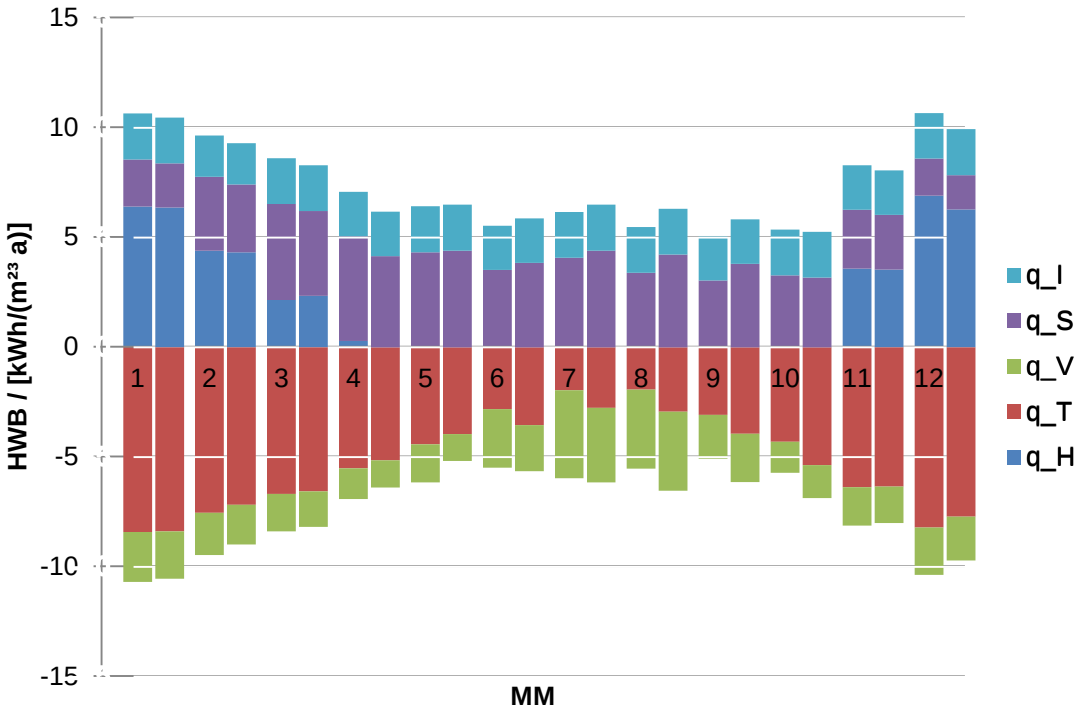
- 1*-model
- „lumped mass“
- Leitwerte (UA, $\dot{V} \cdot \rho \cdot c_p$)
- solare Gewinne ($g \cdot I_S \cdot f$)

$\Rightarrow$ „wie PHPP“ (Monatsbilanz, ISO 13790)

Anpassungsparameter

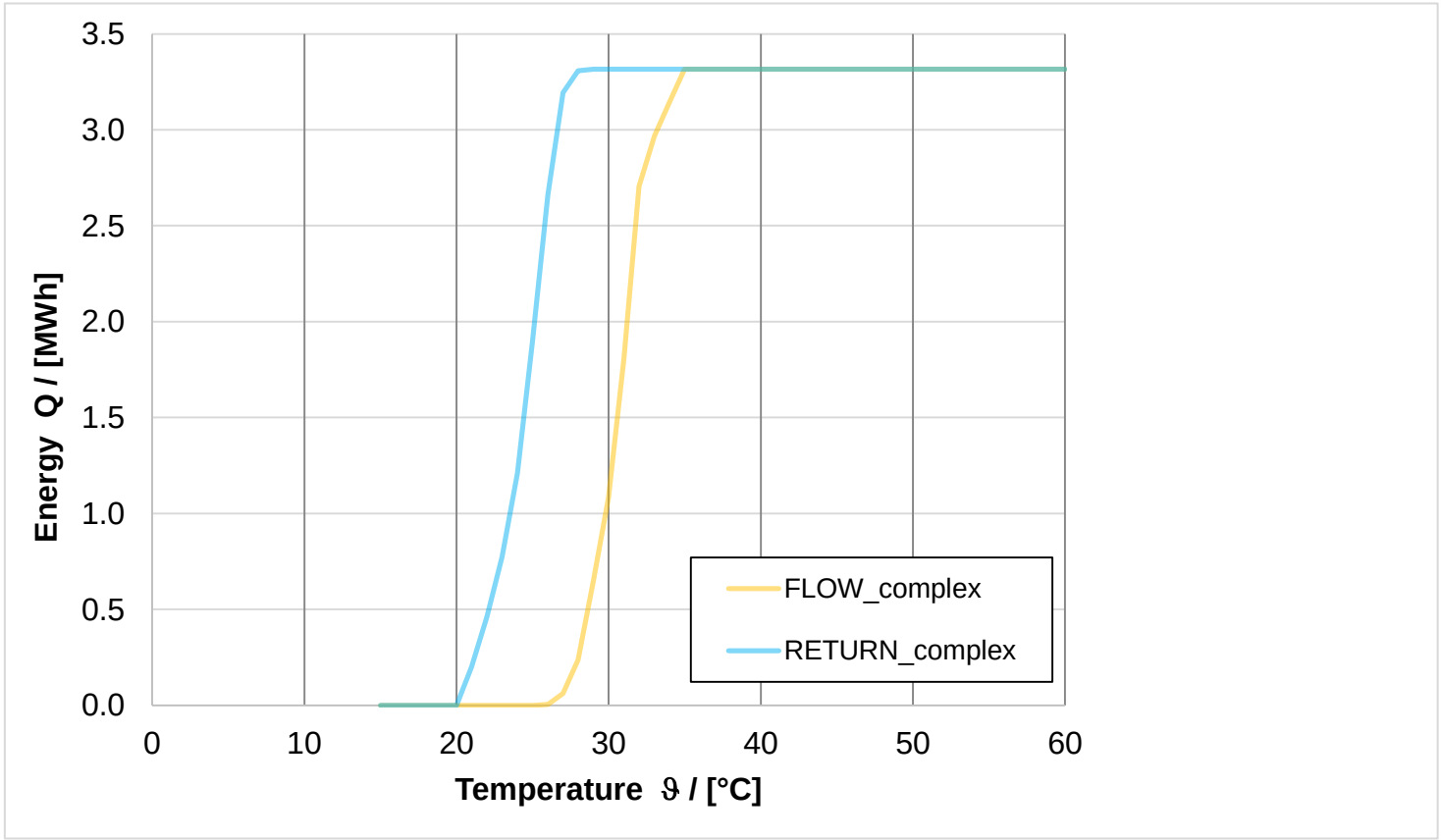
- Radiatorexponent, Masse Radiator (mc_p)
- Masse Luftknoten des Gebäudes (mc_p)

Monatsbilanz



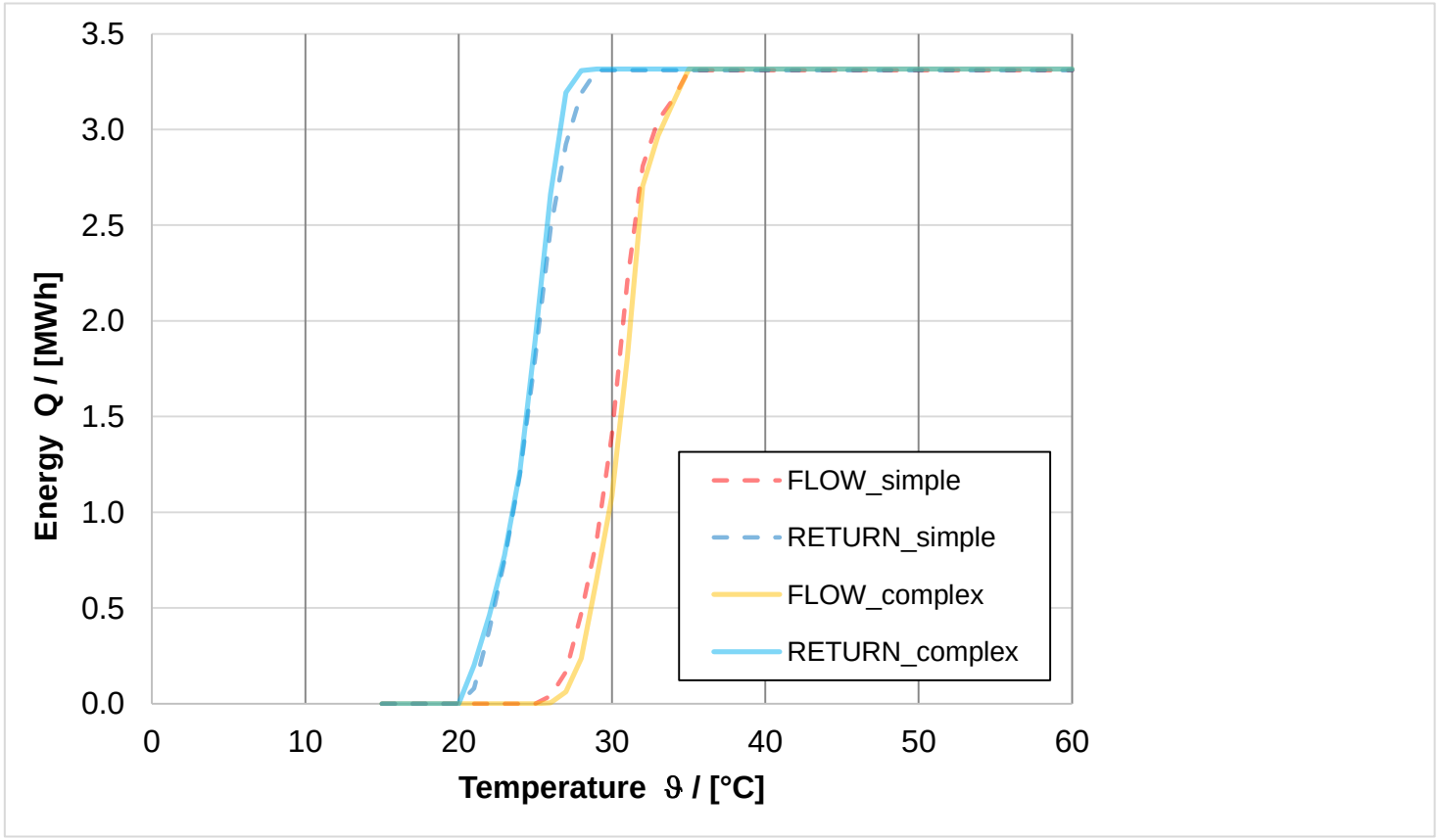
Lastkurven – complex building model

Standort: Innsbruck

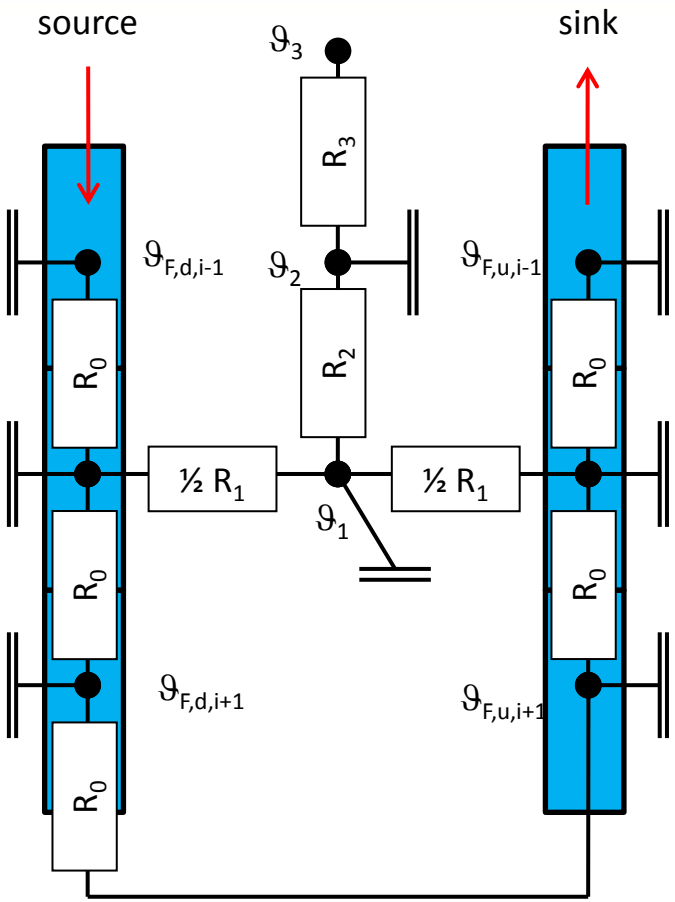


Lastkurven – complex and simple building model

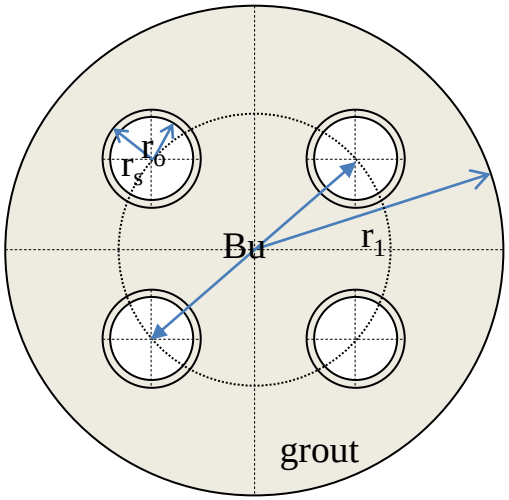
Standort: Innsbruck



CARNOT EWS model



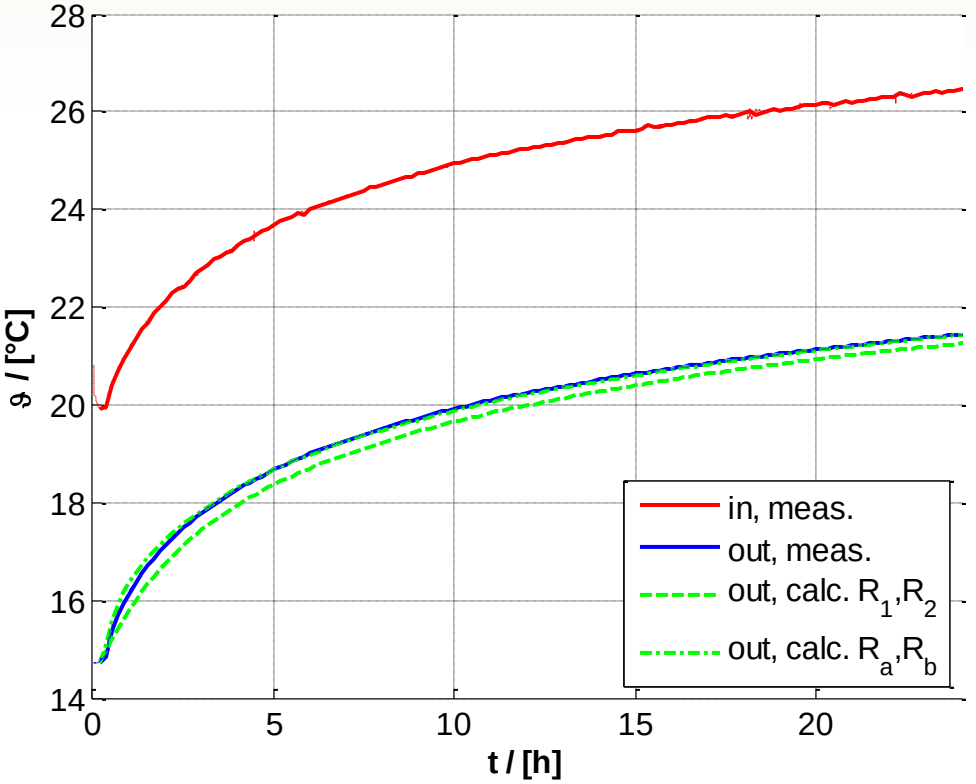
- on-off massflow
- g-function
- initial temperature field
- validation



Vergleich EWS – Thermal Response Test

Vergleich Messung und Simulation (R1, R2), (Berechnung, kein Fit)

	Q (90h) / [kWh]	Q (24 h) / [kWh]
TRT	825.5	436.5
EWS	847.3	455.7
err / [%]	2.7	4.4



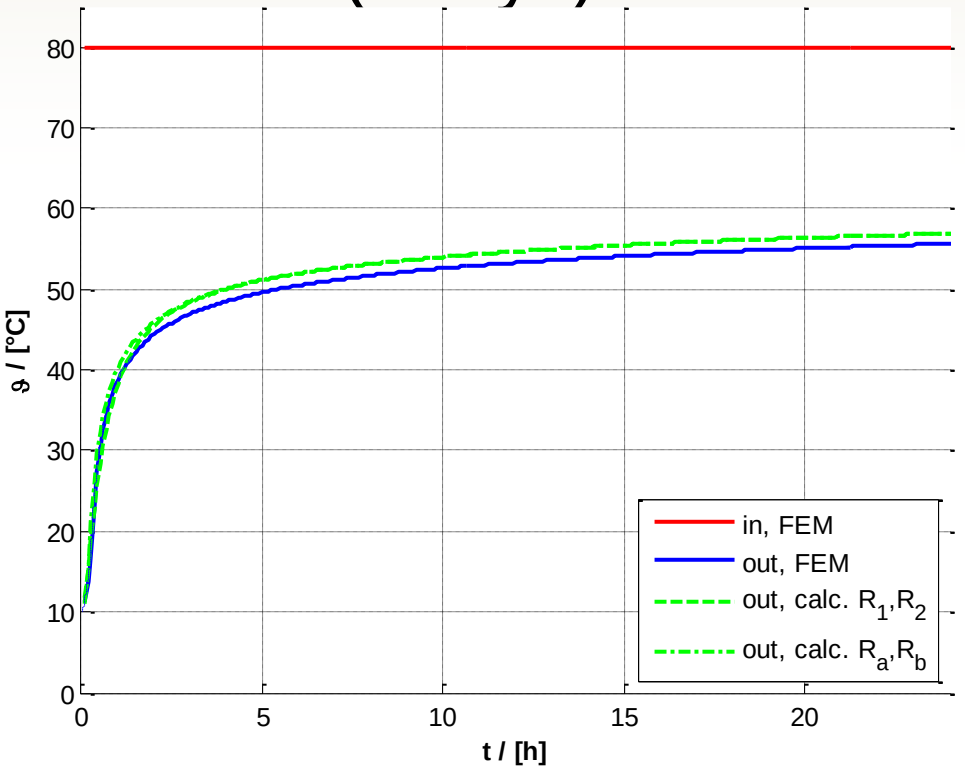
Daten: TRT, ZAE Bayern
2-U, H = 193 m, D_b = 0.2 m, D = 40/3.7 mm
mdot = 0.44 kg/s (Wasser)
ϑ_g = 14.7 °C

	grout	soil
λ / [W/(m K)]	2.1	2.3
ρ / [kg/m³]	2500	2500
c / [J/(kg K)]	800	800

Vergleich EWS – FEM (Ansys)

Vergleich Berechnung und Simulation (R1, R2)

	Q (2160h) / [kWh]	Q (24 h) / [kWh]
FEM	38138.7	715.2
EWS	38085.7	690.6
err / [%]	0.14	3.4



Daten: ANSYS FEM Simulation
D. Bauer, ITW, Uni Stuttgart, unveröffentlicht
2-U, H = 100 m, D_b = 0.13 m, D = 32/3 mm
S = 0.06 m
mdot = 0.25 kg/s (Wasser)
ϑ_{ini} = 10.0 °C

	grout	soil
λ / [W/(m K)]	2.2	2.3
ρ / [kg/m³]	2600	1460
c / [J/(kg K)]	850	1500

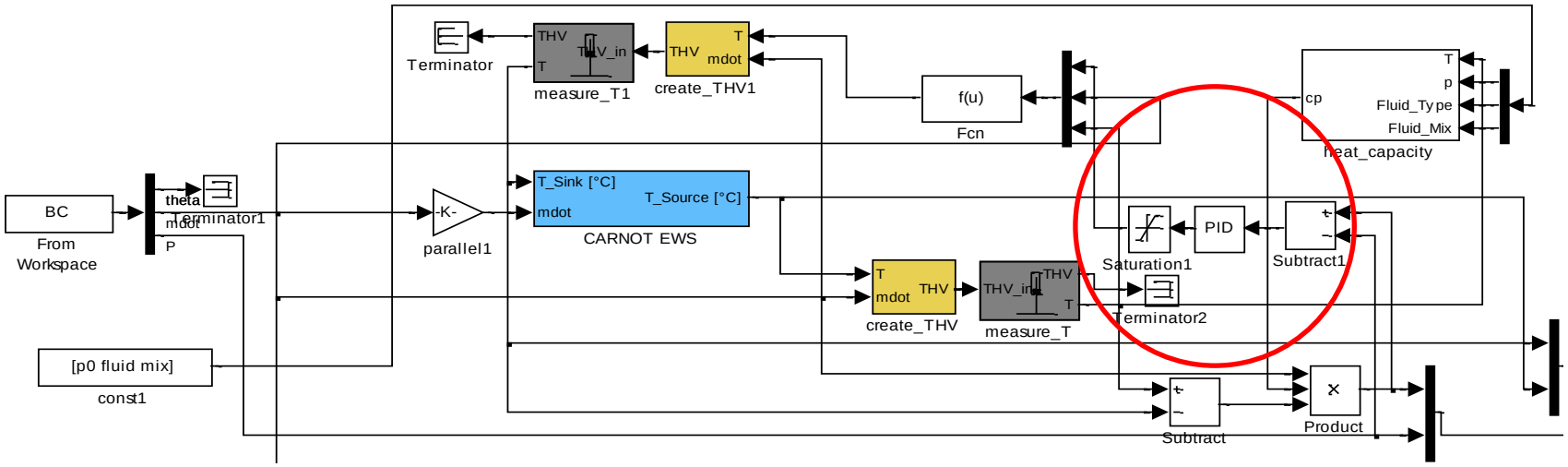
Validierung EWS - Lastprofile

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Q (H)	0.43	0.21	0.09	0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.22	0.43
Q (H+DHW)	1.24	0.65	0.36	0.25	0.26	0.25	0.21	0.21	0.25	0.26	0.50	1.19

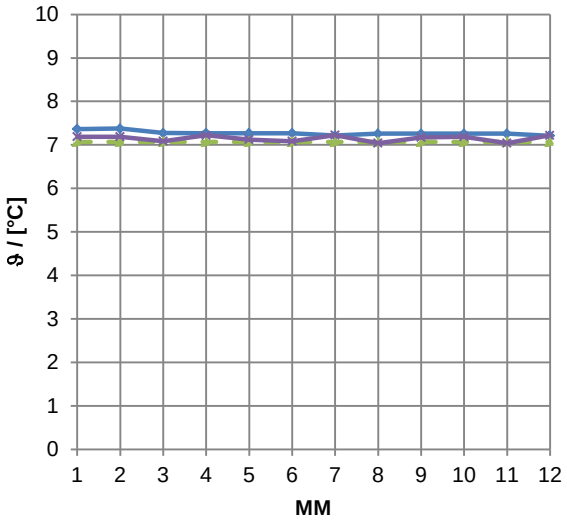
type	2U
height	50 | 75 | 100 m
borehole diameter	D_b = 0.18 m
pipe	D = 32/3.0 mm
pipe thermal conductivity	l_p = 0.48 W/(m K)
pipe distance	Bu = 0.1293 m
massflow	mdot = 0.5 kg/s (water-glycol 25%)
undisturbed ground temperature	ϑ_g = 10.0 °C
Geothermal gradient	T_{Grad} = 0.025K/m (= 0.05 W/m²)

	grout	soil
λ / [W/(m K)]	1.0	2.0
ρ / [kg/m³]	2000	2500
c / [J/(kg K)]	1000	800

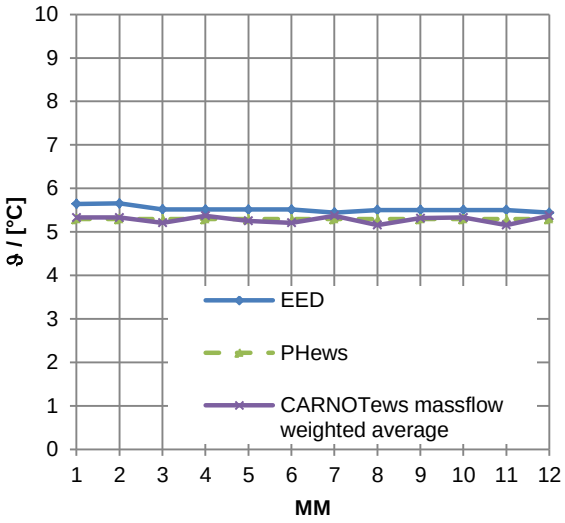
Validierung CARNOT EWS



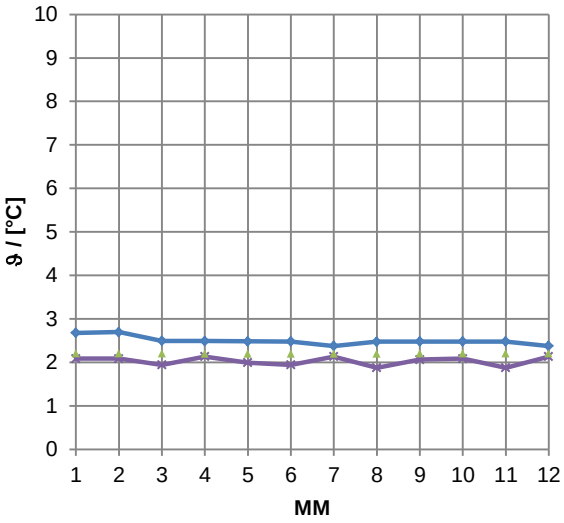
Validierung Langzeitverhalten



100 m



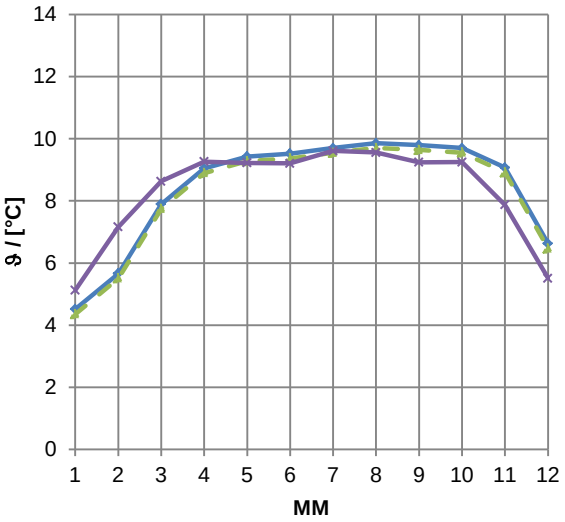
75 m



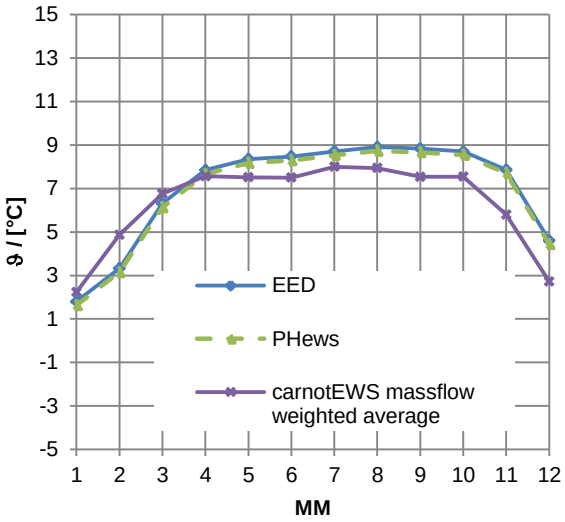
50 m

constant load $\dot{Q}$ = 1667 W

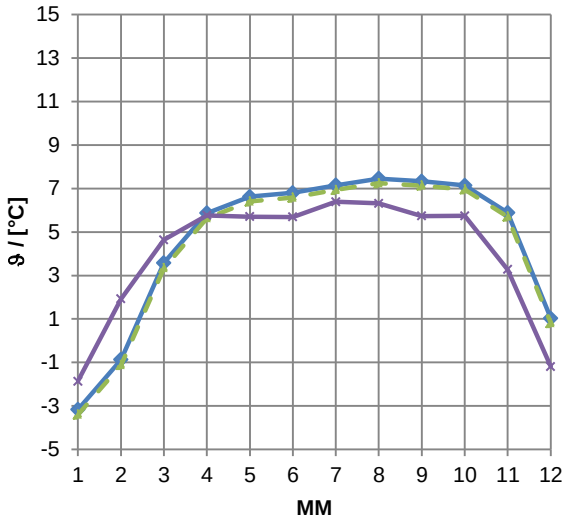
Validierung Langzeitverhalten



100 m



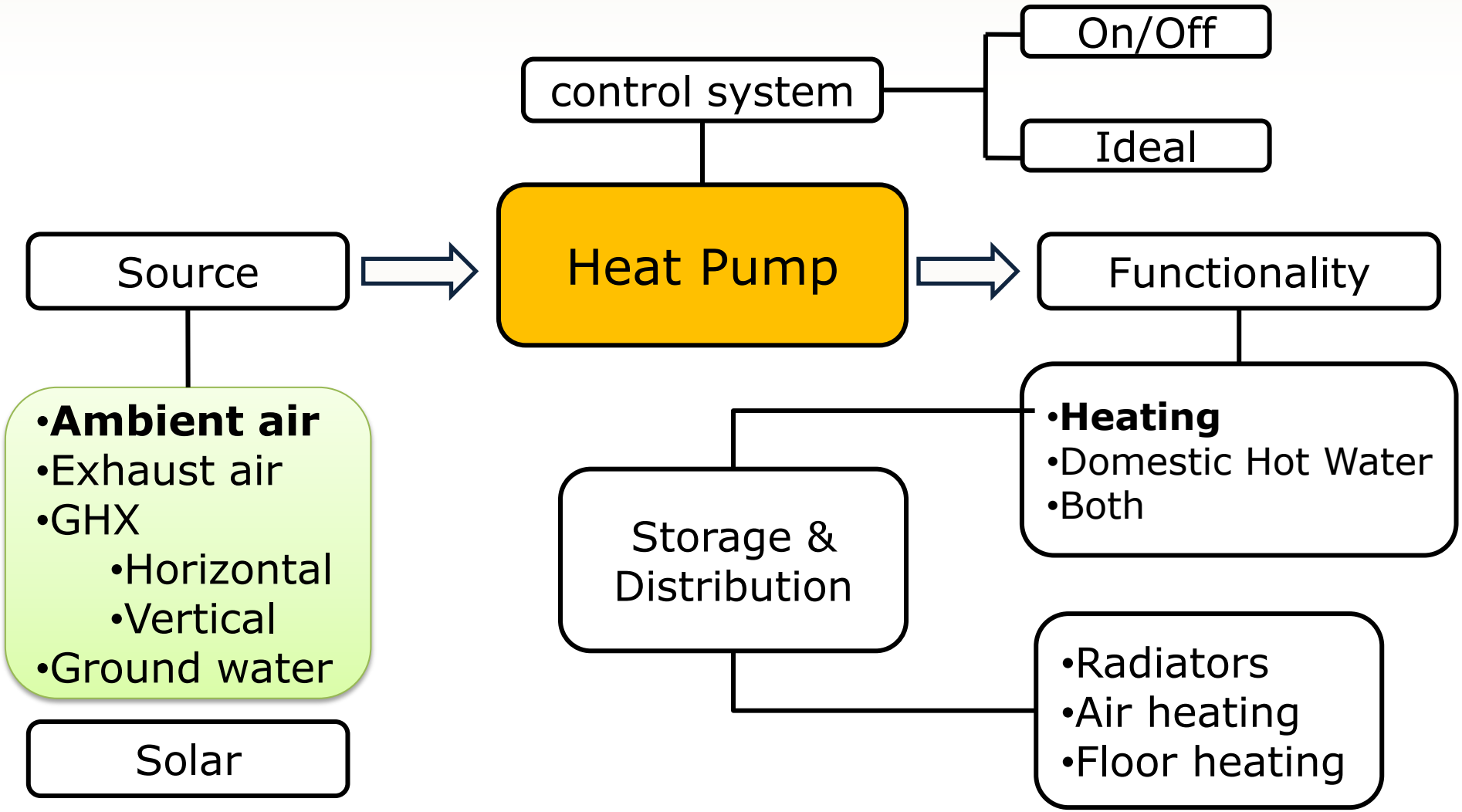
75 m



50 m

heating + dhw profile

Heat Pump Options

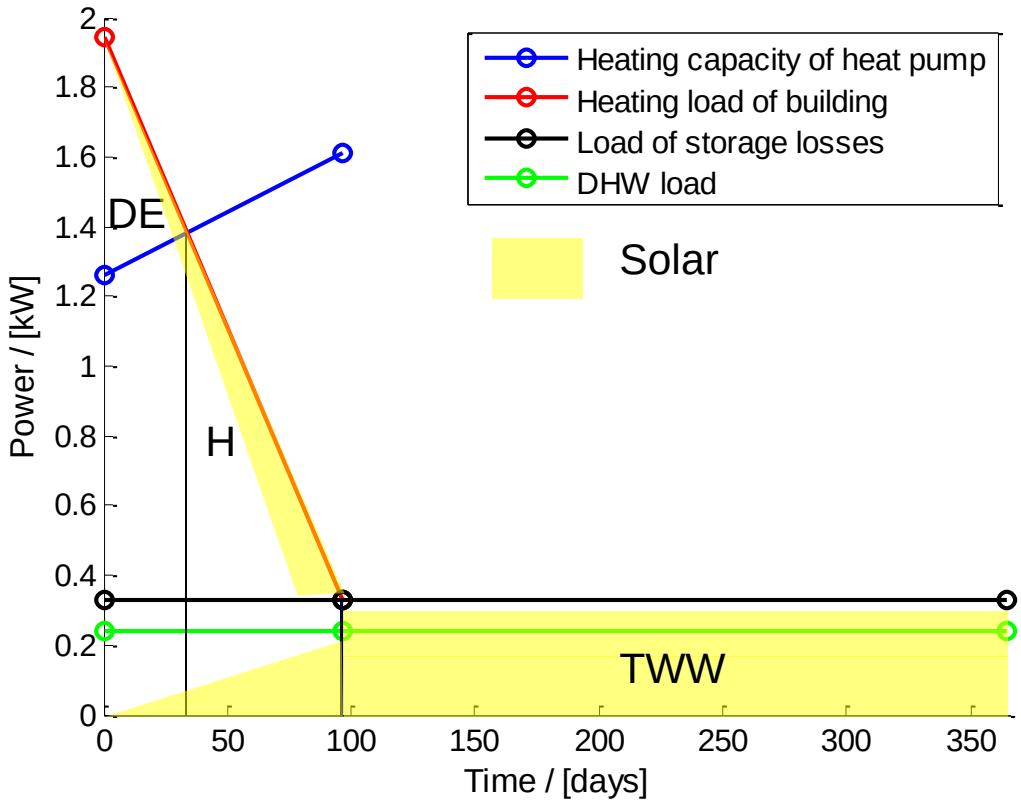


new worksheet "heat pump" in PHPP

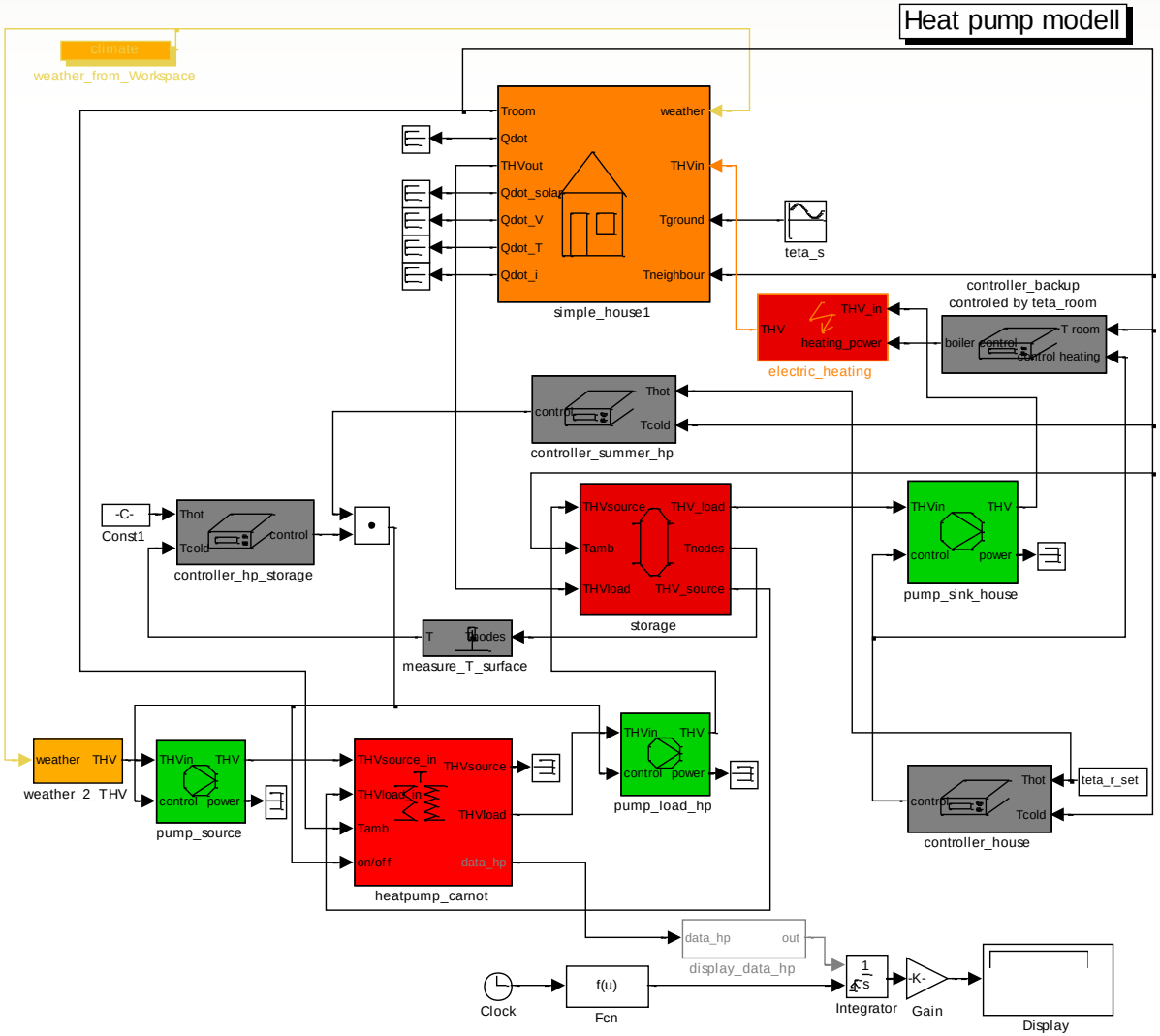
„enhanced" bin method

"Cross-Validation" by comparison with a model in Matlab/ Simulink using Carnot Blockset

ToDo:
Validation of HGHX
Validation of Solar



Air-Sourced HP Model in Simulink/Carnot

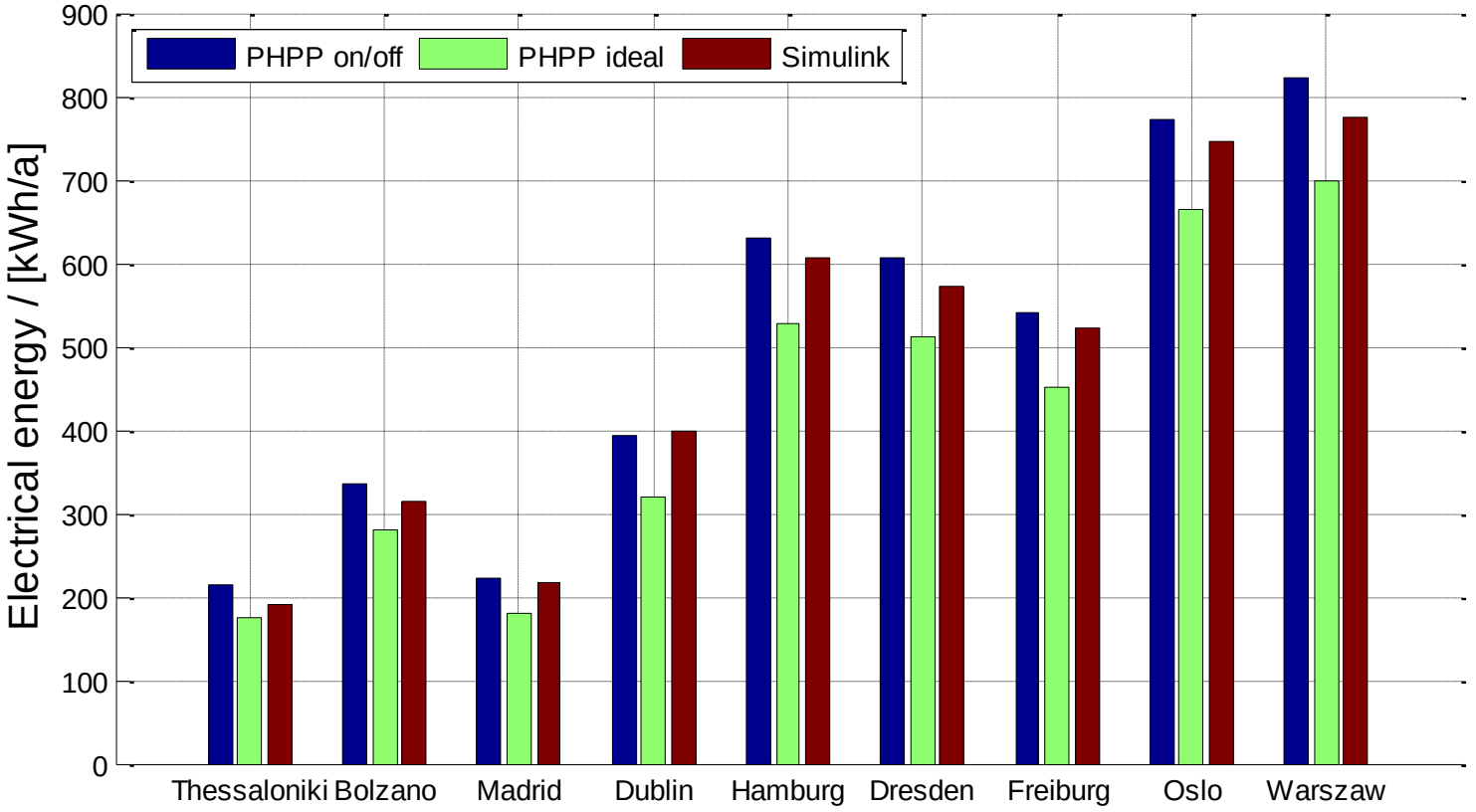


Results

Air source heat pump

Distribution system: floor heating without store (ϑ_{snk}=35 °C)

A single family house adapted to Passive House standard in several climates.

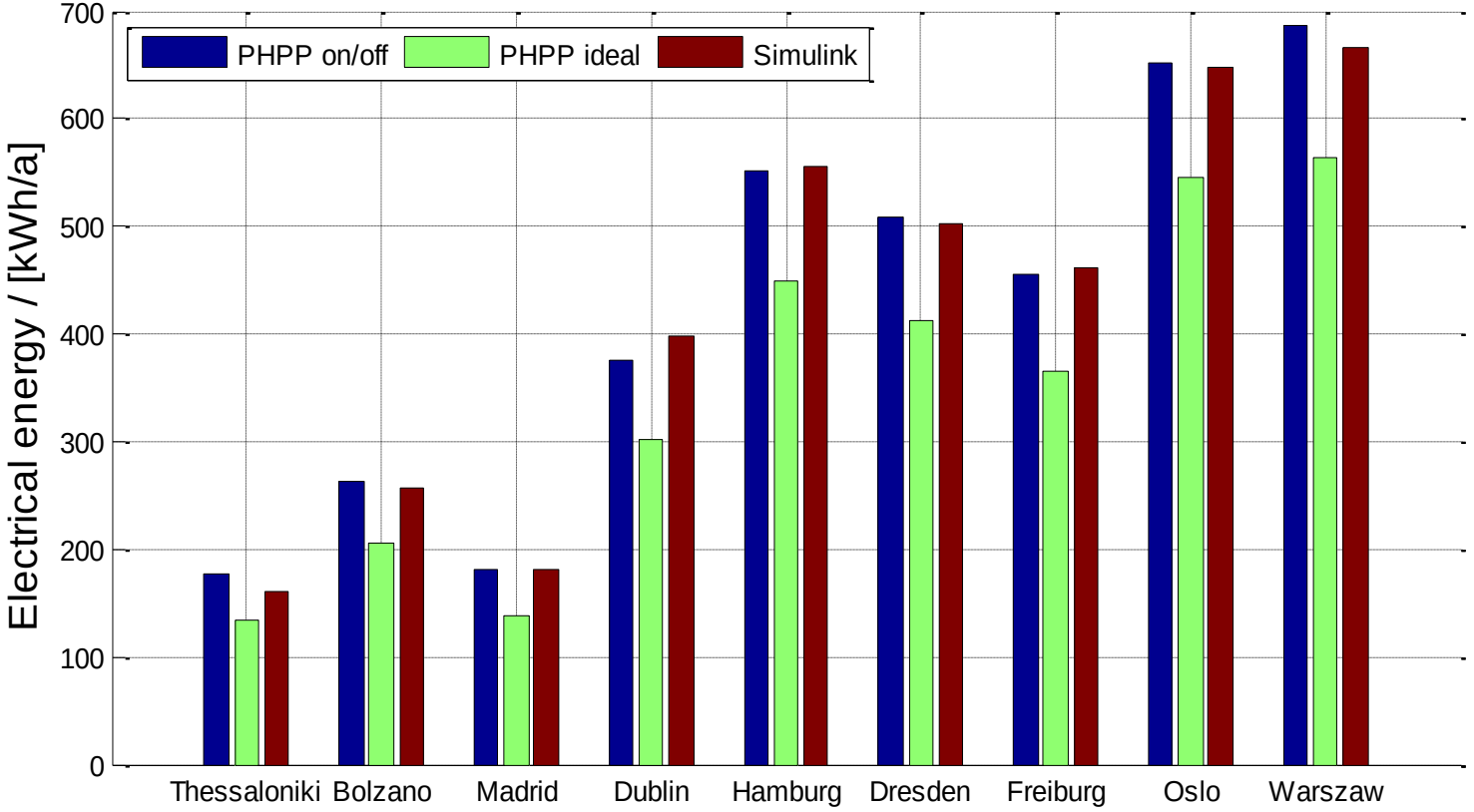


Results

GHX sourced heat pump

Distribution system: floor heating without store (ϑ_{snk}=35 °C)

A single family house adapted to Passive House standard in several climates



Zusammenfassung: Modelle

0) Cross-Validierung Gebäudemodell (Mehrzonenmodell) (TRNSYS, Dynbil)
vergleich Complex-simple building

(neue) Modelle

1) Horizontal Ground Heat Exchanger
- 1D / 2D / 2D radialsym.
- Eisbildung, Latentwärme

2) V-GHX EWS (erweitert, validiert)

Zukünftige Tätigkeiten

- automatisiertes Fitten des „simple building“ an das „complex building“
- Kopplung HAM-Wall (1D, pdepe)
- Kopplung Comsol (2D/3D FEM)
- Heat pump model (→ Facade integrated micro heat pump iNSPiRe)