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ISFH CalTeC



| Annex to Solar Keymark Certificate | Licence Number | 011-7S2994 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 area ($A_G$) | Gross length | Gross width | Gross height | Power output per collector Gb = 850 W/m2, Gd = 150 W/m2 & u = 1.3 m/s $\vartheta_m - \vartheta_a$ | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 0 K | 10 K | 30 K | 50 K | 70 K | 92 K |
| | m² | mm | mm | mm | W | W | W | W | W | W |
| **Weiser Power 800** | 1.57 | 2 110 | 745 | 128 | 763 | 750 | 715 | 672 | 620 | 553 |
| **Weiser Power 1200** | 2.36 | 2 110 | 1 120 | 128 | 1 148 | 1 127 | 1 076 | 1 011 | 932 | 831 |
| **Weiser Power 1600** | 3.15 | 2 110 | 1 495 | 128 | 1 532 | 1 504 | 1 436 | 1 349 | 1 244 | 1 109 |
| **Weiser Power 2400** | 4.74 | 2 110 | 2 245 | 128 | 2 301 | 2 259 | 2 156 | 2 026 | 1 869 | 1 665 |
| Power output per m² gross area | | | | | 486 | 477 | 455 | 428 | 395 | 351 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Performance parameters test method | Steady state - outdoor | | | | | | | | | |
| Performance parameters (related to $A_G$) | η0, b | a1 | a2 | a3 | a4 | a5 | a6 | a7 | a8 | Kd |
| Units | - | W/(m²K) | W/(m²K²) | J/(m³K) | - | J/(m²K) | s/m | W/(m²K⁴) | W/(m²K⁴) | - |
| Test results | 0.495 | 0.80 | 0.007 | | | 4 060 | | | | 0.88 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Incidence angle modifier test method | | Quasi dynamic - outdoor | | | | | | | | |
| Incidence angle modifier | Angle | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° |
| Transversal | $K_{\theta T,coll}$ | 1.01 | 1.02 | 1.03 | 1.04 | 1.07 | 1.08 | 0.83 | 0.42 | 0.00 |
| Longitudinal | $K_{\theta L,coll}$ | 1.00 | 0.99 | 0.98 | 0.96 | 0.93 | 0.87 | 0.75 | 0.38 | 0.00 |

| | | | |
|---|---|---|---|
| Heat transfer medium for testing | Water | | |
| Flow rate for testing (per gross area, $A_G$) | dm/dt | 0.020 | kg/(sm²) |
| Maximum temperature difference during thermal performance test | $(\vartheta_m-\vartheta_a)_{max}$ | 62 | K |
| Standard stagnation temperature (G = 1000 W/m²; $\vartheta_a$ = 30 °C) | $\vartheta_{stg}$ | 280 | °C |
| Maximum operating temperature | $\vartheta_{max\ op}$ | 100 | °C |
| Maximum operating pressure | $p_{max,op}$ | 1000 | kPa |

| | | | |
|---|---|---|---|
| Testing laboratory | ISFH CalTeC | http://www.isfh.de | |
| Test report(s) | 016-20/KT1 | Dated | 21.06.2021 |
| | 16-19/K1 | | 21.06.2021 |
| | 50-19/KT1 | | 21.06.2021 |

**Comments of testing laboratory** — Datasheet version: 6.1, 2019-07-11

The given collector efficiency parameters were determined at the collector type Weiser Power 2400 (report No. 016-20/KT1). The power output for each subtype was calculated with the collector efficiency parameters from the Weiser Power 2400.

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|---|---|---|---|
| **Annex to Solar Keymark Certificate** | | **Licence Number** | **011-7S2994 R** |
| **Supplementary Information** | | **Issued** | **2021-06-24** |

**Annual collector output in kWh/collector at mean fluid temperature $\vartheta_m$**

| **Standard Locations** | **Athens** | | | **Davos** | | | **Stockholm** | | | **Würzburg** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Collector name** $\vartheta_m$ | **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 |
| | | | | | | | | | | | | |
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| | | | | | | | | | | | | |
| Annual output per m² gross area | 815 | 714 | 596 | 698 | 592 | 482 | 501 | 416 | 330 | 538 | 447 | 353 |
| Annual efficiency, $\eta_a$ | 46% | 40% | 34% | 43% | 36% | 30% | 43% | 36% | 28% | 43% | 36% | 28% |
| Fixed or tracking collector | Fixed (slope = latitude - 15°; rounded to nearest 5°) | | | | | | | | | | | |
| Annual irradiation on collector plane | 1765 kWh/m² | | | 1630 kWh/m² | | | 1166 kWh/m² | | | 1244 kWh/m² | | |
| 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 ϑm (mean of in- and outlet temperatures). The calculation of the annual collector performance is performed with the official Solar Keymark spreadsheet tool Scenocalc Ver. 6.1 (July 2019). A detailed description of the calculations is available at http://www.estif.org/solarkeymarknew/

## 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 | -- |
| Maximum tested positive load | 4500 | Pa |
| Maximum tested negative load | 3250 | Pa |
| Hail resistance using steel ball (maximum drop height) | 2 | m |

| | | | | | |
|---|---|---|---|---|---|
| G (W/m²) > | 1000 | $\vartheta_a$ (°C) > | 20 | $H_X$ (MJ/m²) > | 600 |

## Additional collector attribute(s)

- ☐ Using external power source(s) for normal operation
- ☐ Active or passive measure(s) for self-protection
- ☐ Co-generating thermal and electrical power
- ☐ Façade collector(s)

## Energy Labelling Information

| | Reference Area, $A_{sol}$ (m²) |
|---|---|
| Weiser Power 800 | 1.57 |
| Weiser Power 1200 | 2.36 |
| Weiser Power 1600 | 3.15 |
| Weiser Power 2400 | 4.74 |
| | |
| | |
| | |
| | |

## Additional Informative Technical Data

| **Hydraulic Designation Code** | Aperature Area, $A_a$ (m²) |
|---|---|
| 10-VH-12S-A:5,3880-C:13,745 | 1.01 |
| 15-VH-12S-A:5,3880-C:13,1115 | 1.52 |
| 20-VH-12S-A:5,3880-C:13,1495 | 2.03 |
| 30-VH-12S-A:5,3880-C:13,2245 | 3.04 |
| | |
| | |
| | |
| | |

**Data required for CDR (EU) No 811/2013 - Reference Area $A_{sol}$**

| | |
|---|---|
| Collector efficiency ($\eta_{col}$) | 44% |

Remark: Collector efficiency (ηcol) 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/m², expressed in % and rounded to the nearest integer. Deviating from the regulation ηcol is based on reference area (Asol) 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 ($\eta_0$) | 0.49 | -- |
| First-order coefficient ($a_1$) | 0.80 | W/(m²K) |
| Second-order coefficient ($a_2$) | 0.007 | W/(m²K²) |
| 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.*

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## 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 $\vartheta_m$ | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Standard Locations | Athens | | | Davos | | | Stockholm | | | Würzburg | | |
| Collector name $\vartheta_m$ | 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 $\vartheta_m$ | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Standard Locations | Athens | | | Davos | | | Stockholm | | | Würzburg | | |
| Collector name $\vartheta_m$ | 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 Tm = 50°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.

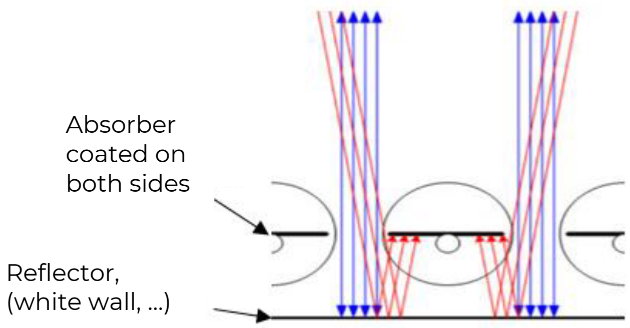
| *DF-collector without reflector (page 1)* | | |
|---|---|---|
| η0, b | a1 | a2 |
| - | W/(m²K) | W/(m²K²) |
| 0.495 | 0.80 | 0.007 |

ca. +15 % →

| *DF-collector with reflector (page 1)* | | |
|---|---|---|
| η0, b | a1 | a2 |
| - | W/(m²K) | W/(m²K²) |
| 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[1] 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.




**Most of the light is reflected directly in the case of vertical irradiation; no light falls on the lower absorber surfaces.**
**Frequency: briefly, when the sun is exactly vertical above the collector.**

**With oblique irradiation, the light is reflected by the reflector onto the lower absorber surfaces.**
**Frequency: at all other positions of the sun during the day.**

**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.

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