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What's in an OG-100 Solar Thermal Collector Certificate

ICC-SRCC OG-100 certifications are the preferred resource used by manufacturers, incentive programs, and code officials to assess the safety, durability, and performance of solar thermal collectors. Applications for solar thermal energy systems and the types of collectors used in them can vary widely. For this reason, SRCC's OG-100 certificates provide a range of technical information to serve the diverse needs of consumers, building officials, rebate programs and system designers. This document provides a guide to the key information provided in SRCC's OG-100 solar thermal certificates.

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An ICC Evaluation Service Program

OG-100 Solar Thermal Collector Certification

No./1000xxxx

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www.solar-rating.org | **(800) 423-6587** | **(562) 699-0543**

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CERTIFICATION HOLDER:	EVALUATION SUBJECT	
Manufacturer Address 1 City, State, Zip Country www.website.com	**BRAND:**	Brand Name
2	**MODEL:**	Model Name/Number
	TYPE:	Glazed Flat Plate Liquid Heating Collector

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PRODUCT CERTIFICATION SYSTEM:

The ICC-SRCC OG-100 certification program include[illegible]uation and performance ratings for solar thermal collectors as established in the *ICC-SRCC Rules for Solar Heating & Cooling Product Listing Reports.* The program also includes periodic factory inspections and surveillance of the manufacturer's quality management system.

COMPLIANCE WITH THE FOLLOWING STANDARD(S): *ICC 901/SRCC 100 - 2020, Solar Thermal Collectors Standard* 4

5 **OG-100 THERMAL PERFORMANCE RATINGS:**

ICC-SRCC OG-100 thermal performance ratings provided for the collector are calculated for a 24-hour period using OG-100 standard conditions using collector parameters measured through laboratory testing. Actual performance will vary with local conditions, installation details and usage.

OG-100 STANDARD DAILY PRODUCTION TABLE

5a Kilowatt-hours (thermal) per Collector per Day				Thousands of BTU per Collector per Day 5b			
Climate → **Category** **(T_i-T_a)**	High Radiation (6.3 kWh/m²•day)	Medium Radiation (4.7 kWh/m²•day)	Low Radiation (3.1 kWh/m²•day)	**Climate →** **Category** **(T_i-T_a)**	High Radiation (2 kBTU/ft²•day)	Medium Radiation (1.5 kBTU/ft²•day)	Low Radiation (1 kBTU/ft²•day)
A (-5°C)	11.4	8.7	6.0	**A (-9°F)**	38.8	29.7	20.5
B (5°C)	10.3	7.6	4.9	**B (9°F)**	35.1	26.0	16.9
C (20°C)	8.8	6.2	3.5	**C (36°F)**	30.0	21.0	12.0
D (60°C)	6.0	3.5	1.2	**D (90°F)**	20.4	11.9	4.1
E (80°C)	3.4	1.3	0.0	**E (144°F)**	11.7	4.4	0.0

A – Pool Heating (Warm Climate) **B** – Pool Heating (Cool Climate) **C** – Water Heating (Warm Climate) **D** – Space & Water Heating (Cool Climate) **E** – Commercial Hot Water & Cooling

1. **Certification Holder** – The name and address of the organization that holds the ICC-SRCC OG-100 certification.
2. **Model** – The specific product(s) covered by the certification. This model number must match the product label for a product to be considered certified.
3. **Type** – Category of solar thermal collector addressed in the certification.
4. **Standard** – Standard used to evaluate the solar thermal collector.
5. **OG-100 Thermal Performance Ratings** – Provides the thermal performance ratings for the collector over a 24-hour period using OG-100 standard conditions and parameters measured in laboratory testing. The 5 categories of use are **A**- Pool Heating(Warm Climate), **B**- Pool Heating(Cool Climate), **C**- Water Heating(Warm Climate), **D**- Space & Water Heating(Cool Climate), and **E**- Commercial Hot Water & Cooling. The "Clear C Rating" is commonly used by incentive programs. High Solar Radiation, Medium Solar Radiation, and Low Solar Radiation correspond to Clear Sky, Partly Cloudy, and Overcast weather conditions, respectively.

5a **Kilowatt-hours (thermal) per Collector per Day** – The total daily energy output for the collector at a particular temperature differential and rating day, calculated using standard OG-100 conditions, and expressed in Kilowatt-hours/Collector/Day.

5b **Thousands of BTU per Collector per Day** – The total daily energy output for the collector at a particular temperature differential and rating day, calculated using standard OG-100 conditions, and expressed in BTU/Collector/Day.

6 **Thermal Efficiency** – This section provides the technical performance values measured for the collector in laboratory testing. They are used with the thermal efficiency to allow the peak efficiency ($\eta_{0,hem}$) of the collector to be determined as a function of fluid temperature, air temperature, solar irradiance and wind speed. The performance parameters provided for the collector are determined through testing to the methods established in the test standards at the fluid flowrate listed.

Solar system designers use the following equation to calculate the performance of the collector under different conditions. The instantaneous useful power output is ($\dot{Q}$), where K_θ is the incidence angle modifier, A_G is the gross area of the collector, G is the net normal solar irradiance incident on the collector, and $\eta_{0,hem}$ is the instantaneous peak collector efficiency.

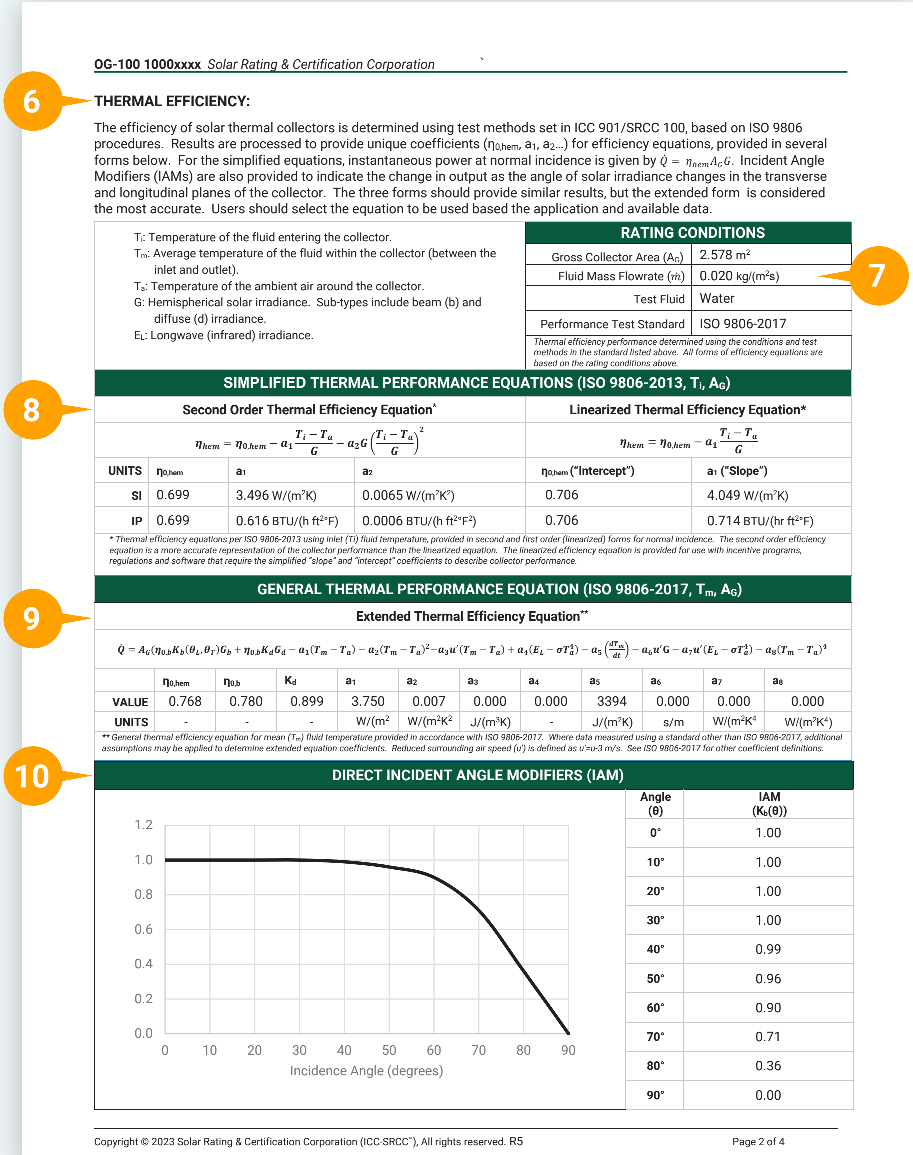
$$\dot{Q} = K_\theta A_G G \eta_{0,hem}$$

OG-100 certificates provide three different forms of the efficiency equations. They provide similar results, but vary in terms of input, complexity and accuracy.

7 **Linearized Thermal Performance Equation** – First order equation for evaluating the
peak efficiency ($\eta_{0,hem}$) of the collector. The peak efficiency ($\eta_{0,hem}$) is commonly known as the "intercept" and a_1 is commonly known as the "slope." It is the easiest to use, but not as accurate as the second-order or extended equations.

8 **Second Order Thermal Efficiency Equation** – Equation for evaluating the power output of the collector, as a function of heat loss coefficient (a_1), temperature dependence of heat loss coefficient (a_2), inlet temperature of the fluid (T_i), ambient air temperature (T_a), and net solar irradiance (G). It is a bit more accurate than the linear equation, but still easy to use.

9 **Extended Thermal Efficiency Equation** – Most accurately provides the peak efficiency ($\eta_{0,hem}$) of the collector. As defined in ISO 9806-2017, the power output of the collector is determined as a function of gross area of the collector (A_G), incidence angle modifier for direct solar irradiance $K_b(\theta_L, \theta_T)$, direct solar irradiance (beam irradiance) (G_b), incidence angle modifier for diffuse solar radiation (K_d), diffuse solar irradiance (G_d), mean temperature of the fluid (T_m), ambient air temperature (T_a), heat loss coefficient (a_1), temperature dependence of heat loss coefficient (a_2), wind speed dependence of the heat loss coefficient (a_3), sky temperature dependence of the heat loss coefficient (a_4), effective thermal capacity (a_5), wind speed dependence of the zero loss efficiency (a_6), radiation losses (a_8), reduced surrounding air speed u'=u – 3m/s (u'), longwave irradiance (E_L), and the Stefan-Boltzmann constant (σ). This form of the equation is commonly used in other international certification programs.



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6 **THERMAL EFFICIENCY:**

The efficiency of solar thermal collectors is determined using test methods set in ICC 901/SRCC 100, based on ISO 9806 procedures. Results are processed to provide unique coefficients ($\eta_{0,hem}$, a_1, a_2...) for efficiency equations, provided in several forms below. For the simplified equations, instantaneous power at normal incidence is given by $\dot{Q} = \eta_{hem} A_G G$. Incident Angle Modifiers (IAMs) are also provided to indicate the change in output as the angle of solar irradiance changes in the transverse and longitudinal planes of the collector. The three forms should provide similar results, but the extended form is considered the most accurate. Users should select the equation to be used based the application and available data.

T_i: Temperature of the fluid entering the collector.
T_m: Average temperature of the fluid within the collector (between the inlet and outlet).
T_a: Temperature of the ambient air around the collector.
G: Hemispherical solar irradiance. Sub-types include beam (b) and diffuse (d) irradiance.
E_L: Longwave (infrared) irradiance.

RATING CONDITIONS	
Gross Collector Area (A_G)	2.578 m^2
Fluid Mass Flowrate ($\dot{m}$)	0.020 kg/(m^2s) 7
Test Fluid	Water
Performance Test Standard	ISO 9806-2017

Thermal efficiency performance determined using the conditions and test methods in the standard listed above. All forms of efficiency equations are based on the rating conditions above.

8 **SIMPLIFIED THERMAL PERFORMANCE EQUATIONS (ISO 9806-2013, T_i, A_G)**

Second Order Thermal Efficiency Equation*

$$\eta_{hem} = \eta_{0,hem} - a_1 \frac{T_i - T_a}{G} - a_2 G \left(\frac{T_i - T_a}{G}\right)^2$$

Linearized Thermal Efficiency Equation*

$$\eta_{hem} = \eta_{0,hem} - a_1 \frac{T_i - T_a}{G}$$

UNITS	$\eta_{0,hem}$	a_1	a_2	$\eta_{0,hem}$ ("Intercept")	a_1 ("Slope")
SI	0.699	3.496 W/(m^2K)	0.0065 W/(m^2K^2)	0.706	4.049 W/(m^2K)
IP	0.699	0.616 BTU/(h ft²°F)	0.0006 BTU/(h ft²°F²)	0.706	0.714 BTU/(hr ft²°F)

** Thermal efficiency equations per ISO 9806-2013 using inlet (Ti) fluid temperature, provided in second and first order (linearized) forms for normal incidence. The second order efficiency equation is a more accurate representation of the collector performance than the linearized equation. The linearized efficiency equation is provided for use with incentive programs, regulations and software that require the simplified "slope" and "intercept" coefficients to describe collector performance.*

9 **GENERAL THERMAL PERFORMANCE EQUATION (ISO 9806-2017, T_m, A_G)**

Extended Thermal Efficiency Equation**

$$\dot{Q} = A_G(\eta_{0,b}K_b(\theta_L,\theta_T)G_b + \eta_{0,b}K_dG_d - a_1(T_m - T_a) - a_2(T_m - T_a)^2 - a_3u'(T_m - T_a) + a_4(E_L - \sigma T_a^4) - a_5\left(\frac{dT_m}{dt}\right) - a_6u'G - a_7u'(E_L - \sigma T_a^4) - a_8(T_m - T_a)^4$$

	$\eta_{0,hem}$	$\eta_{0,b}$	K_d	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8
VALUE	0.768	0.780	0.899	3.750	0.007	0.000	0.000	3394	0.000	0.000	0.000
UNITS	-	-	-	W/(m^2	W/(m^2K^2	J/(m^3K)	-	J/(m^2K)	s/m	W/(m^2K^4	W/(m^2K^4)

*** General thermal efficiency equation for mean (T_m) fluid temperature provided in accordance with ISO 9806-2017. Where data measured using a standard other than ISO 9806-2017, additional assumptions may be applied to determine extended equation coefficients. Reduced surrounding air speed (u') is defined as u'=u-3 m/s. See ISO 9806-2017 for other coefficient definitions.*

10 **DIRECT INCIDENT ANGLE MODIFIERS (IAM)**

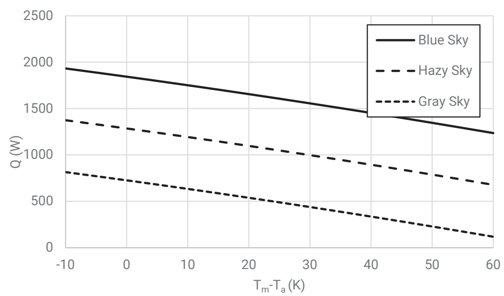
Angle (θ)	IAM ($K_b(\theta)$)
0°	1.00
10°	1.00
20°	1.00
30°	1.00
40°	0.99
50°	0.96
60°	0.90
70°	0.71
80°	0.36
90°	0.00

10 **Direct Incident Angle Modifiers (IAM)** – The IAM provides change to the output of the collector at different angles, as the sun moves across the sky, compared to the performance when it is directly over the collector. The IAM value is used together with the thermal efficiency equation to calculate the output of the collector throughout the day as the sun moves across the sky between sunrise and sunset.

11

POWER OUTPUT:

The instantaneous power output of the collector under different conditions is calculated at the Standard Reporting Conditions (SRC) defined by ISO 9806-2017 using the measured performance coefficients above.



11a

STANDARD COLLECTOR POWER OUTPUT (W)			
Based on Standard Rating Conditions (SRC) and mean temperature (T_m) in accordance with ISO 9806-2017			
T_m-T_a (°C)	Blue sky G_b = 850, G_d = 150 (W/m²)	Hazy sky G_b= 440, G_d= 260 (W/m²)	Grey sky G_b=0, G_d= 400 (W/m²)
-10	1932	1374	815
0	1843*	1285	726
10	1751	1193	634
20	1655	1097	538
30	1556	998	438
40	1453	894	335
50	1346	788	229
60	1236	677	118

**Peak Power is defined by ISO 9806 as the Blue Sky irradiance condition at T_m-T_a =0 and normal incidence.*

TEST SAMPLE SPECIFICATIONS:

12

The specifications of the collector sample submitted for testing are provided below.

TEST & SAMPLE SPECIFICATIONS					
Gross Length:	1.24 m	4.1 ft	**Maximum Design Temperature:**	101 °C	214 °F
Gross Width:	2.08 m	6.8 ft	**Maximum Design Pressure:**	1000 kPa	145 psi
Gross Depth:	95.0 mm	3.7 in	**Standard Stagnation Temperature:**	200 °C	392 °F
Empty Weight:	38.0 kg	84 lb			
Fluid Capacity:	1.7 L	0.5 gal			
Notes:	Standard stagnation at 1000 W/m² and 30 °C as defined by ISO 9806 – 2017.				

11 **Standard Collector Power Output** – This section provides the instantaneous power output performance for 3 distinct climate conditions when the sun is directly over the collector. They are defined by the ISO 9806-2017 standard as the Standard Reporting Conditions (SRC): Blue Sky, Hazy Sky, and Gray Sky. Generally, the output power decreases as the temperature differential increases, and heat is lost to the environment.

11a Results are given in graphical and tabular form. The peak power is shown under Blue Sky conditions where the average fluid temperature and air temperature are equal.

12 **Test & Sample Specifications** – The key specifications of the collector are provided along with the design properties verified through laboratory testing are provided in this section.

13 **Identification** – The minimum product information to be provided on product labeling, as specified by the ICC 901/SRCC 100 standard is specified. Certified products must display the ICC-SRCC OG-100 mark shown to indicate certification.

14 **Conditions** – Specific requirements, conditions, terms and limitations for the installation and use of the certified product are listed. Hyperlinks provide direct access to important reference documents with more details.

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IDENTIFICATION:

Certified collectors must be labeled in accordance with the *ICC-SRCC Rules for Certification Mark and Certificate Use*. Labels must contain information as specified in the standard listed above.

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CONDITIONS:

1. Collector must be installed and operated in accordance with the manufacturer's published instructions and local codes and regulations.
2. OG-100 Standard Performance Ratings and Standard Collector Power Output have been calculated for the tested components using standardized conditions established by the OG-100 program and associated test standards.

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For more information on the OG-100 program, visit the ICC-SRCC website, www.solar-rating.org/og-100