Annex to Solar Keymark Certificate

Licence Number	SKM 10107.1
Date issued	2020-11-30
Issued by	DQS Hellas

Licence holder	NOBEL INTERNATIONAL EAD	Country	BULGARIA
Brand (optional)	SOLFOS	Web	http://nobel.bg
Street, Number	48, VITOSHA BLV	E-mail	info@nobel.bg
Postcode, City	2100 ELIN PELIN	Tel	+359 2 4210232

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	87 K
	m^2	mm	mm	mm	W	W	W	W	W	W
Solfos CuS 2000	2.01	2,002	1,005	60	1,449	1,378	1,208	1,000	752	512
Solfos CuS 2600	2.53	2,002	1,266	60	1,824	1,735	1,521	1,258	947	644
Power output per m^2 gross area					721	686	601	497	374	255

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	-	$W/(m^2K)$	$W/(m^2K^2)$	$J/(m^3K)$	-	$J/(m^2K)$	s/m	$W/(m^2K^4)$	$W/(m^2K^4)$	-
Test results	0.741	3.27	0.024	0.000	0.00	0	0.000	0.00	0.0E+00	0.82

Incidence angle modifier test method		Steady state - outdoor								
Incidence angle modifier	Angle	10°	20°	30°	40°	50°	60°	70°	80°	90°
Transversal	$K_{\theta T,coll}$	1.00	0.99	0.96	0.92	0.85	0.74	0.58	0.35	0.00
Longitudinal	$K_{\theta L,coll}$	1.00	0.99	0.96	0.92	0.85	0.74	0.58	0.35	0.00

Heat transfer medium for testing	Water		
Flow rate for testing (per gross area, A_G)	dm/dt	0.021	kg/(sm²)
Maximum temperature difference during thermal performance test	$(\vartheta_m-\vartheta_a)_{max}$	57	K
Standard stagnation temperature (G = 1000 W/m²; ϑ_a = 30 °C)	ϑ_{stg}	158	°C
Maximum operating temperature	ϑ_{max_op}		°C
Maximum operating pressure	$p_{max,op}$	1000	kPa

Testing laboratory	NCSR Demokritos	www.solar.demokritos.gr	
Test report(s)	4286 DQ2	Dated	10/12/2020
	4291 DE2		10/12/2020
	4292 DE2		10/12/2020

Comments of testing laboratory

Datasheet version: 6.1, 2019-09-26

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Supplementary Information	Issued	2020-11-30

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
Solfos CuS 2000		2,165	1,483	868	1,626	1,052	569	1,201	742	397	1,302	795	416
Solfos CuS 2600		2,725	1,867	1,093	2,047	1,324	716	1,512	934	499	1,638	1,000	523
Annual output per m² gross area		1,077	738	432	809	524	283	598	369	197	648	395	207
Annual efficiency, η_a		61%	42%	24%	50%	32%	17%	51%	32%	17%	52%	32%	17%
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)					A	--
G (W/m²) >	1000	ϑ_a (°C) >	20	H_X (MJ/m²) >		600
Maximum tested positive load					3000	Pa
Maximum tested negative load					3000	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)
Solfos CuS 2000	2.01
Solfos CuS 2600	2.53

Additional Informative Technical Data

	Hydraulic Designation Code	Aperature Area, A_a (m²)
Solfos CuS 2000	7-VH-1234S-A:7.2,1842-C:20.6,1060-	1.85
Solfos CuS 2600	10-VH-1234S-A:7.2,1842-	2.36

Data required for CDR (EU) No 811/2013 - Reference Area

Collector efficiency (η_{col})	55%

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 (η_0)	0.72	--
First-order coefficient (a_1)	3.27	W/(m²K)
Second-order coefficient (a_2)	0.024	W/(m²K²)
Incidence angle modifier IAM (50°)	0.84	--

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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