

Report STO5-kkr-110817-E02

Evaluation of calculation results of excel based collector gain calculator

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Qaist project

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This report consists of 14 pages. Results may only be published wholly and not in a content distorting manner.

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1 Inter-comparison process –SKN tool vs. Trnsys

The following report describes results of different simulations. The aim of the simulations was to validate if the solar gains calculated by the newly developed excel based collector yield calculator (Qaist Project) are comparable with results generated by common types used in trnsys.

For this different steps were done:

1.1 Choosing common types

To prepare an inter-comparison of the results of the SKN Tool with common results that would be generated using trnsys for the very same collector there were 5 different trnsys collector types chosen. These are:

- T832
- T152
- T1b
- T540
- T71

All of these models have basically the possibility to handle similar input characteristics as the SKN tool does.

The next preparation work is to check the radiation data. Because there are different possibilities to generate, include and use these data.

1.2 Including a new location

To see where differences in the results come from or better to exclude variations in the radiation data at least there was an inter-comparison with Meteonorm 6.1 done (see chapter 1.3).

As well the SKN Tool offers the possibility to include new own locations, meaning own weather data.

This was done and worked well. One suggestion for improvement from ISE side would be, to name the rows in the data file more clearly or give a close by legend to explain the values in every row. Otherwise it is very easy to bring in some other data from external sources (like Meteonorm) with a different meaning as used in the SKN Tool. For example radiation data on an inclined area or on horizontal and so on.

1.3 Inter-comparison with Meteonorm 6.1

As said before it is important to exclude the influence of variations in radiation and weather data from the result if one wants to see the differences resulting potentially from different models.

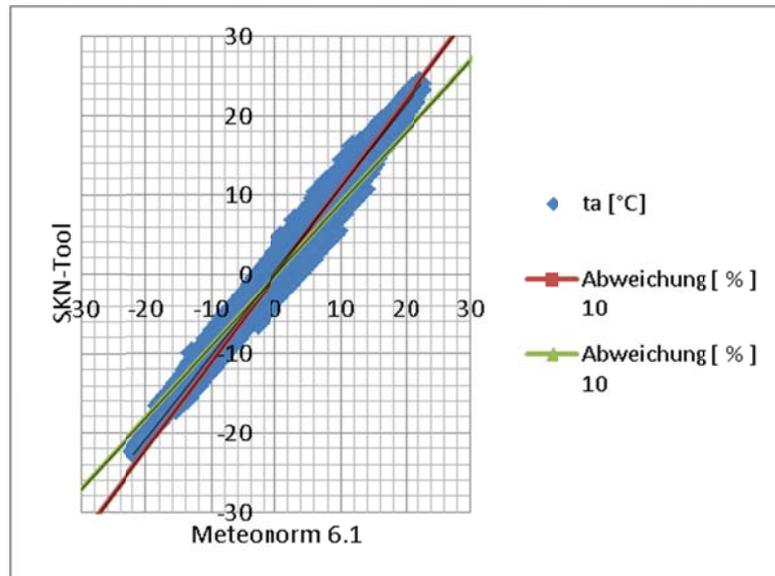


Figure 1, Ambient temperature deviation between SKN Tool and Meteonorm 6.1 for Davos

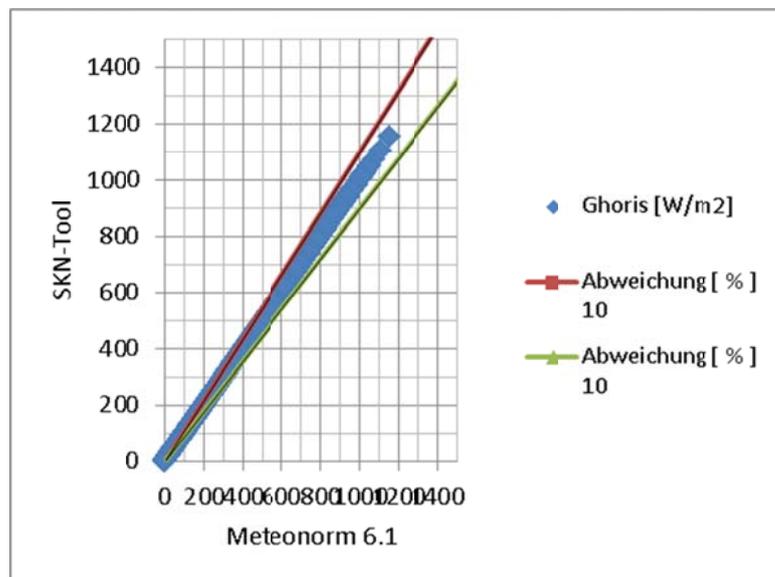


Figure 2 Hourly radiation value G deviation SKN Tool and Meteonorm 6.1 for Davos

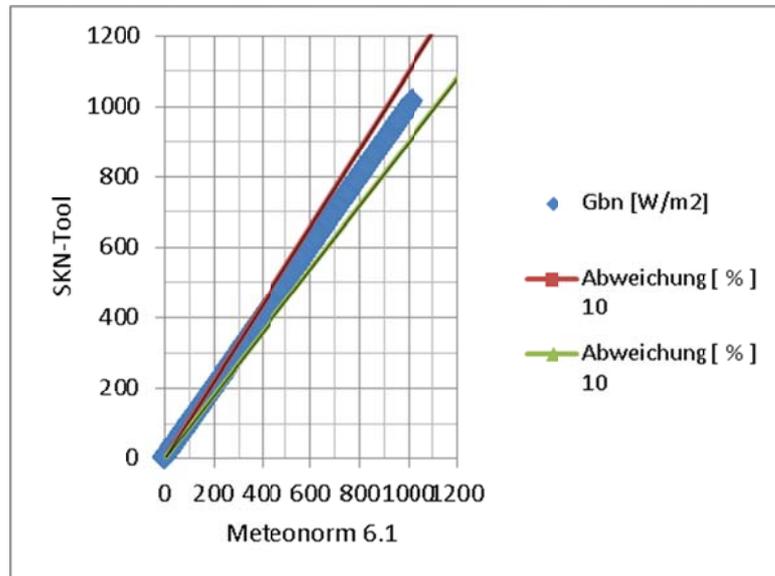


Figure 3 Normal beam radiation deviation between SKN Tool and Meteororm 6.1 for Davos

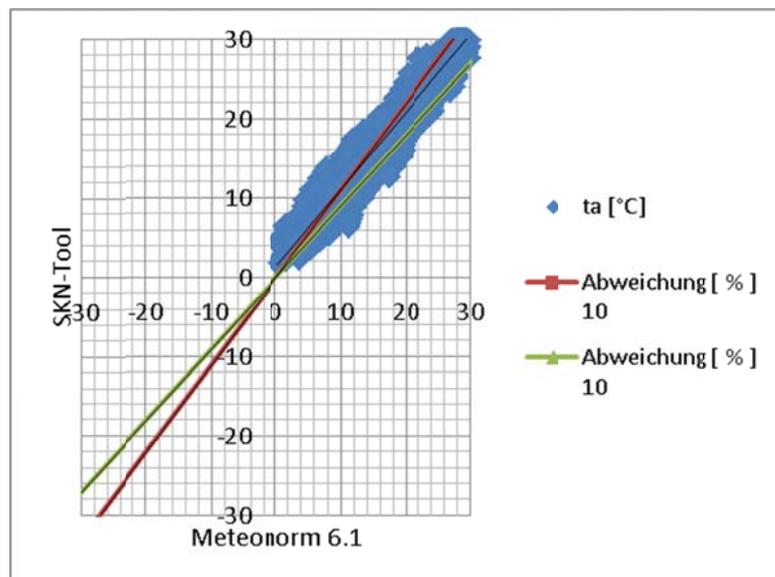


Figure 4 Ambient temperature deviation between SKN Tool and Meteororm 6.1 for Athens

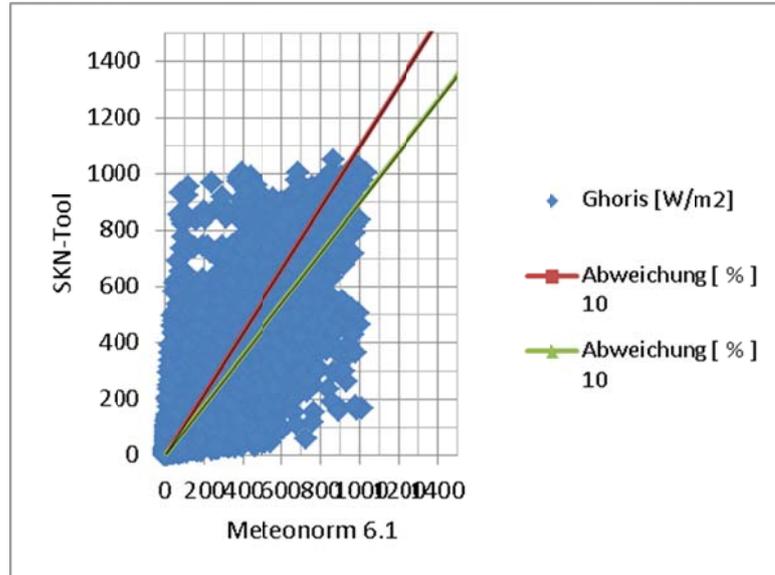


Figure 5 Hourly radiation value G deviation SKN Tool and Meteonorm 6.1 for Athens

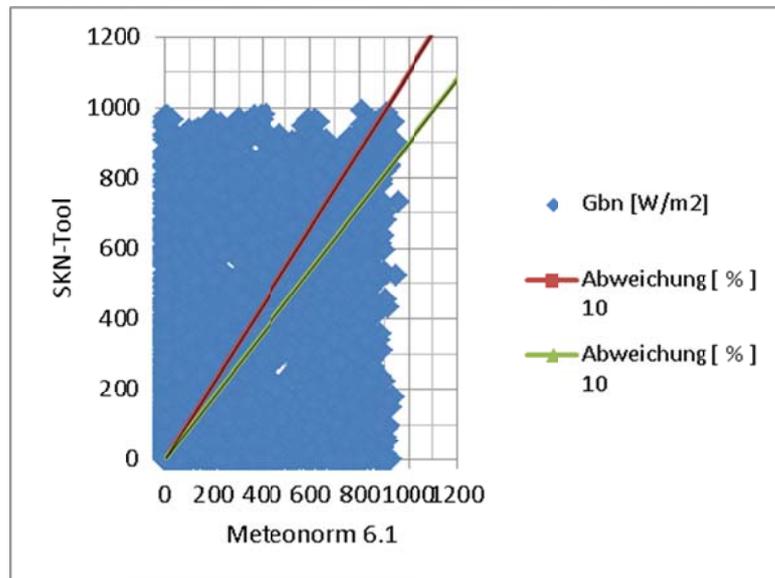


Figure 6, Normal beam radiation deviation between SKN Tool and Meteonorm 6.1 for Athens

For this reason the weather data implemented in the SKN Tool were compared towards Meteonorm 6.1 data and a trnsys integrated irradiance

calculation tool. The report shows the maximum deviation (figure 1 to figure 3) and the minimal deviation (figure 4 to figure 6) on the bases of hourly values. Although the deviation is enormous in Athens the influence is mostly in the hourly distribution. So check sum figures on essential values like beam radiation and so on show not such a wide deviation. So the deviation within the results is acceptable.

Table 1, Check sum of beam radiation

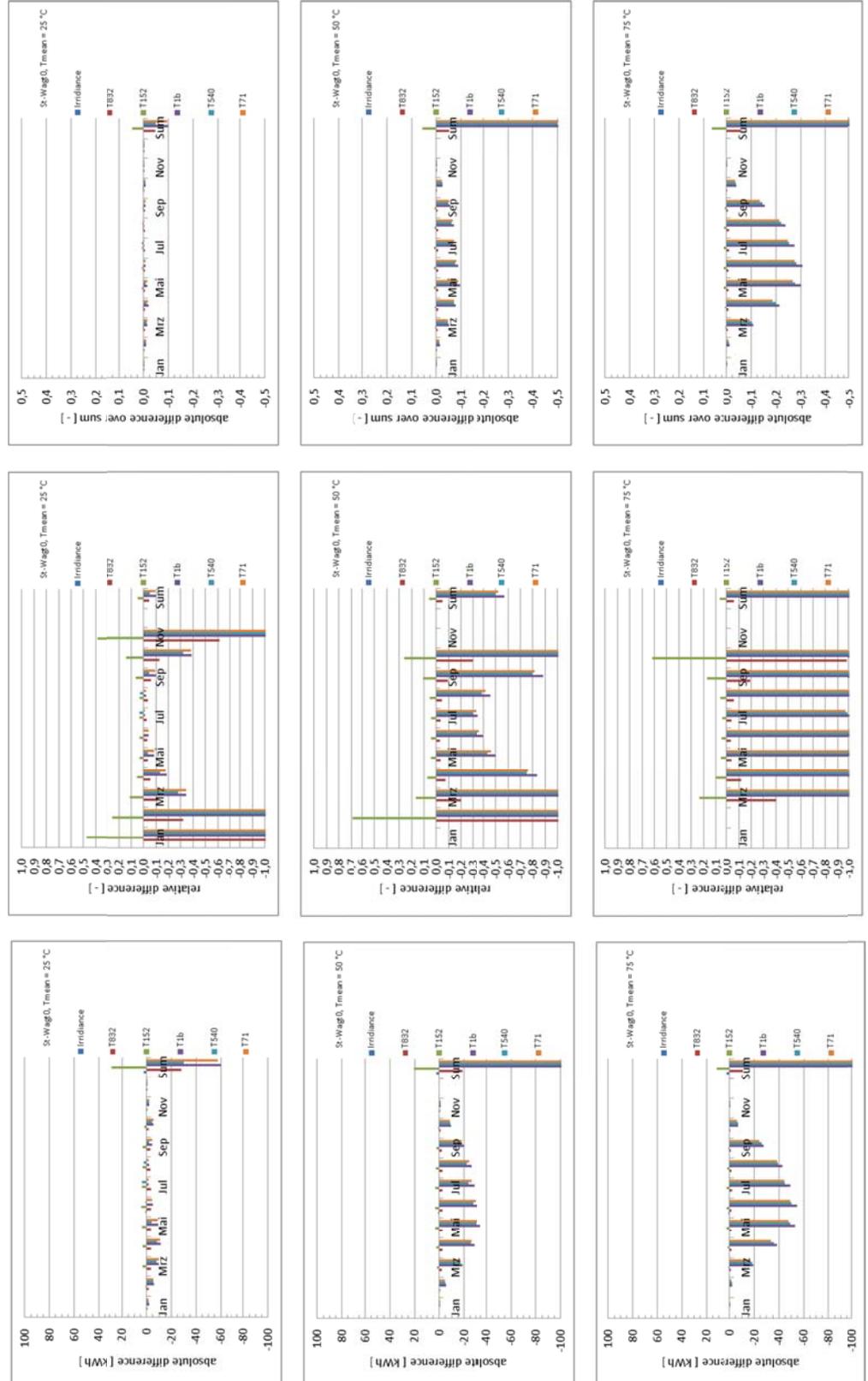
Deviation [-]	-0,03	-0,06	-0,01
Check Sum Gb [kWh]	1566	1456	2965

1.4 Inter-comparison of yearly collector energy gain and radiation data

The collector yield is calculated in the SKN Tool at special angles and location in combination with three different operation temperature levels. This was "re-build" in trnsys too. The results show that in situation where the angle is low (especially beta) the results are nicely fitting together. For situations at an incidence angle of 90 in combination with a deviation from south of 90 the deviation gets enormous at some locations (Athens) for others (Stockholm) it is still fine. In the following figures these results are shown on two examples; Athens and Stockholm as they identified maximum and minimum deviations in the comparison of four locations. The numbers in brackets behind the location give the azimuth and inclination angle.

On the other hand the following figure shows as well the deviation different trnsys types generate calculating the identical collector in the very same situation for Stockholm. For Athens these deviations especially in the sum (last column) are even lower.

Figure 7, (next page) Deviation in sum in the collector yield at different temperature levels generated by different trnsys types in comparison with the SKN Tool (relative and absolute and in absolute sum)



1.4.1 Type 832

In the following chapters the results of the analysis for the type 832 as one of the most enhanced trnsys types are shown.

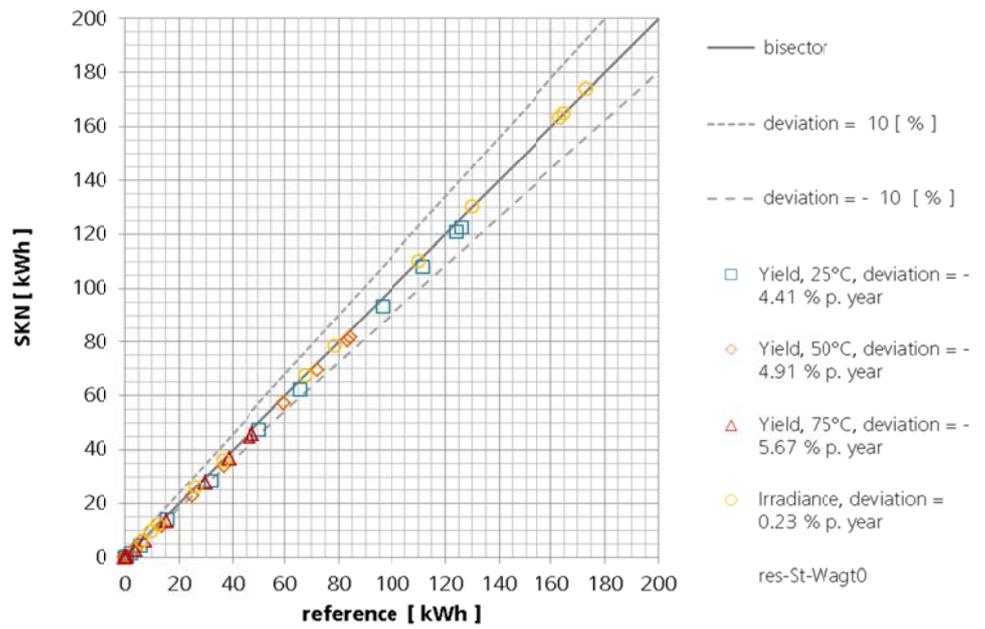


Figure 8, Deviation in Stockholm (0/0) between type 832 and SKN Tool

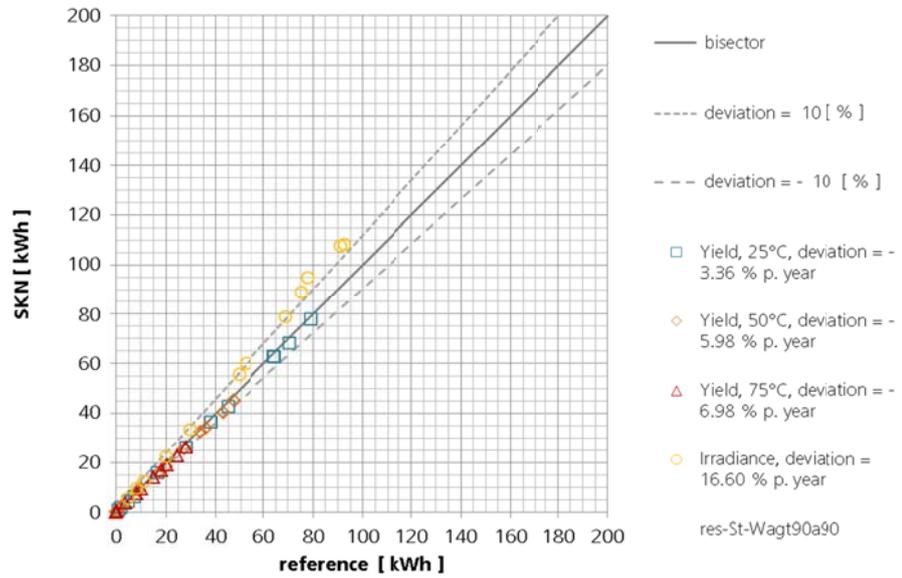


Figure 9, Deviation in Stockholm (90/90) between type 832 and SKN Tool

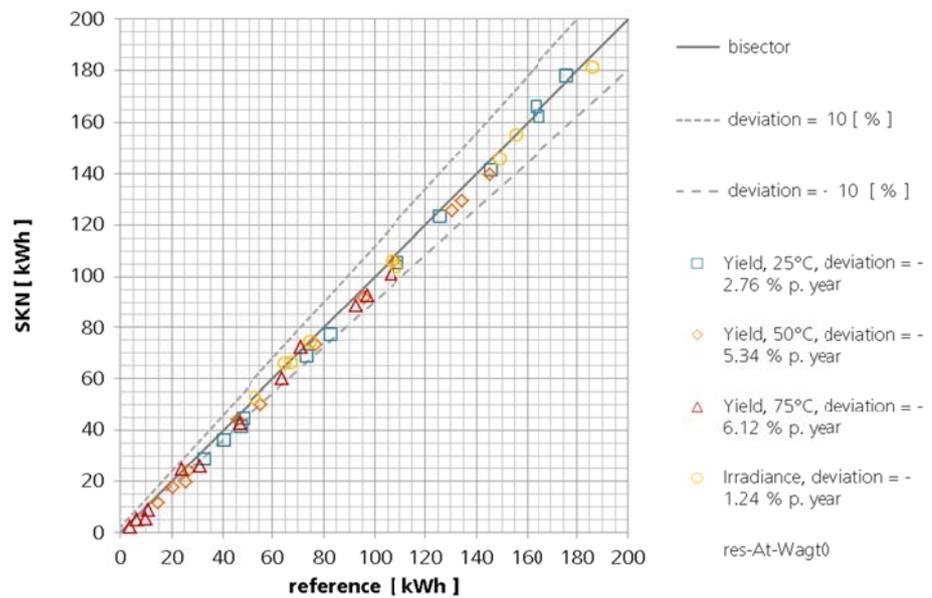


Figure 10, Deviation in Athens (0/0) between type 832 and SKN Tool

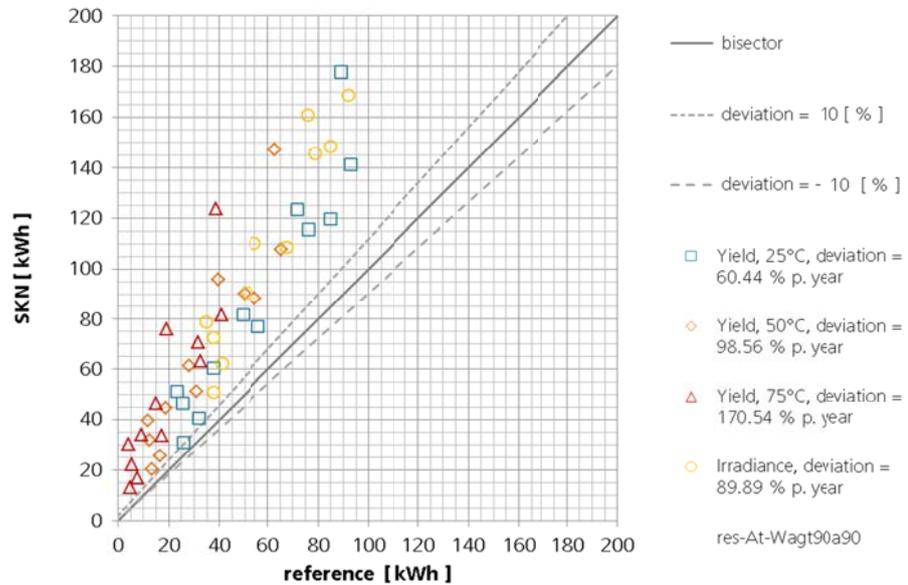


Figure 11, Deviation in Athens (90/90) between type 832 and SKN Tool

1.5 Inter-comparison of IAM based on b0 vs. IAM bi-axional table

The SKN Tool provides two different methods to type in the IAM. This is consistent with the two different methods resulting from the EN 12975-2:2006.

The results show that the deviation of using b0 or a 10° steps table in the yield are perfectly low.

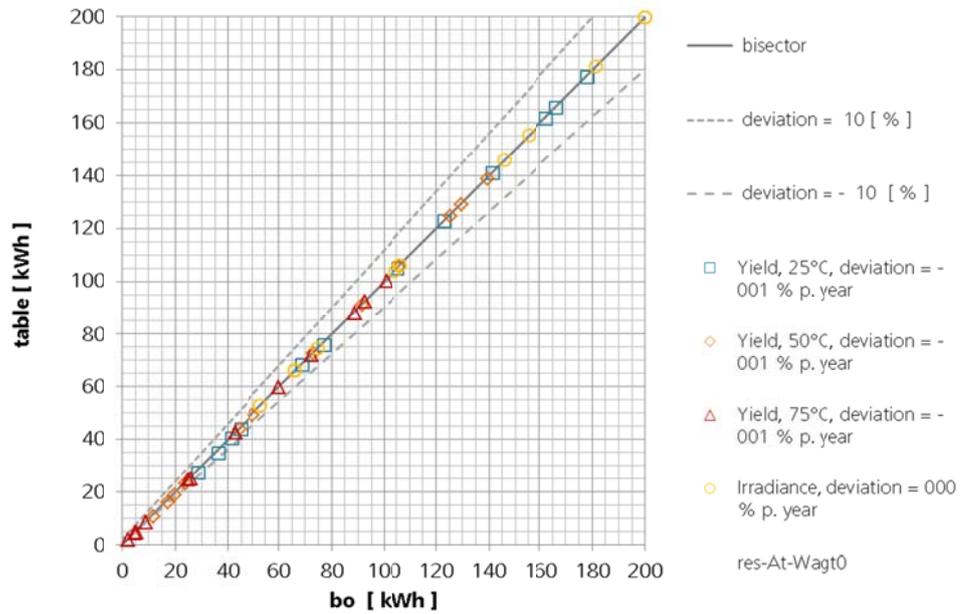


Figure 12, Deviation using b0 method vs. using 10° step table in the collector yield

1.6 Inter-comparison using an asymmetric IAM

For some special configurations it is important to be able to calculate the yield for an asymmetric acceptance angle of the collector. Therefore the comparison was done for an asymmetric not tracked collector as well. The deviations are very low.

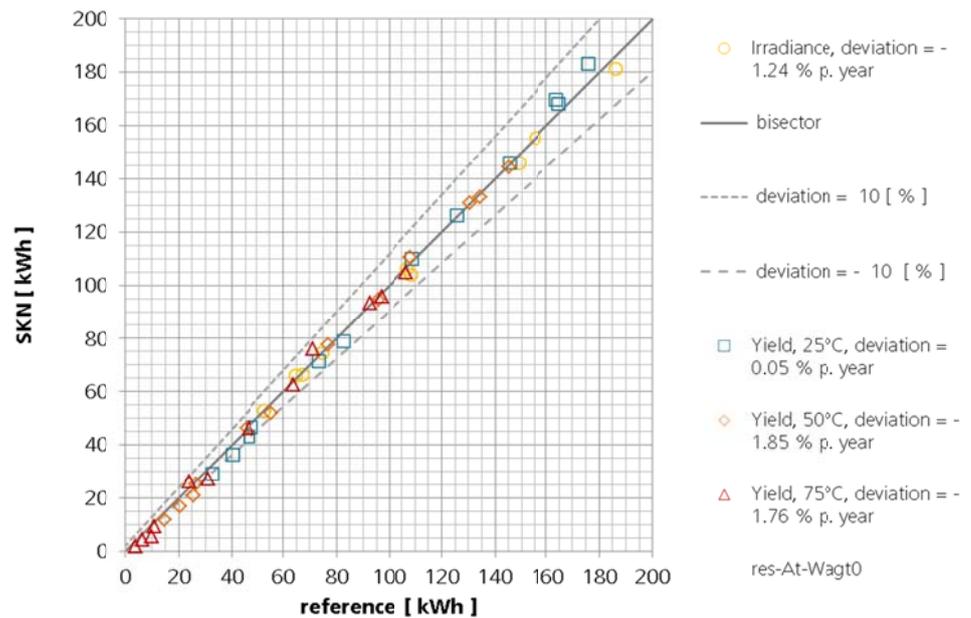


Figure 13, Deviation of an asymmetric collector construction in the yearly collector yield

1.7 Conclusions

The SKN Toll provides a quite simple to use calculation tool for yearly collector yields. The necessary input data have of course to be prepared in a consistent way, but this is possible using common programs which are commercially available. The results are over all comparable with results generated by using trnsys. It is important to see that also using different trnsys types the results are not the same for a very same collector. Therefore small deviations are almost a must.

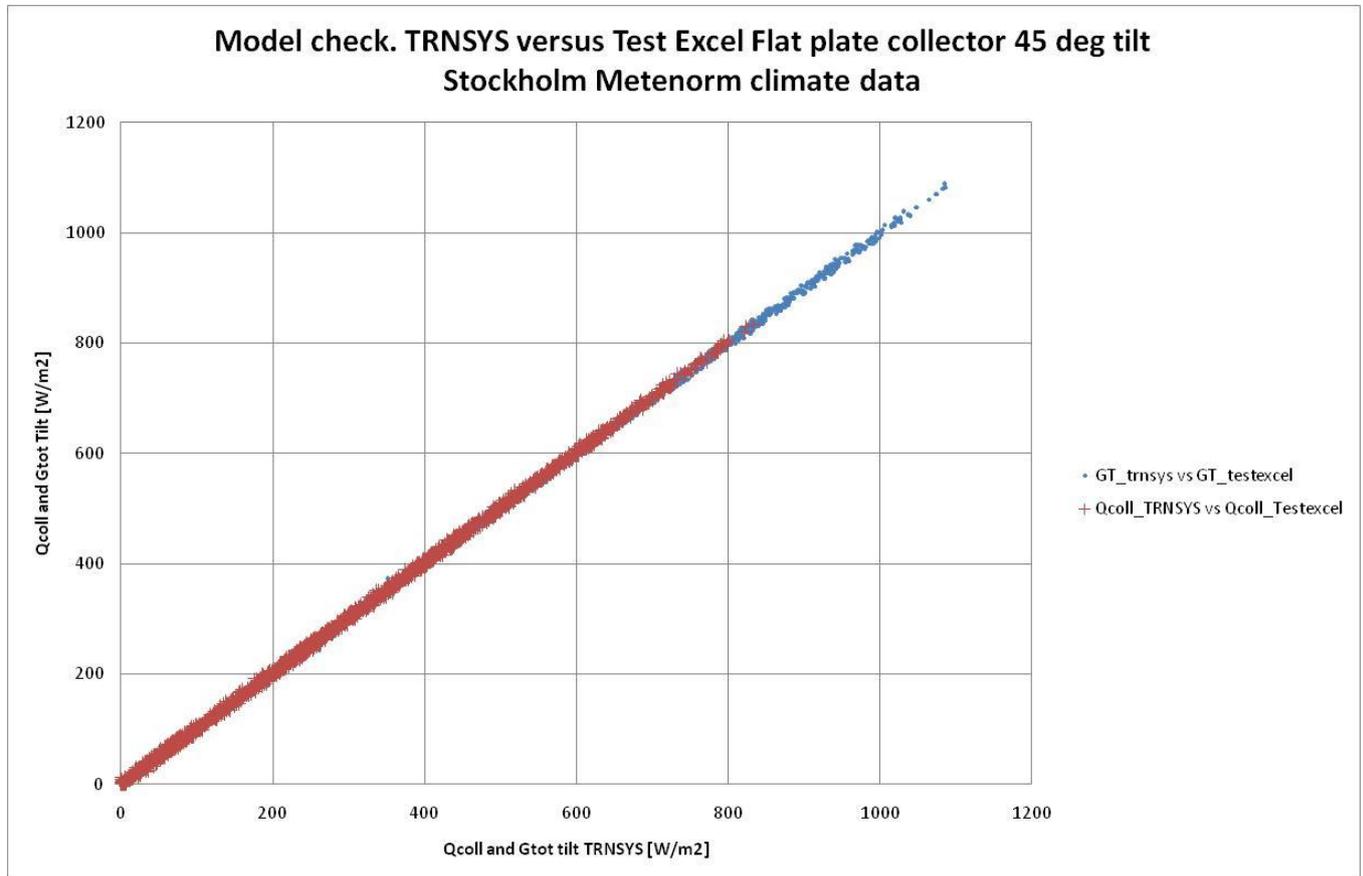
Only when it comes to big angles in combination of a high deviation in the weather data file very big deviations in the yield showed up. So this should be double checked and solved.

The SKN Tool does not take into account any system aspects and is therefore only meant to compare performance results of different collectors. One very important factor of a collector in correspondence with the complete system is its heat capacity. This parameter is as well ignored.

The Tool can therefore not answer the question what collector is the better or which collector should be bought.

Also it is very important to keep track with technological development, meaning to enlarge and adapt the SKN Tool contiguously. (e.g. air heaters, PVt collectors, ...)

Check of test-Excel versus TRNSYS Type 136 Hay simulation. Climate Stockholm Metenorm. Collector tilt 45 deg and Tracking options.



Fixed mounting 45 deg south

	GTtot	GTbeam	Gtdiff	Qcoll 25C	Qcoll 50C	Qcoll 75C
EXCEL Test sheet BP	1203.0	670.7	532.3	724.6	462.5	252.1
TRNSYS type 136 Hay	1204.5	672.7	531.7	722.8	460.9	251.0
Excel/TRNSYS	0.999	0.997	1.001	1.002	1.003	1.004

Two axis Tracking 50C

Twoaxis track. 50C	GTtot	GTbeam	Gtdiff	Qcoll 50C
EXCEL Test sheet BP	1649.5	1049.1	600.4	786.5
TRNSYS type 136 Hay	1651.4	1049.2	602.2	783.1
Excel/TRNSYS	0.999	1.000	0.997	1.004

Vertical Axis 45 collector tilt 50C

Vertical axis 50C	GTtot	GTbeam	Gtdiff				Qcoll 50C		
EXCEL Test sheet BP	1569.1	972.2	596.9				711.8		
TRNSYS type 136 Hay	1570.7	972.3	598.4				708.2		
Excel/TRNSYS	0.999	1.000	0.997				1.005		

EW axis 50C

EW horis. axis 50C	GTtot	GTbeam	Gtdiff				Qcoll 50C		
EXCEL Test sheet BP	1301.9	755.5	546.4				507.3		
TRNSYS type 136 Hay	1303.4	755.7	547.6				503.6		
Excel/TRNSYS	0.999	1.000	0.998				1.007		

NS axis 50C

NS horis. axis 50C	GTtot	GTbeam	Gtdiff				Qcoll 50C		
EXCEL Test sheet BP	1399.8	836.8	563.0				584.9		
TRNSYS type 136 Hay	1400.7	836.7	564.1				581.3		
Excel/TRNSYS	0.999	1.000	0.998				1.006		

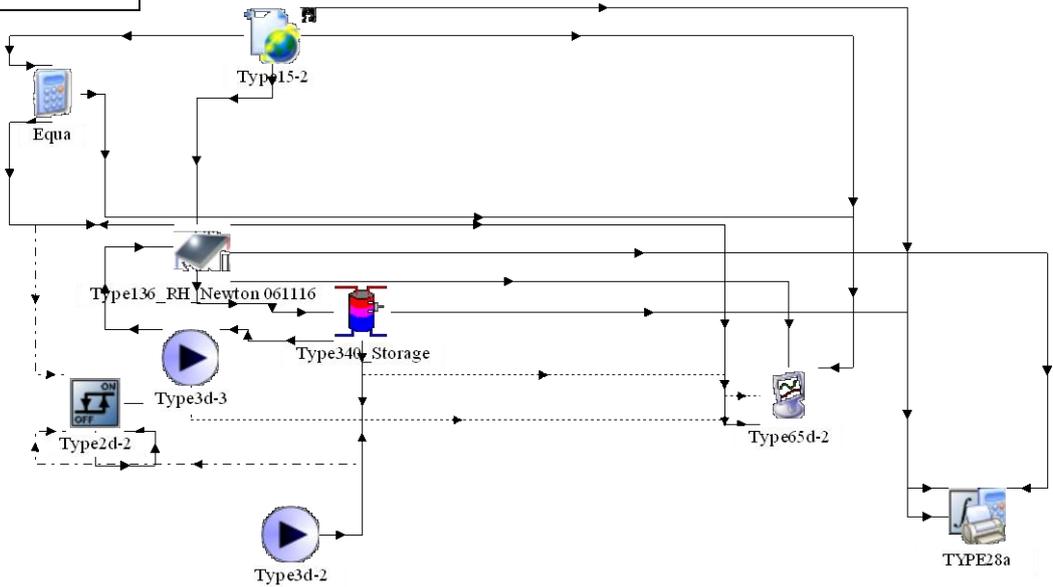
Some important input data for the calculation comparisons

Flat plate collector. b0 Incidence angle function. Climate Stockholm. TRNSYS very low mCe value assumed to give close to static results. Radiaton model to tilted surface: Hay and Davies.

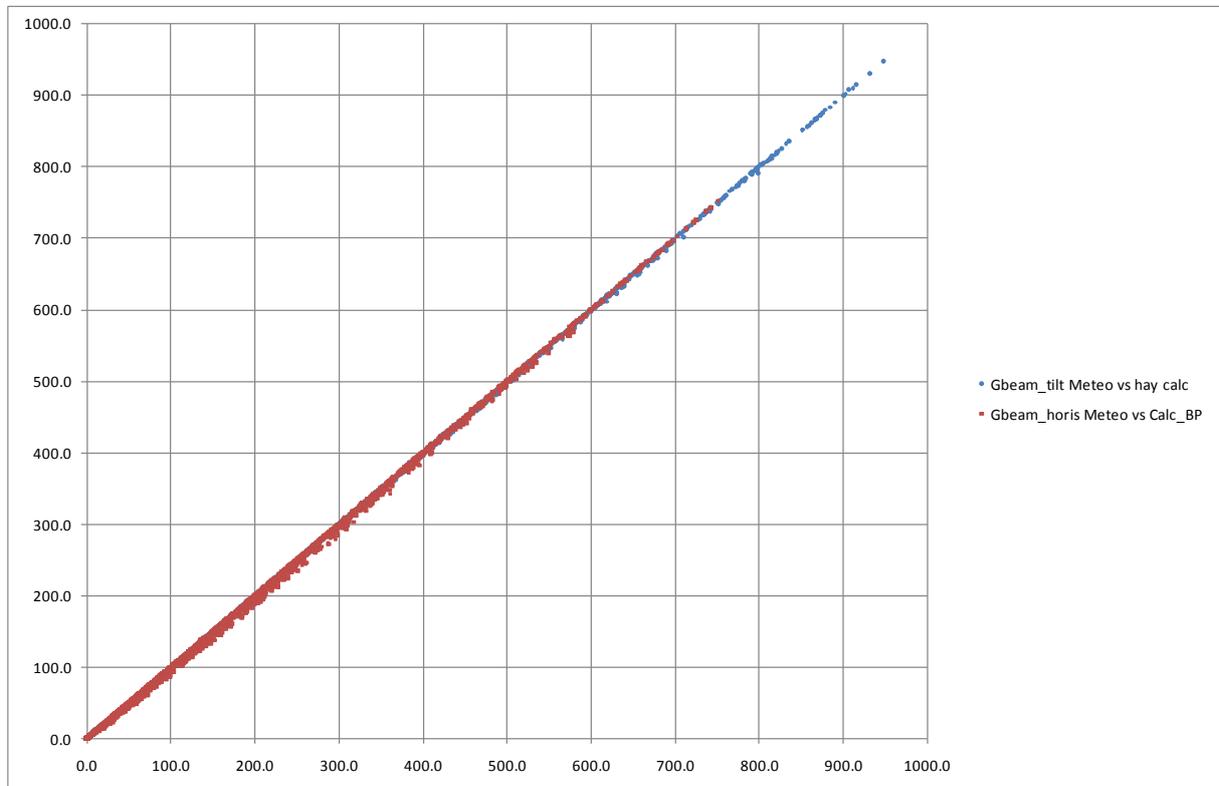
	Flat plate		
F'ta_en	0.8	Summer timeshift=1	0
Ktätadiff	0.9	Latitude Climate	59.35
b0	0.15	Longitude climate	-17.95
c1 (tm-ta)	3.5	Longitude timezone	-15
c2 (tm-ta)^2	0.02	Collector Tilt	45
c3 wind*(tm-ta)	0	Collector Azimuth	0
c4 (EL-Ta^4)	0		
c5 dTm/dt	0		
c6 wind*Gtot	0		
Korrektion vind	0.5		

TRNSYS model layout

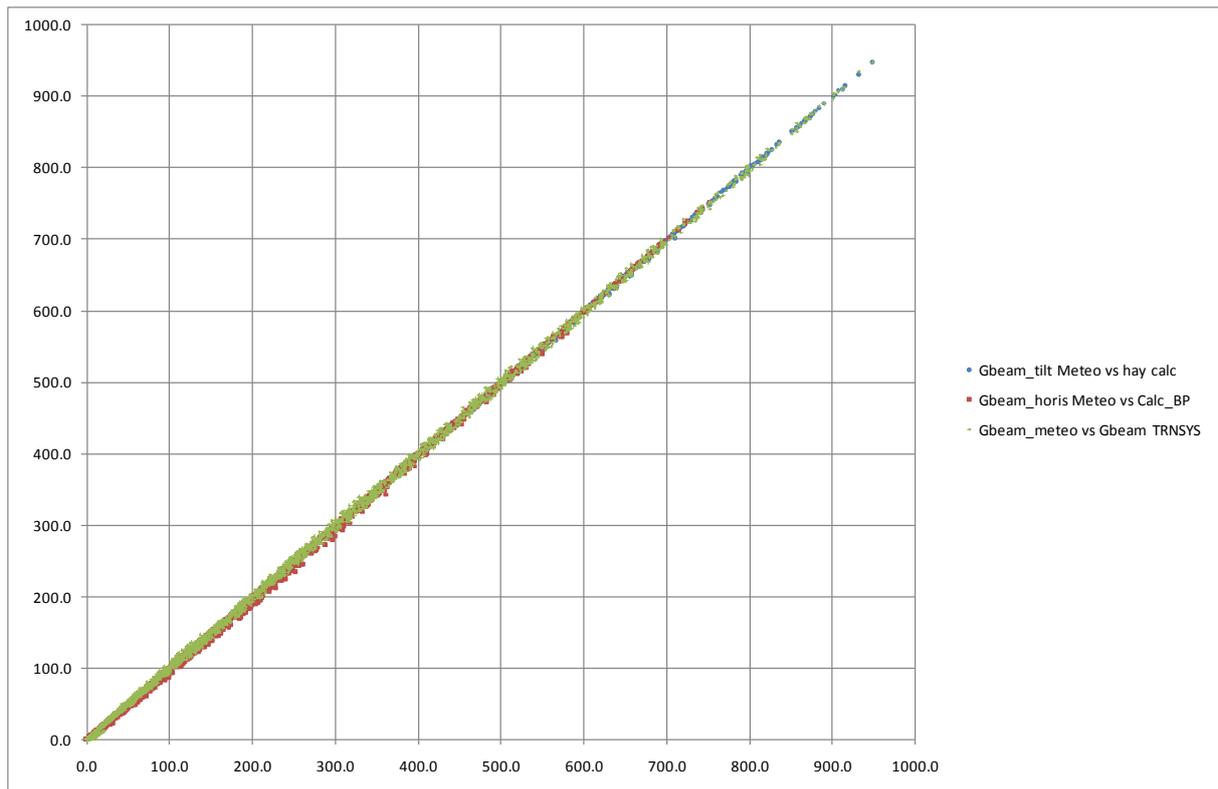
TRNSYS för jämförelse mot SP Excel
2011 Parametrar från SP excel.
Klimat Stockholm Meteonorm Hay
1996-2005.



Check of Beam Radiation Meteonorm Test_excel and TRNSYS. Both on horizontal surface and tilted surface 45 deg.



Beam Radiation on horizontal surface and tilted surface 45 deg. Stockholm



Gbeam on horizontal and tilted surface Teste Excel, Meteonorm and TRNSYS.