TÜVRheinland®
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Precisely Right.

Annex to Solar Keymark Certificate

Licence Number	**011-7S2964 F**
Date issued	**2020-01-16**
Issued by	**TÜV Rheinland Energy GmbH**

Licence holder	**LLC"Vist-Energy**	**Country**	Russia
Brand (optional)		**Web**	www.vistenergy.ru
Street, Number	Zorge Street 70/1	**E-mail**	corp@vistenergy.ru
Postcode, City	344090 Rostov-on-Don City, Rostov region	**Tel**	+7 (861)21-76-136

Collector Type	Flat plate 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	100 K
	m²	mm	mm	mm	W	W	W	W	W	W
P-G/0.8-T/L/LT-1.82	2.00	2 000	1 000	95	1 553	1 477	1 314	1 136	944	630
P-G/0.8-T/L/LT-2.80	3.00	3 000	1 500	95	2 329	2 215	1 971	1 704	1 417	944
Power output per m² gross area					776	738	657	568	472	315

Performance parameters test method	Quasi dynamic									
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	0.783	3.72	0.009	0.000	0.00	12 180	0.000	0.00	0.0E+00	0.94

Incidence angle modifier test method		Quasi dynamic - outdoor								
Incidence angle modifier	Angle	10°	20°	30°	40°	50°	60°	70°	80°	90°
Transversal	$K_{\theta T,coll}$	1.00	1.00	0.98	0.96	0.93	0.88	0.77	0.00	0.00
Longitudinal	$K_{\theta L,coll}$	1.00	1.00	0.98	0.96	0.93	0.88	0.77	0.00	0.00

Heat transfer medium for testing	Water-Glycole		
Flow rate for testing (per gross area, A_G)	dm/dt	0.020	kg/(sm²)
Maximum temperature difference during thermal performance test	$(\vartheta_m-\vartheta_a)_{max}$	70	K
Standard stagnation temperature (G = 1000 W/m²; ϑ_a = 30 °C)	ϑ_{stg}	220	°C
Maximum operating temperature	$\vartheta_{max\ op}$	n.n.	°C
Maximum operating pressure	$p_{max,op}$	800	kPa

Testing laboratory	TÜV Rheinland (Shanghai) Co., Ltd.	http://www.tuv.com/solarenergy	
Test report(s)	154150039_Linuo_P-G-2.80_ISO_Report_chen 154150039_Linuo_P-G-1.82_ISO_Report_chen	**Dated**	08.11.2017 09.11.2017

Comments of testing laboratory

Datasheet version: 6.1, 2019-09-26

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Supplementary Information	Issued	2020-01-16

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
P-G/0.8-T/L/LT-1.82		2 489	1 789	1 199	1 897	1 330	865	1 391	925	578	1 519	1 001	615
P-G/0.8-T/L/LT-2.80		3 734	2 683	1 798	2 845	1 995	1 298	2 087	1 388	867	2 278	1 502	923
Annual output per m² gross area		1 245	894	599	948	665	433	696	463	289	759	501	308
Annual efficiency, η_a		71%	51%	34%	58%	41%	27%	60%	40%	25%	61%	40%	25%
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 (September 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)					C	--
G (W/m²) >	800	ϑ_a (°C) >	10	H_x (MJ/m²) >		600
Maximum tested positive load					2760	Pa
Maximum tested negative load					1888	Pa
Hail resistance using steel ball (maximum drop height)					2	m

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)
P-G/0.8-T/L/LT-1.82	2.00
P-G/0.8-T/L/LT-2.80	3.00

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

Collector efficiency (η_{col})	61%

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.

Additional Informative Technical Data

Hydraulic Designation Code	Aperature Area, A_a (m²)
9-VH-1234S-A:8,1874-C:20,1050	1.85
14-VH-1234S-A: 8,1874-C:20,1550	2.83

Data required for CDR (EU) No 812/2013 - Reference Area A_{sol}

Zero-loss efficiency (η_0)	0.78	--
First-order coefficient (a_1)	3.72	W/(m²K)
Second-order coefficient (a_2)	0.009	W/(m²K²)
Incidence angle modifier IAM (50°)	0.92	--

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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