

Annex to Solar Keymark Certificate						Licence Number		011-7S471 R			
						Date issued		2021-06-24			
						Issued by		ISFH CalTeC			
Licence holder		AkoTec Produktionsgesellschaft mbH				Country		Germany			
Brand (optional)						Web		http://www.akotec.eu			
Street, Number		Grundmühlenweg, 3				E-mail		info@akotec.eu			
Postcode, City		D-16278 Angermünde				Tel		+49 3331 2571640			
Collector Type						Evacuated tubular collector					
Collector name	Gross height	Gross area (A_G)	Gross length	Gross width	Aperture area (A_a)	Power output per collector					
						G _b = 850 W/m ² , G _d = 150 W/m ² & u = 1.3 m/s θ _m - θ _a					
						0 K	10 K	30 K	50 K	70 K	88 K
	mm	m ²	mm	mm	m ²	W	W	W	W	W	W
Weiser Power 1000	120	1.57	2 110	745	1.44	907	889	850	806	757	709
Weiser Power 1500	120	2.36	2 110	1 120	2.16	1 363	1 337	1 278	1 212	1 138	1 065
Weiser Power 2000	120	3.15	2 110	1 495	2.89	1 820	1 784	1 706	1 618	1 519	1 422
Weiser Power 3000	120	4.74	2 110	2 245	4.33	2 733	2 680	2 562	2 429	2 282	2 136
Power output per m² gross area						577	566	541	513	482	451
Performance parameters test method		Steady state - outdoor									
Performance parameters (related to A_G)		η ₀ , b	a1	a2	a3	a4	a5	a6	a7	a8	Kd
Units		-	W/(m ² K)	W/(m ² K ²)	J/(m ³ K)	-	J/(m ² K)	s/m	W/(m ² K ⁴)	W/(m ² K ⁴)	-
Test results		0.583	1.08	0.004			4 100				0.93
Incidence angle modifier test method		Quasi dynamic - outdoor									
Incidence angle modifier		Angle	10°	20°	30°	40°	50°	60°	70°	80°	90°
Transversal		K _{θT, coll}	1.02	1.05	1.05	1.04	1.05	1.05	0.87	0.43	0.00
Longitudinal		K _{θL, coll}	1.00	0.99	0.98	0.95	0.91	0.84	0.69	0.34	0.00
Heat transfer medium for testing						Water					
Flow rate for testing (per gross area, A_G)						dm/dt		0.020	kg/(sm ²)		
Maximum temperature difference during thermal performance test						(θ _m -θ _a) _{max}		58	K		
Standard stagnation temperature (G = 1000 W/m²; θ_a = 30 °C)						θ _{stg}		310	°C		
Maximum operating temperature						θ _{max, op}		100	°C		
Maximum operating pressure						p _{max, op}		100	kPa		
Testing laboratory		Institut für Solarenergieforschung GmbH				http://www.isfh.de					
Test report(s)		16-19/K1 50-19/KT1				Dated		21.06.2021 21.06.2021			
Comments of testing laboratory						Datasheet version: 6.0, 2018-10-30					
The given collector efficiency parameters were determined at the collector type Weiser Power 3000 (report No. 16-19/K1). The power output for each subtype was calculated with the collector efficiency parameters from the Weiser Power 3000.						Institut für Solarenergieforschung GmbH An Ohrberg 1 D-31880 Emmen Tel.: 05151/999-100 Fax: 05151/999-500					
DIN CERTCO • Alboinstraße 56 • 12103 Berlin, Germany Tel: +49 30 7562-1131 • Fax: +49 30 7562-1141 • E-Mail: info@dincertco.de • www.dincertco.de											

Annex to Solar Keymark Certificate										Licence Number		011-7S471 R	
Supplementary Information										Issued		2021-06-24	
Annual collector output in kWh/collector at mean fluid temperature ϑ_m													
Standard Locations		Athens			Davos			Stockholm			Würzburg		
Collector name	ϑ_m	25°C	50°C	75°C	25°C	50°C	75°C	25°C	50°C	75°C	25°C	50°C	75°C
Weiser Power 1000		1 549	1 361	1 169	1 323	1 142	969	951	801	662	1 022	861	710
Weiser Power 1500		2 329	2 046	1 757	1 988	1 718	1 456	1 430	1 204	995	1 536	1 294	1 067
Weiser Power 2000		3 108	2 732	2 345	2 654	2 293	1 944	1 909	1 608	1 328	2 050	1 727	1 424
Weiser Power 3000		4 667	4 102	3 522	3 986	3 443	2 919	2 867	2 414	1 994	3 078	2 594	2 139
Annual output per m ² gross area		985	866	744	841	727	616	605	510	421	650	548	451
Fixed or tracking collector		Fixed (slope = latitude - 15°; rounded to nearest 5°)											
Annual irradiation on collector plane		1765 kWh/m ²			1714 kWh/m ²			1166 kWh/m ²			1244 kWh/m ²		
Mean annual ambient air temperature		18.5°C			3.2°C			7.5°C			9.0°C		
Collector orientation or tracking mode		South, 25°			South, 30°			South, 45°			South, 35°		
The collector is operated at constant temperature ϑ_m (mean of in- and outlet temperatures). The calculation of the annual collector performance is performed with the official Solar Keymark spreadsheet tool Scenocalc Ver. 6.0 (October 2018). A detailed description of the calculations is available at www.solarkeymark.org/scenocalc													
Additional Information													
Collector heat transfer medium										Water-Glycole			
The collector is deemed to be suitable for roof integration										No			
The collector was tested successfully under the following conditions:													
Climate class (A+, A, B or C)										A		--	
G (W/m ²) >		1000		ϑ_a (°C) >		20		H _x (MJ/m ²) >		600			
Maximum tested positive load										4500		Pa	
Maximum tested negative load										3250		Pa	
Hail resistance using steel ball (maximum drop height)										2		m	
Additional collector attribute(s)													
<input type="checkbox"/> Using external power source(s) for normal operation <input type="checkbox"/> Active or passive measure(s) for self-protection <input type="checkbox"/> Co-generating thermal and electrical power <input type="checkbox"/> Wind and/or infrared sensitive collector(s) (WISC) <input type="checkbox"/> Façade collector(s)													
Energy Labelling Information													
	Reference Area, A _{sol} (m ²)		Hydraulic Designation Code										
Weiser Power 1000	1.57		10-VH-12S-A:5,3880-C:13,745										
Weiser Power 1500	2.36		15-VH-12S-A:5,3880-C:13,1115										
Weiser Power 2000	3.15		20-VH-12S-A:5,3880-C:13,1495										
Weiser Power 3000	4.74		30-VH-12S-A:5,3880-C:13,2245										
Data required for CDR (EU) No 811/2013 - Reference Area A_{sol}													
Collector efficiency (η_{col})		53%											
Remark: Collector efficiency (η_{col}) is defined in CDR (EU) No 811/2013 as collector efficiency of the solar collector at a temperature difference between the solar collector and the surrounding air of 40 K and a global solar irradiance of 1000 W/m ² , expressed in % and rounded to the nearest integer. Deviating from the regulation η_{col} is based on reference area (A _{sol}) which is aperture area for values according to EN 12975-2 or gross area for ISO 9806:2017.													
Data required for CDR (EU) No 812/2013 - Reference Area A_{sol}													
Zero-loss efficiency (η_0)										0.58		--	
First-order coefficient (a_1)										1.08		W/(m ² K)	
Second-order coefficient (a_2)										0.004		W/(m ² K ²)	
Incidence angle modifier IAM (50°)										0.98		--	
Remark: The data given in this section are related to collector reference area (A _{sol}) which is aperture area for values according to EN 12975-2 or gross area for ISO 9806. Consistent data sets for either aperture or gross area can be used in calculations like in the regulation 811 and 812 and simulation programs.													
DIN CERTCO • Alboinstraße 56 • 12103 Berlin, Germany Tel: +49 30 7562-1131 • Fax: +49 30 7562-1141 • E-Mail: info@dincertco.de • www.dincertco.de													

Explanation of the Solar Keymark certificate

For a quick and easy assessment of a collector's performance, you should take a look at the second or fourth page of the Keymark certificate. Here, the expected annual yields are given for the respective collectors, depending on the location and the temperature difference between the collector and the outside temperature. These values are determined by a simulation taking into account the location, position of the sun and weather influences. The collectors are optimally aligned in this simulation. The difference in yield between collectors with power and standard tubes is clearly visible here, for example.

DF-collector with reflector

Annual collector output in kWh/collector at mean fluid temperature ϑ_m													
Standard Locations		Athens			Davos			Stockholm			Würzburg		
Collector name	ϑ_m	25°C	50°C	75°C	25°C	50°C	75°C	25°C	50°C	75°C	25°C	50°C	75°C
Weiser Power 1000		1 549	1 361	1 169	1 323	1 142	969	951	801	662	1 022	861	710
Weiser Power 1500		2 329	2 046	1 757	1 988	1 718	1 456	1 430	1 204	995	1 536	1 294	1 067
Weiser Power 2000		3 108	2 732	2 345	2 654	2 293	1 944	1 909	1 608	1 328	2 050	1 727	1 424
Weiser Power 3000		4 667	4 102	3 522	3 986	3 443	2 919	2 867	2 414	1 994	3 078	2 594	2 139

DF-collector without reflector

Annual collector output in kWh/collector at mean fluid temperature ϑ_m													
Standard Locations		Athens			Davos			Stockholm			Würzburg		
Collector name	ϑ_m	25°C	50°C	75°C	25°C	50°C	75°C	25°C	50°C	75°C	25°C	50°C	75°C
Weiser Power 800		1 281	1 122	937	1 096	931	758	788	655	519	845	703	556
Weiser Power 1200		1 926	1 686	1 408	1 648	1 399	1 140	1 185	984	780	1 270	1 056	835
Weiser Power 1600		2 571	2 251	1 879	2 200	1 868	1 521	1 582	1 313	1 041	1 696	1 410	1 115
Weiser Power 2400		3 861	3 381	2 822	3 304	2 805	2 285	2 375	1 972	1 564	2 546	2 118	1 675

Figure1: Comparison of yields per collector in Würzburg at $T_m = 50^\circ\text{C}$

For a comparison with other collectors, the yields must be divided by the gross area of the respective collector. The yield per square meter of collector area is then obtained.

Difference in efficiency between power and standard collectors

The certificate shows that the efficiency of our collectors with power tubes is lower than that of our collectors with standard tubes.

DF-collector without reflector (page 1)

η_0, b	a_1	a_2
-	$W/(m^2K)$	$W/(m^2K^2)$
0.495	0.80	0.007

ca. +15 %

DF-collector with reflector (page 1)

η_0, b	a_1	a_2
-	$W/(m^2K)$	$W/(m^2K^2)$
0.583	1.08	0.004

Fig. 2: Difference in efficiency between df standard and power tube collectors with vertical irradiation

The reason for this is that the efficiency calculations are based on the aperture area at vertical irradiation. This is larger for collectors with power tubes than for those with standard tubes. Due to the design, only very little light hits the additional rear absorber surface of the power tubes at exactly vertical irradiation.

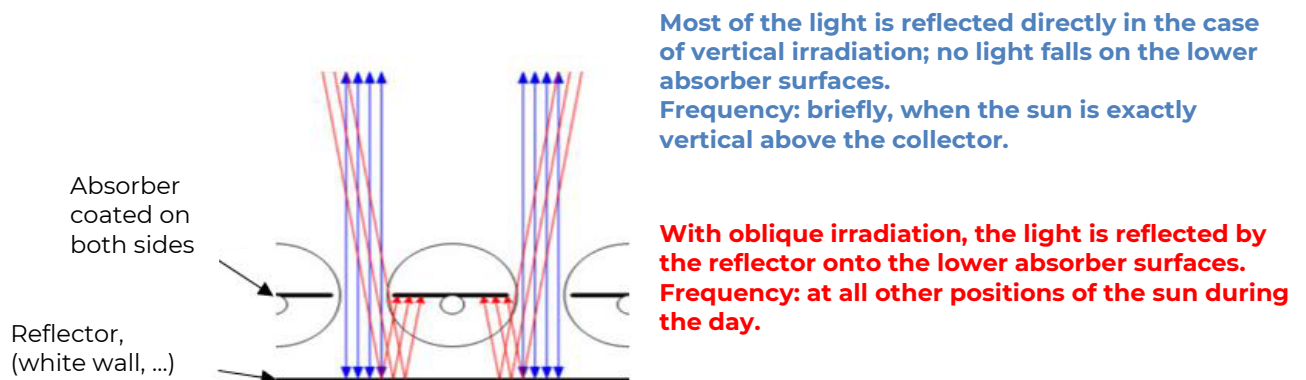


Figure3: Radiation pattern with power tubes and different positions of the sun

This is why collectors with power tubes have almost the same peak output as standard collectors. If the almost identical peak output is now related to the larger aperture area of the power collector, this results in a lower efficiency. As soon as the light falls on the power collector at an angle and the rear absorber surface is irradiated, the efficiency increases.

[1] The aperture area describes the area through which usable light enters the collector. With standard tubes, this is only the area where there are actually tubes. With power tubes, the light that passes between the tubes and is reflected by a surface behind them onto the backs of the tubes is also used. For this reason, the area between the tubes also counts towards the aperture area for power tubes with an absorber on the back. This is therefore larger than for a collector with standard tubes without rear absorbers.

A reflector is required so that the power collectors can achieve their full output. A white façade or a zinc sheet roof can serve as a reflector. Tiles can be provided with a special paint/coating.

Please note: The reflector is not part of the collectors and must be provided by the customer or can be ordered separately. Without a reflector, only the yields of a standard collector are achieved.

The measured angle influence factors are listed directly below the efficiency in the Keymark certificate.

Incidence angle modifier test method		Quasi dynamic - outdoor								
Incidence angle modifier	Angle	10°	20°	30°	40°	50°	60°	70°	80°	90°
Transversal	$K_{\theta T, coll}$	1.02	1.05	1.05	1.04	1.05	1.05	0.87	0.43	0.00
Longitudinal	$K_{\theta L, coll}$	1.00	0.99	0.98	0.95	0.91	0.84	0.69	0.34	0.00

Figure4: Angle influence factors of the df collector with power tubes (page 2)

They describe the increase in output with a change in the angle of irradiation. For example, the output is 1.04 times higher at an angle of irradiation of 10° than with vertical irradiation.