SOLAR RATING & CERTIFICATION CORPORATION™

An ICC Evaluation Service Program

OG-100 Solar Thermal Collector Certification

No./2012015A

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CERTIFICATION HOLDER:	**EVALUATION SUBJECT**	
RG Resource Technologies 900 South Glaspie Street Oxford, MI 48371 USA www.powerpanel.com	**BRAND:**	Power Panel
	MODEL:	PVT1
	TYPE:	Photovoltaic-Thermal Hybrid Collector (PVT), Glazed, Inseparable

PRODUCT CERTIFICATION SYSTEM:

The ICC-SRCC OG-100 certification program includes evaluation 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*

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.

COLLECTOR SPECIFICATIONS:

The certified collector has the following specifications and ratings based on testing to the standards above.

PEAK THERMAL POWER RATING[1]		**Gross Area**	0.98 m^2 (10.6 ft^2)
742 W		**Length**	1.38 m (4.5 ft)
		Width	0.7 m (2.3 ft)
Tested PV Module Specifications[2] (@STC):	P_{MPP}: 136 W I_{SC}: 9.38 ADC V_{OC}: 19.1 VDC	**Empty Weight**	15.9 kg (35 lb)
		Fluid Capacity	2.0 L (0.5 gal)
		Max Design Pressure	4.7 kPa (0.7 psi)
		Approved Fluids	Water, Chlorinated Water

1: *Peak thermal power production at Standard Rating Condition (SRC) and Blue Sky conditions as defined in ISO 9806. See Power Output Section for more information and conditions.*

2: Photovoltaic electrical power production not included in published OG-100 or ISO 9806 performance ratings.

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OG-100 THERMAL PERFORMANCE RATINGS:

ICC-SRCC OG-100 thermal performance ratings are provided for one collector are calculated for a 24-hour period using OG-100 standard conditions based on collector performance parameters measured through laboratory testing. Results are provided for three use categories under three levels of solar irradiance (high, medium, low). Actual performance will vary with local conditions, installation details and usage. Results do not include electrical energy production from photovoltaic cells.

		OG-100 DAILY THERMAL ENERGY OUTPUT *(kWh/d)*		
APPLICATION*	**OG-100 CATEGORY**	**HIGH** *(6.3 kWh/m²•d)*	**MEDIUM** *(4.7 kWh/m²•d)*	**LOW** *(3.1 kWh/m²•d)*
Pool Heating in Warm Climate *(T_i-T_a = -5°C)*	**A**	4.43	3.35	2.28
Pool Heating in Cool Climate *(T_i-T_a = +5°C)*	**B**	4.02	2.94	1.87
Water Heating in Warm Climate *(T_i-T_a = +20°C)*	**C**	3.47	2.40	1.35
Water Heating in Cool Climate *(T_i-T_a = +50°C)*	**D**	2.51	1.49	0.54
Commercial Hot Water & Cooling *(T_i-T_a = +80°C)*	**E**	1.68	0.76	0.06

** T_i: Inlet Water Temperature to Collector, T_a: Ambient Air Temperature*

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 $\dot{Q} = K_\theta \eta_{hem} A_G G$. Incident Angle Modifiers (IAMs) are provided to indicate the change in output as the incidence angle of solar irradiance changes. 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 with sub-types beam (b) and diffuse (d)
E_L: Longwave (infrared) irradiance.
ε/α: Collector emissivity/absorptance ratio.

RATING CONDITIONS	
Gross Collector Area (A_G)	0.984 m²
Fluid Mass Flowrate ($\dot{m}$)	0.041 kg/(m²s)
Test Fluid	Water
Performance Test Standard	ISO 9806-1-1994

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	0.751	3.570 W/(m²K)	0.0000 W/(m²K²)	0.751	3.570 W/(m²K)
IP	0.751	0.629 BTU/(h ft²°F)	0.0000 BTU/(h ft²°F²)	0.751	0.629 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.*

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

Extended Thermal Efficiency Equation*

$$\dot{Q} = A_G(\eta_{0,b} K_b(\theta_L, \theta_T) G_b + \eta_{0,b} K_d G_d - a_1(T_m - T_a) - a_2(T_m - T_a)^2 - a_3 u'(T_m - T_a) + a_4(E_L - \sigma T_a^4) - a_5\left(\frac{dT_m}{dt}\right) - a_6 u' G - a_7 u'(E_L - \sigma T_a^4) - a_8(T_m - T_a)^4$$

	$\eta_{0,b}$	K_d	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8
VALUE	0.775	0.819	3.736	0.000	0.000	0.000		0.000	0.000	0.000
UNITS	-	-	W/(m²K)	W/(m²K²	J/(m³K)	-	J/(m²K)	s/m	W/(m²K⁴)	W/(m²K⁴)

** 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.*

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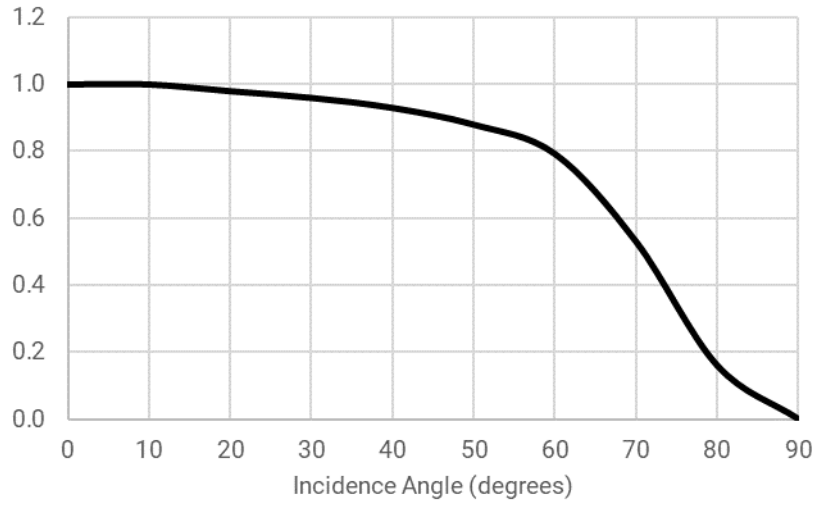
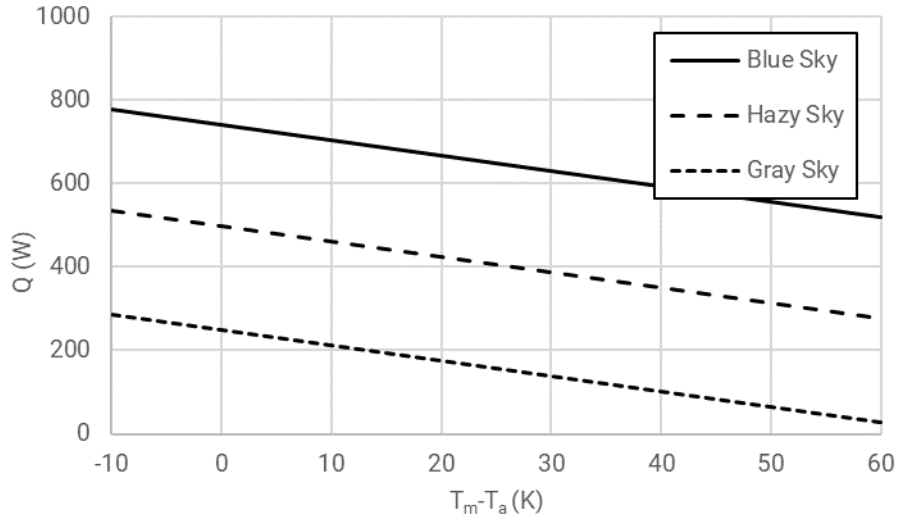
DIRECT INCIDENT ANGLE MODIFIERS (IAM)



Angle (θ)	Overall (K(θ))
0°	1.00
10°	1.00
20°	0.98
30°	0.96
40°	0.93
50°	0.88
60°	0.79
70°	0.53
80°	0.16
90°	0.00

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.



STANDARD COLLECTOR POWER OUTPUT (W) – THERMAL ONLY

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	778	534	287
0	742*	498	250
10	705	461	213
20	668	424	176
30	631	387	140
40	594	351	103
50	558	314	66
60	521	277	29

** Peak thermal power is defined by ISO 9806 as the Blue Sky irradiance conditions at T_m-T_a =0 and normal incidence, as defined in ISO 9806.*

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IDENTIFICATION:

Certified systems must be identified with the OG-300 certification mark below in accordance with the *Rules for Certification Mark and Certificate Use* and labeled in with the information below per *ICC 901/SRCC 100*:

1. Manufacturer's name and model number.
2. OG-100 collector certification number
3. Maximum operating pressure
4. Dry weight
5. Fluid volume
6. Compatible heat transfer fluids
7. Standard stagnation temperature
8. Year of manufacture and/or serial number.

CONDITIONS:

1. Collector must be installed and operated in accordance with the solar thermal and PV manufacturer's published instructions and local codes and regulations. Solar thermal panel must be assembled with the photovoltaic module in accordance with the solar thermal manufacturer's installation requirements.
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. OG-100 performance ratings and power output values do not include electrical power production for PVTs. Actual performance will vary based on the specific usage, installation, and local environmental conditions.
3. The collector listed in this ICC-SRCC OG-100 certification must be labeled in accordance with the *ICC-SRCC Rules for Mark and Certificate Use*.
4. OG-100 certifications do not include mounting hardware and fixtures.
5. Solar thermal collectors and mounting hardware and appurtenances must comply with all applicable local requirements for fire resistance. Solar thermal collectors must be mounted in accordance with the requirements of the collector and mounting hardware manufacturers to comply with local codes for structural loading for wind, seismic, snow and other loads.
6. Solar thermal collectors must be used with the heat transfer fluids listed in this document.
7. All electrical wiring, connections, components and labeling shall comply with the National Electrical Code (NFPA 70) and other local regulations and as specified by the manufacturer. OG-100 certification does not address electrical safety and durability. Separate photovoltaic listing to UL 1703 or UL 61730 is required for the installed PV module.
8. Solar thermal collector manufactured under a quality control program subject to periodic evaluation in accordance with the requirements of ICC-SRCC.
9. This document must be reproduced in its entirety.
10. Certification status should be confirmed on the ICC-SRCC Directory at www.solar-rating.org

Vincent Chui, S.E.
VP of Evaluation Services

CERTIFICATE # 3299.01, 3299.03

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