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Calculation of the seasonal efficiency of solar thermal and heat pump combination by using the Bin method

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- Challenges
- Analysis of the existing methods
- Basic parameters of the developed calculation method
- Comparison of the Calculation and the Simulation results

Challenges

- *How can the overall efficiency of a combination of solar thermal – heat pump be determined by using data from standard testing?*

- Basic questions
  - Which parameters are influencing the calculation?
  - Which conditions are influencing the calculation?
  - How can these parameters and conditions be connected without simulation to receive the system efficiency?

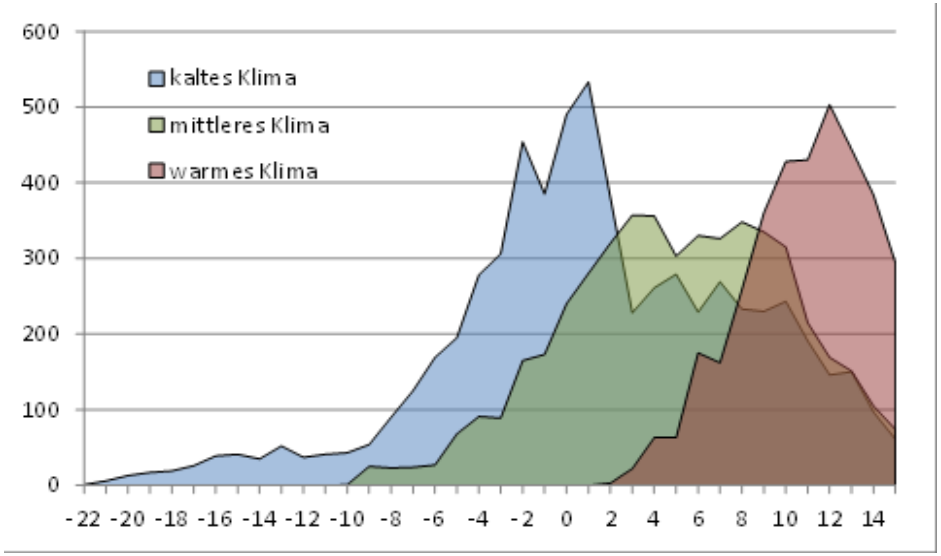
Challenges

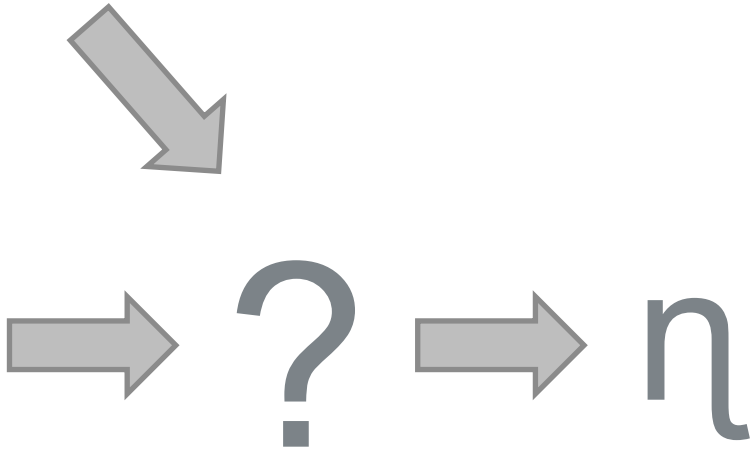
Table 13: Average daytime temperature [°C]

	January	February	March	April	May	June	July	August	September	October	November	December
Average climate conditions	+ 2,8	+ 2,6	+ 7,4	+ 12,2	+ 16,3	+ 19,8	+ 21,0	+ 22,0	+ 17,0	+ 11,9	+ 5,6	+ 3,2

Table 14: Average global solar irradiance [W/m^2]

	January	February	March	April	May	June	July	August	September	October	November	December
Average climate conditions	70	104	149	192	221	222	232	217	176	129	80	56



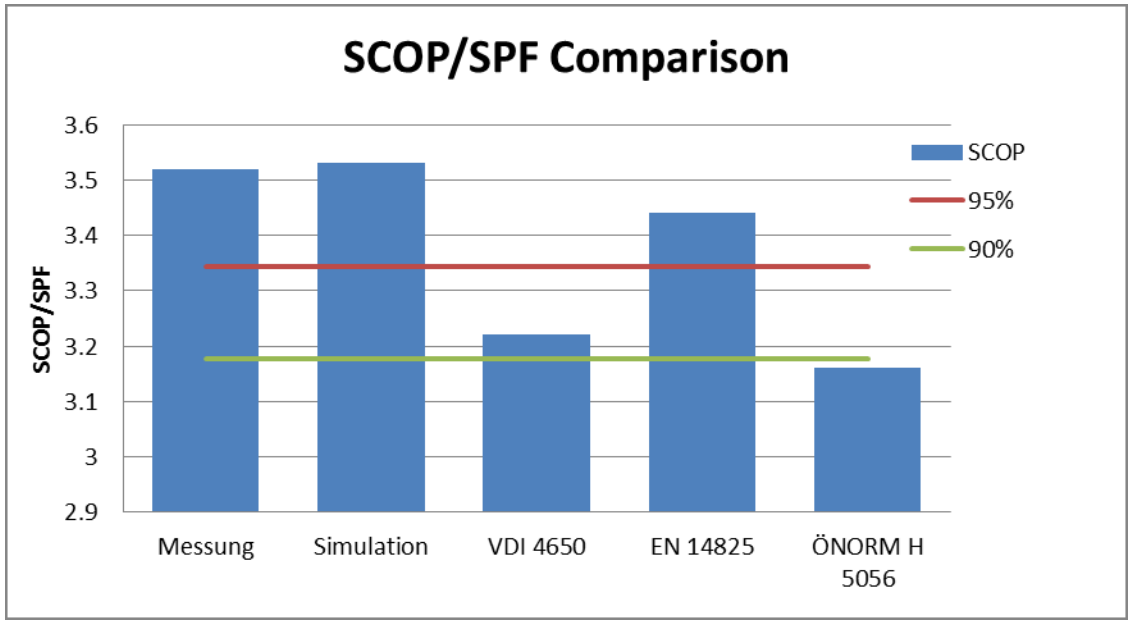


Analysis of the existing methods

- Rating matrix

methode	capacity controll	additional heating system	different climate conditions	difficulty to use the methode	reproducability of the results
VDI 4650	does not apply	neutral	does not apply	applies	applies
JAZCalc	does not apply	does not apply	does not apply	applies	applies
EN 15316-4-2	applies	applies	applies	does not apply	does not apply
EN 14825	applies	applies	applies	does not apply	applies
EN 15316-4-3	standard for solar collectors	applies	applies	neutral	applies

Analysis of the existing methods

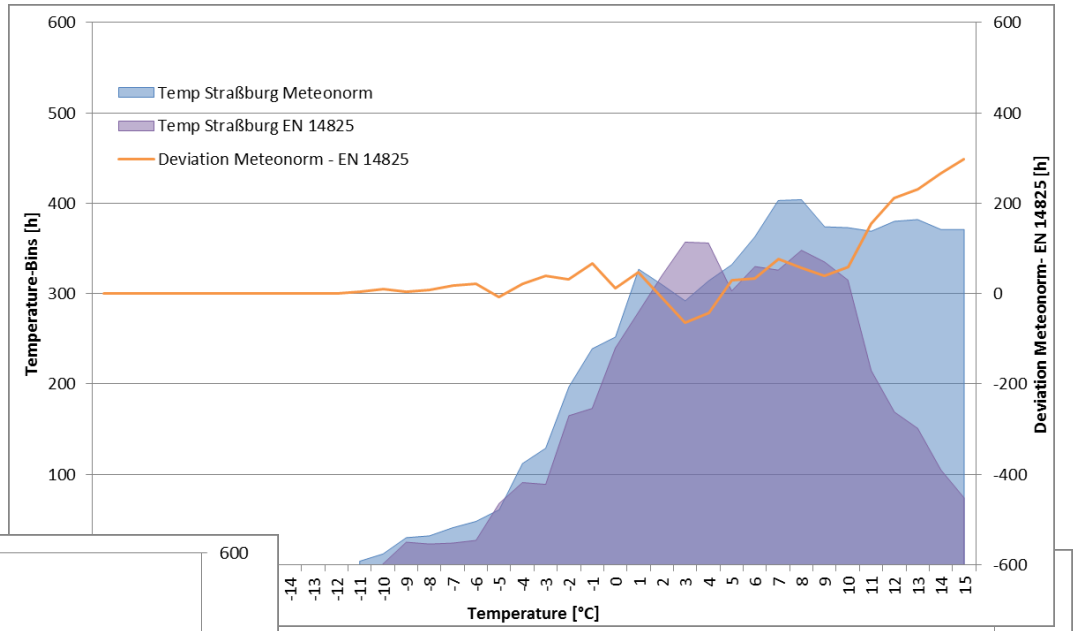


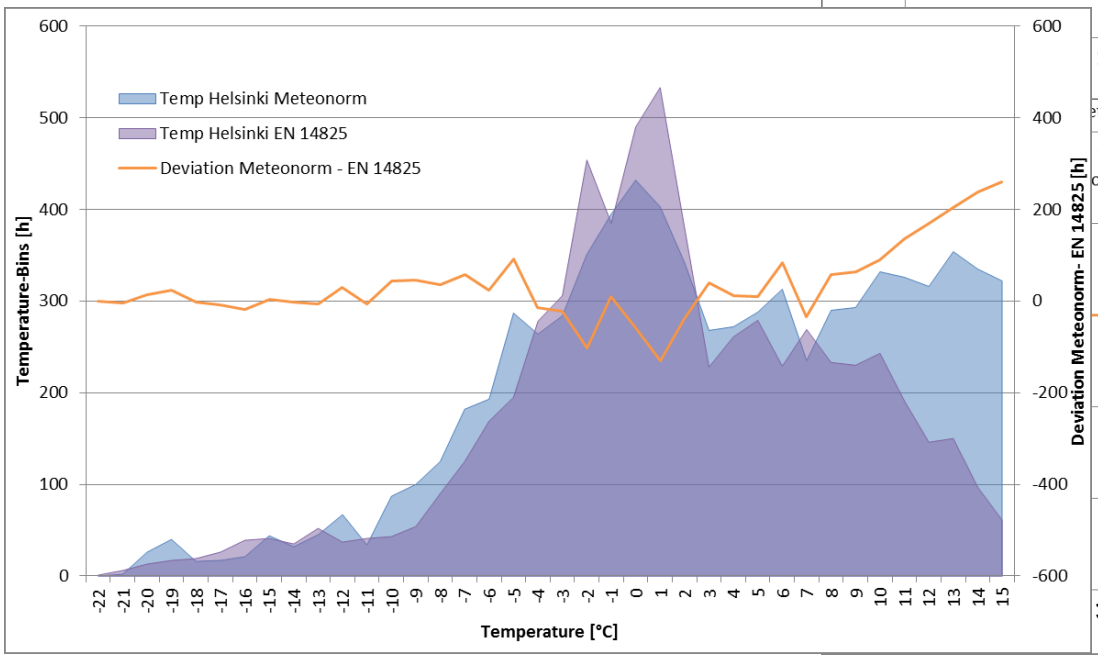
Calculation method

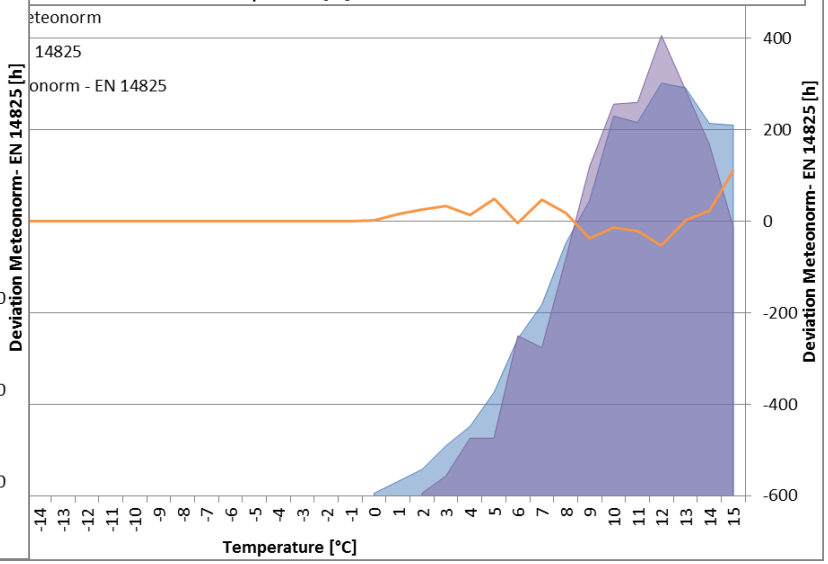
- Basic parameters:
  - Collector:
    - Efficiency
    - Orientation
    - Location of installation
  - Heat pump:
    - COP
    - Working range
    - Location of installation
  - Storage
    - Size
    - Losses

Calculation method

- Comparison for all three climates
- Deviation of Bin-hours and Meteonorm data

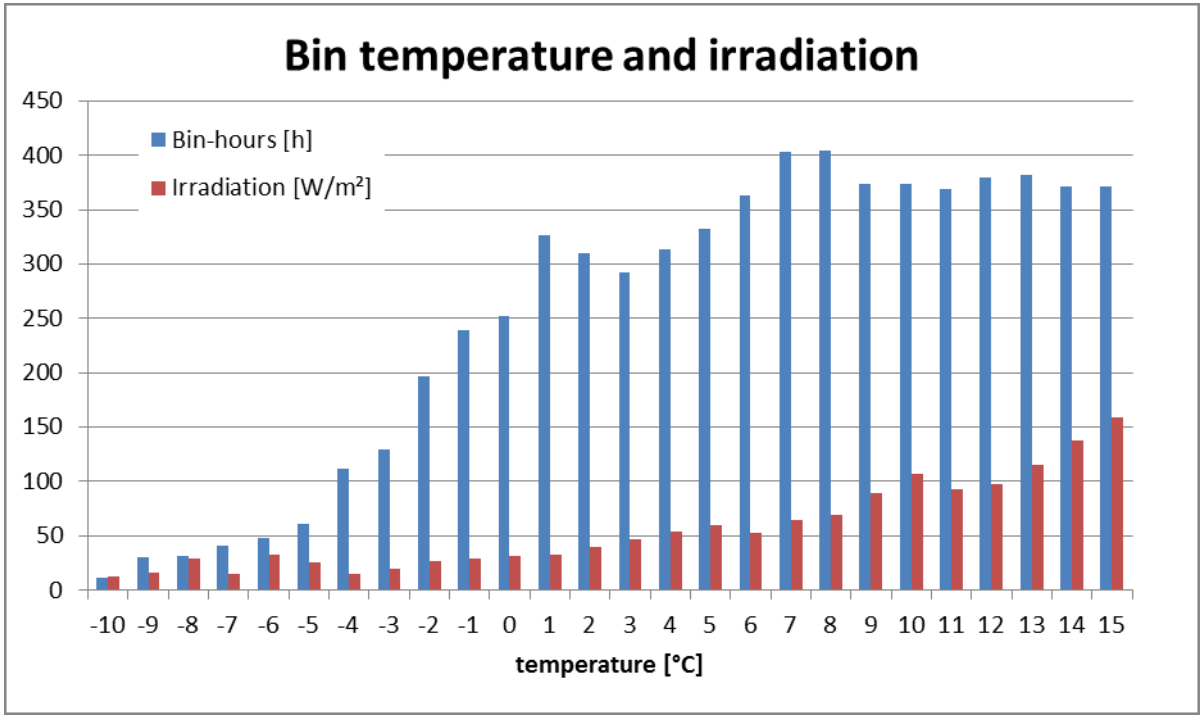






Calculation method

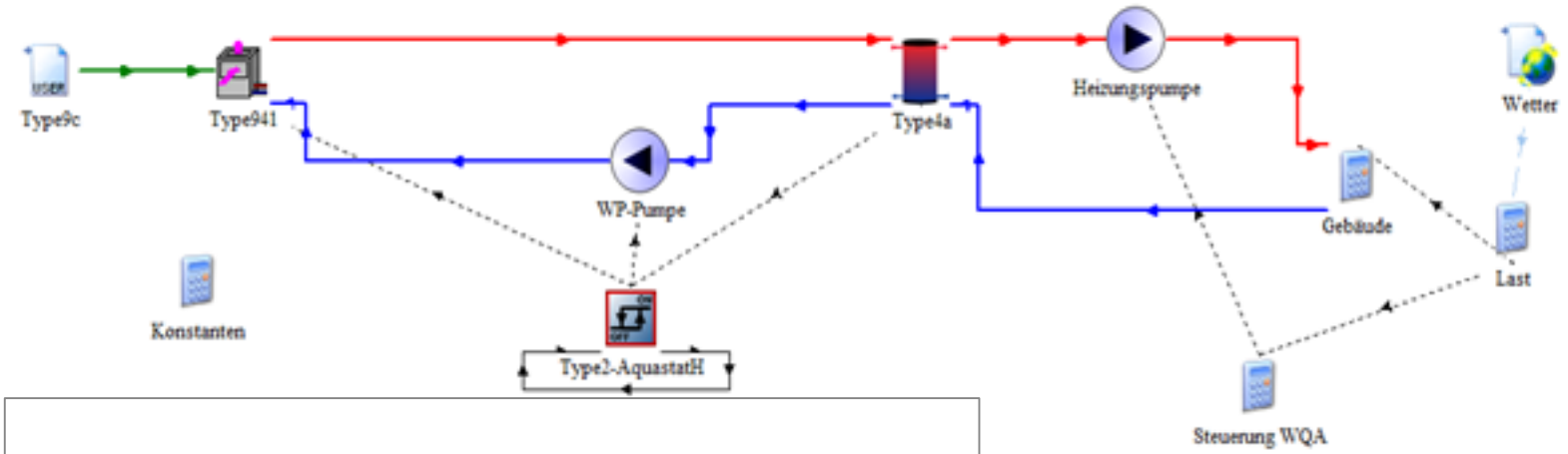
- Connection of temperature and irradiation for the EN14825 locations
  - Athen
  - Strasbourg
  - Helsinki

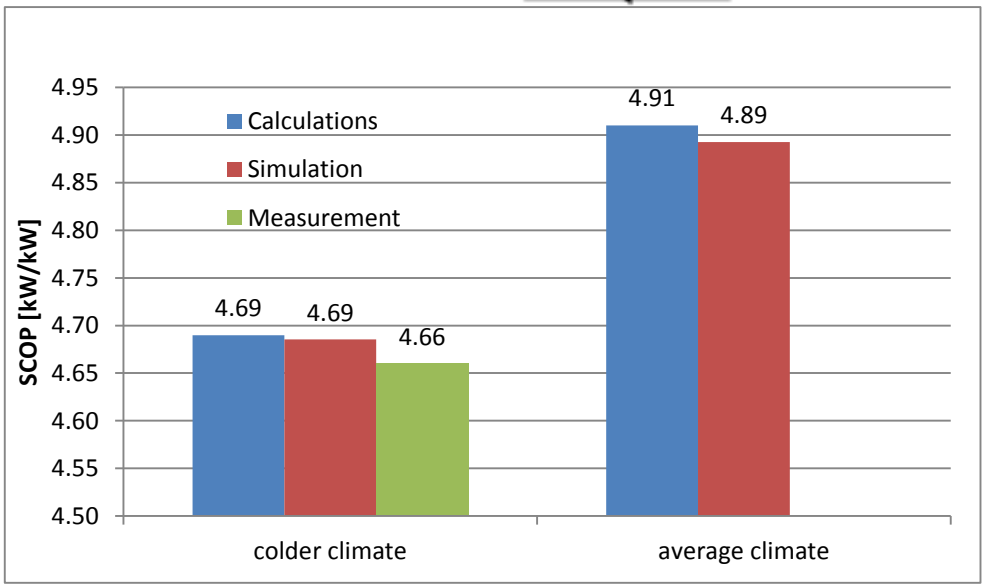


Calculation method

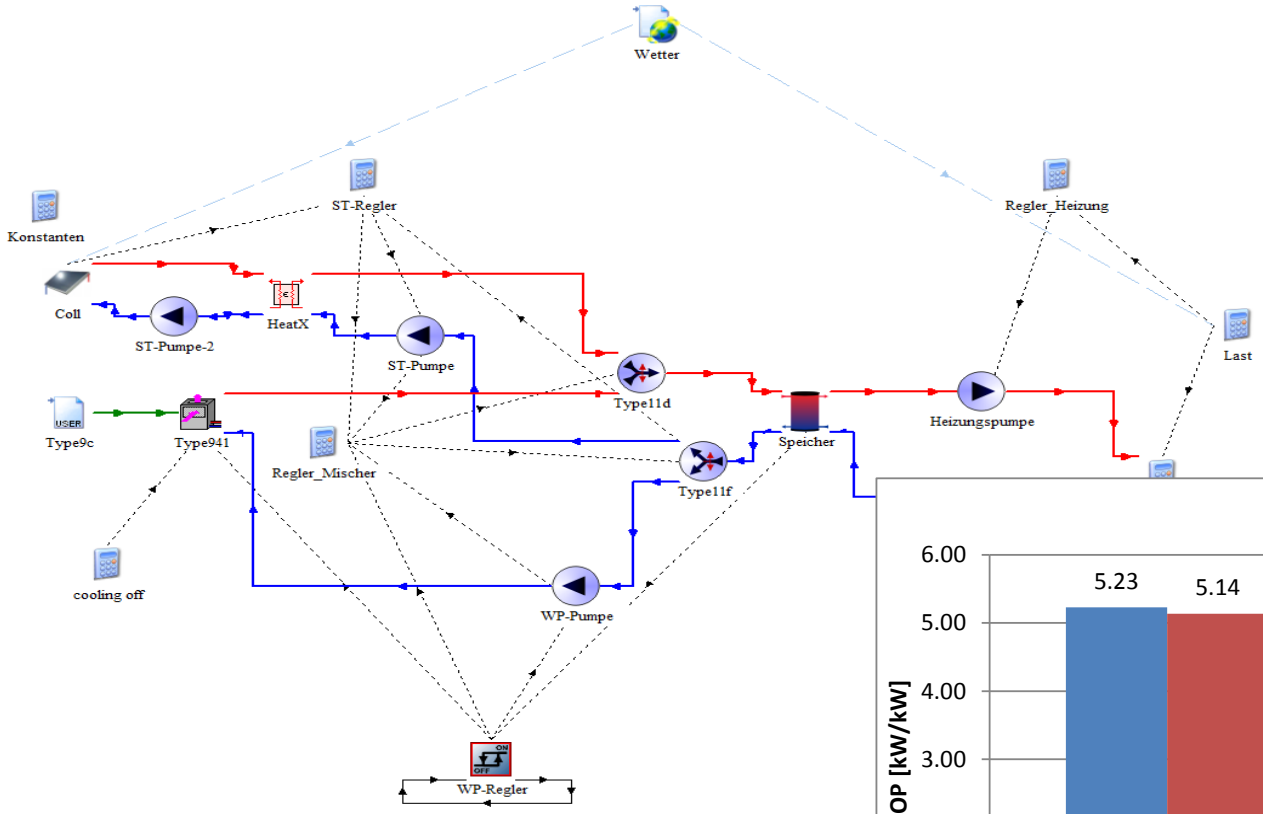
- Calculation procedure in 5 steps:
  - 1 step determination of:
    - Efficiency
    - Orientation
    - Location of installation
  - 2 step:
    - Calculation of the irradiance at the location in connection with Bin temperature
  - 3 step:
    - Calculation of the collector capacity by using the determined “Bin” irradiance
  - 4 step:
    - Connection of the heat pump COP, collector efficiency and storage losses at each Bin
  - 5 step:
    - Calculation of the overall SCOP

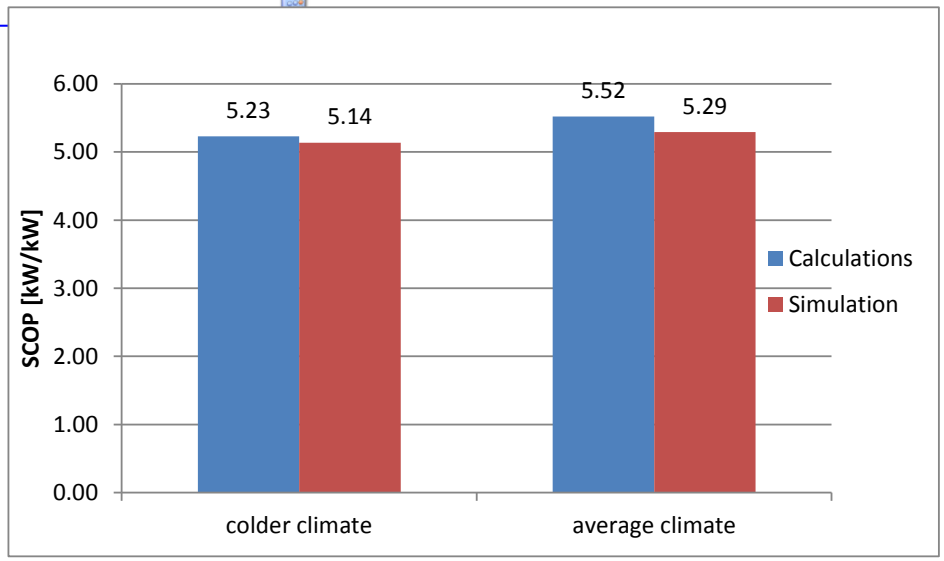
Calculation-Simulation-Measurement



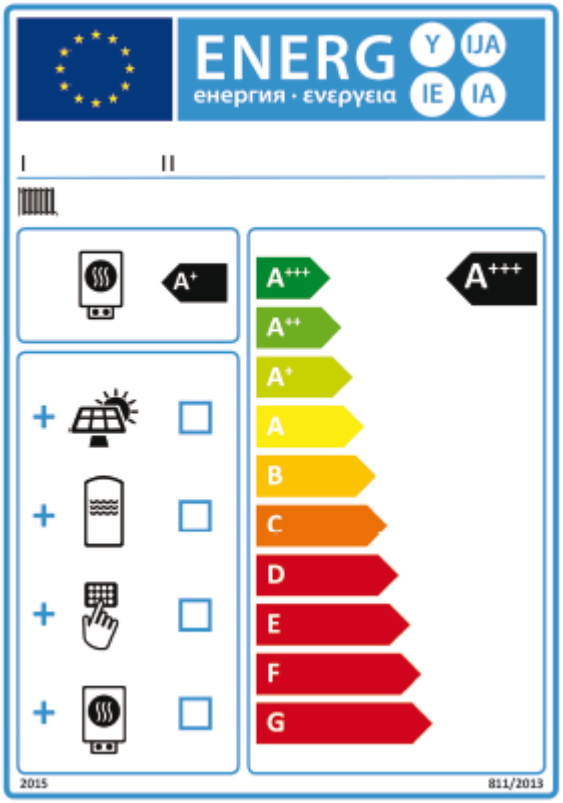


Calculation-Simulation ST and HP system





Packagelabel calculation



Seasonal space heating energy efficiency of low temperature heat pump (%) — 'I' — 196.4 % (1)

Temperature control — From fiche of temperature control: — 3.5 % (2)

Supplementary boiler — From fiche of second boiler — Seasonal space heating energy efficiency (in %)

(0 - 196.4) x 0.00 = 0.0 % (3)

Solar contribution. From fiches of solar-only system

'III':		Acol [m^2]		'IV'		Vstore [m^3]		η_c [-]		Tank rating		(4)
(2.01	x	10.00	+	0.79	x	0.75	) x	0.45 x	0.75	x	0.81	= 5.7 %

\+

Seasonal space heating energy efficiency of package under average climate — (5) 205.6 %

Seasonal space heating energy efficiency class of package under average climate

F	E	D	C	B	A	A+	A++	A+++ ▼
≥ 55%	≥ 59%	≥ 61%	≥ 100%	≥ 107%	≥ 115%	≥ 123%	≥ 150%	≥ 175%

Seasonal space heating energy efficiency under colder and warmer climate conditions

Colder: (5) 205.6 - 'V' 5 = 200.6 %

Warmer: (5) 205.6 + 'VI' 5 = 210.6 %

The energy efficiency of the package of products provided for in this fiche may not correspond to its actual energy efficiency once installed in a building, as this efficiency is influenced by further factors such as heat losses in the distribution system and the dimensioning of the products in relation to the building size and characteristics.

Conclusion

- Comparable results
- Takes different influences into account
  - Temperature
  - Irradiance
  - Storage losses
- Low deviation between measured data and calculation

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THANK YOU!!

Questions:

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