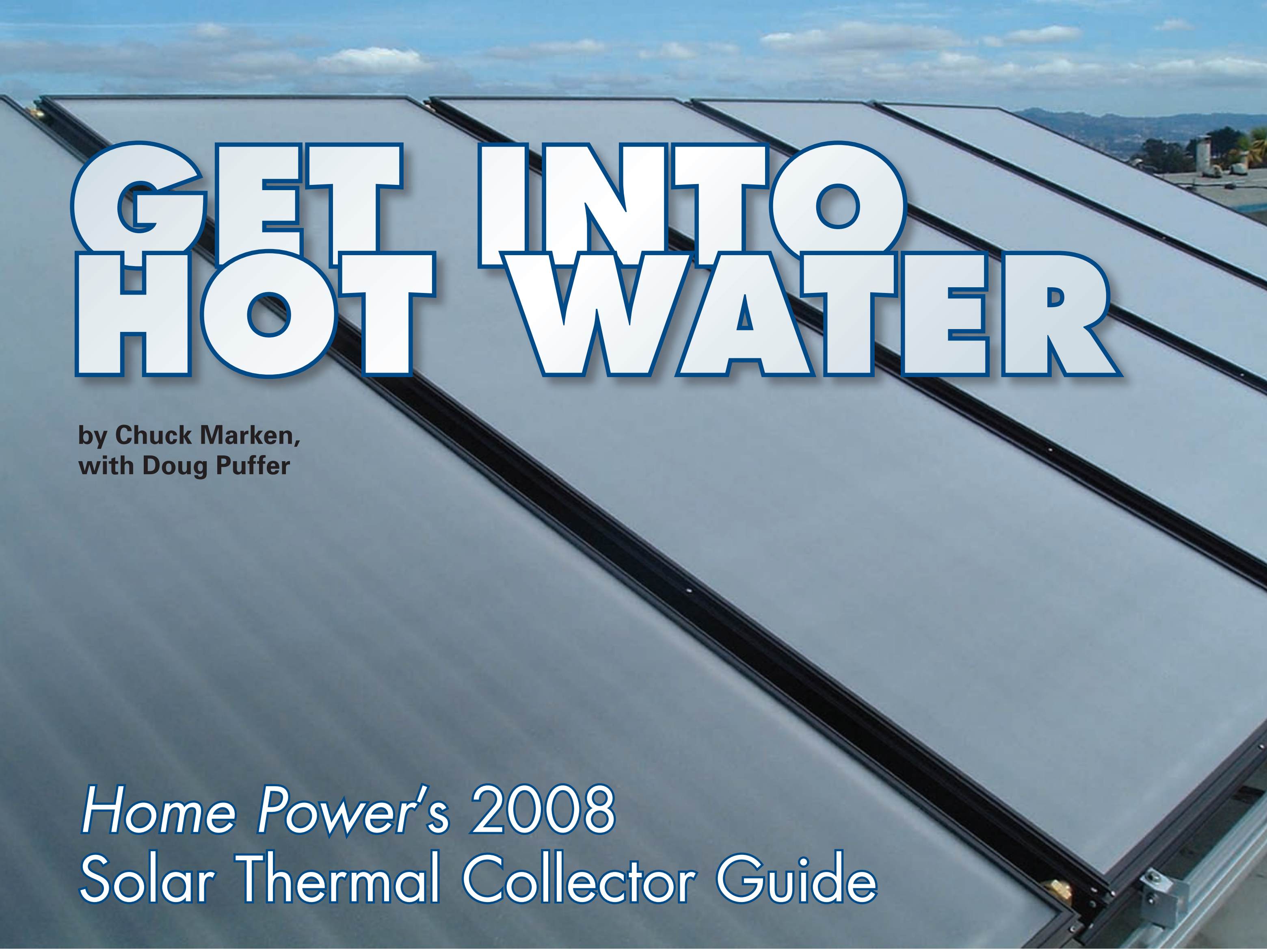


GET INTO HOT WATER

by Chuck Marken, with Doug Puffer

Home Power's 2008 Solar Thermal Collector Guide

Courtesy www.heliodyne.com

If you're shopping for a solar hot water system, arm yourself with the information you need to get the best collector performance for your hard-earned dollar. This guide provides a comprehensive listing of solar water heating collectors certified by the Solar Rating and Certification Corporation (SRCC)—the recognized authority for certifying and rating solar thermal equipment in the United States. It's this qualification that you'll need to claim the federal tax credit for installing a solar hot water (SHW) system.

In the late 1970s and early '80s, many claims were made by solar heating collector manufacturers that were difficult to substantiate. To keep the industry honest, a standard testing protocol for performance and durability was agreed upon to ensure an apples-to-apples comparison. Accredited and independent labs perform the testing, and the SRCC compiles the results. Today, you can access the test data online or download the catalog of certified collectors for easy comparison (see Access).

How to Use This Guide

Collectors included in this article's table have been certified under the SRCC's Operating Guideline 100 (OG-100). The collectors listed are from the SRCC rating guide, which is updated on a continuous basis. However, some collectors have been omitted from the table because they are identical (or have only cosmetic differences) to the collectors listed. Individual solar pool-heating collectors are not included in the table since they all perform nearly identically, but a generic example is included for comparison purposes.

Note that many of the collectors listed also are components of *complete* solar water heating systems, which are certified under the SRCC's OG-300 standard. A future SHW system buyer's guide will discuss these complete systems—including integral collector storage (ICS) units.

Design & Performance

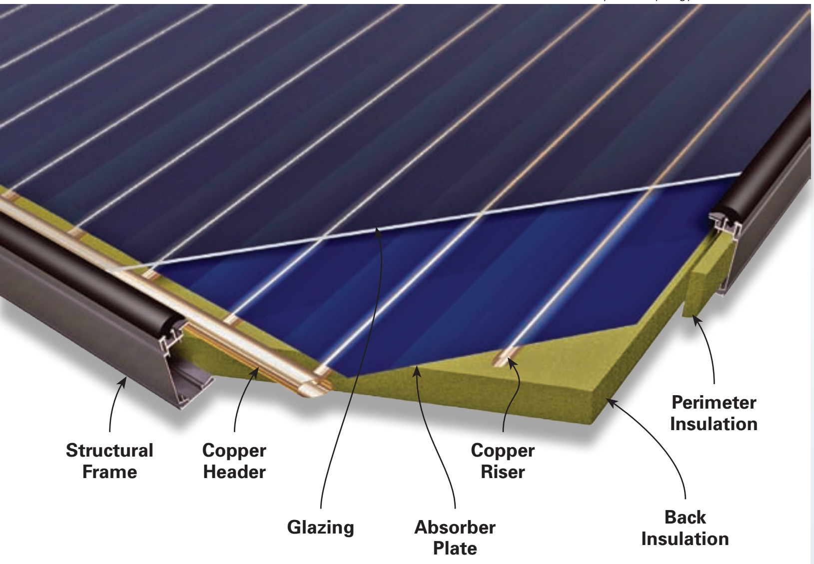
Two general types of SHW collectors are available today: flat-plate collectors and evacuated-tube collectors. The performance of each type depends largely on size, absorber material, absorber coating, outer cover, insulation, and frame. Understanding the role of these factors is the first step in evaluating the collector's performance (see "Specs" sidebar).

Certified *flat-plate collectors* all share similar designs. The real difference is in the materials that make up the frame, insulation, absorber and absorber coating, and transparent glazing. The frame has little to do with performance but a great deal to do with the collector's longevity, as it is the main structural component. Among the flat-plate collectors listed, the insulation is predominantly isocyanurate, a rigid-foam that offers high insulation values per inch and a relatively high service temperature. Some flat-plate collectors are insulated with fiberglass, which has a lower insulation rating per inch of thickness. For glazing, most flat-plate manufacturers have adopted the current standard: one piece of low-iron tempered glass, which passes about 90% of the light to the collector's interior. With few exceptions, the absorber and absorber tubes are made of copper. The absorber coatings for all collectors are either black paint or selective surface (a coating that has high absorption capabilities, similar to black paint, but also has low emissivity, or radiance, to retain the absorbed heat). These specialized coatings help improve the collector's ability to capture solar energy.

Evacuated-tube collectors are available in five different configurations. Four designs use a tube within a tube—a double-glass tube. Between the two layers of glass is the all-important vacuum, which limits heat loss and provides an insulation value that far surpasses that of flat-plate collectors. The twin-glass design works much like a thermos bottle, with the vacuum between two cylinders of glass that are formed together. Many of the evacuated-tube collectors included in the table use a thermos design, a selective-surface absorber, and borosilicate high-transmittance glass. Some collectors use a single glass cylinder with the vacuum filling the entire cylinder, instead of the space between double-glass cylinders. In all cases, the key to high evacuated-tube performance is the vacuum, which provides outstanding insulation.

Flat-Plate Collector Construction

Courtesy www.synergysolar.com



SPECS...

Size: Length, Width, Depth

If south-facing roof space is limited, knowing a collector's physical dimensions will help determine which collector or collectors will be the best fit.

Gross Area (Ft.^{2})

The collector's length times its width. The gross area is the total size of the collector, not just the part gathering heat.

Dry Weight (Lbs.)

This is the collector weight without fluid. Although this is useful information to have for the installation, roof-loading calculations need to include the weight of the fluid as well.

Warranty (Full/Ltd.)

Full- and limited-coverage warranties do have specific conditions, so check the documentation thoroughly to understand what is covered and what is not.

Absorber Material

An absorber material is used to collect the heat from the sun. Copper is the most common material due to its conductive properties.

Absorber Coating

Coatings on the absorber material assist in heat collection. Black coatings are common, as black absorbs heat. Selective surfaces add low emissivity for better heat retention than black paint.

Cover/Glazing

The cover is mainly for protecting the collector from damage but does add some insulating qualities. It should allow as much light as possible through to the absorber while helping slow heat loss.

Frame

The frame is an important structural component of the collector. High-quality materials ensure a longer collector life, which is more critical for coastal environments where salt water may cause certain metals to corrode.

Thousands of Btu

This is the measured energy output of the collector under clear, mildly cloudy, and cloudy conditions. The data in the table is for Category C locations typical of the contiguous United States (see "Operating Categories" sidebar).

Y-Intercept

This represents the efficiency of the collector when the circulating fluid entering the collector is the same temperature as the outside air. Used to assess heat-gain performance, it corresponds with the highest point on a collector's efficiency curve.

Slope (Btu/hr./ft.^{2}/°F)

This represents the efficiency of the collector as the temperature difference between the circulating fluid and the outside air increases. Used to assess heat-loss performance, it shows the steepness of a collector's efficiency curve.

Evacuated-tube collectors, like this 30-tube heat-pipe design Thermomax, offer good performance in cold and cloudy climates.

A *thermosiphon system* is the simplest of the thermos designs. The collector-loop fluid, usually potable water, fills the entire inner tube. The painted, black absorber takes in the solar energy that hits it after passing through the transparent outer glass. This type of evacuated-tube collector is usually inserted into a special unpressurized tank/manifold that will accept many individual tubes. The water inside the evacuated tubes heats up when the sun is shining, which initiates the thermosiphon effect: Hot water moves into the small holding tank above the collectors, pulling cold water through the inside of the collector to be heated. This is technically an ICS system, which will be addressed in the future guide to complete SHW systems.

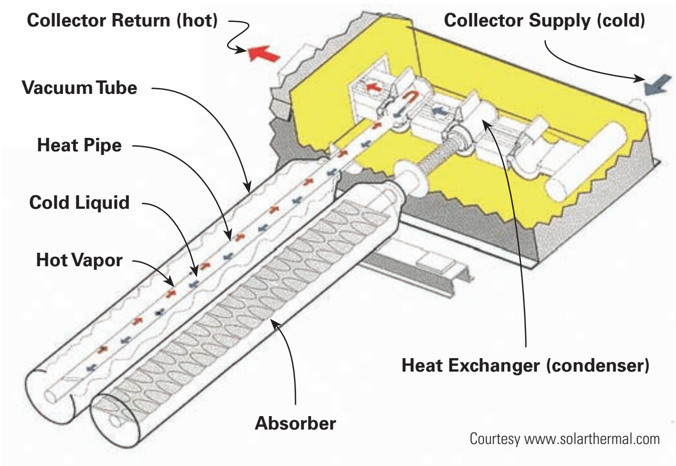
Heat-pipe design collectors use a copper pipe, closed at both ends, which contains a solution that vaporizes when heated. The hot vapor rises to a heat exchanger located in a manifold at the top of the tubes, which transfers heat to the solar fluid (water or glycol) to be circulated through the SHW system. Upon giving up the heat, the vapor condenses back to a liquid and falls to the bottom of the tube to repeat the cycle.

A *direct-flow design* circulates the collector-loop fluid through a tube bonded to a metal absorber within the inner glass. The design of a direct-flow tube and absorber is similar to the design of a flat-plate tube and absorber, except it's more efficient with the supreme insulating qualities of a vacuum. Direct-flow can be more efficient than the heat-pipe design because it eliminates the additional step of heat exchange between the heat-pipe fluid and the collector-loop fluid.

Another thermos-type design uses a mirrored surface to reflect sunlight onto a black target tube that collects the solar energy. By concentrating more energy on the target tube, these collectors can produce higher temperatures than other evacuated-tube designs.

A more traditional design for evacuated tubes is a *single glass tube with a vacuum inside*. These are usually designed as direct-flow collectors with a copper heat pipe or water-flow pipe bonded to a metal-plate absorber. They can also be designed as a heat pipe with a heat exchanger. Vacuums are difficult to seal with common gaskets and sealants. Maintaining the seal between the glass and the copper tube that circulates the fluid has been a problem with these collectors. An evacuated tube without a vacuum is kind of like a car with flat tires—it won't set any performance records.

Heat-Pipe Type Evacuated-Tube Collector Construction



Interpreting Collector Performance

Surface area aside, heat gain and loss influence collector performance most radically. The "Typical Collector Performance Slopes" graph (opposite page) shows collector efficiency as it relates to the difference between the ambient and collector inlet temperatures.

The Y-intercept value for each collector corresponds to a point on the graph where it intersects the Y-axis. This value represents the efficiency of the collector (as a percentage) when the outside temperature is the same as the fluid temperature entering the collector inlet. It's an excellent indicator of the heat gain potential of each type of collector. Higher Y-intercept numbers will result in higher output performance numbers in the SRCC matrix of collector output.

The graph's X-axis (bottom axis) reflects temperature difference: delta T (ΔT), the difference between the ambient temperature and the inlet temperature of the collector loop fluid. As the inlet temperature increases in relation to the ambient temperature, all collectors suffer a loss in efficiency, some more dramatically than others (see "Heat Loss" section).

The steepness of each slope (the diagonal colored lines on the graph) represents how quickly the collector loses heat as ΔT increases. The slope represents heat loss in Btu per hour per square foot per degree Fahrenheit.

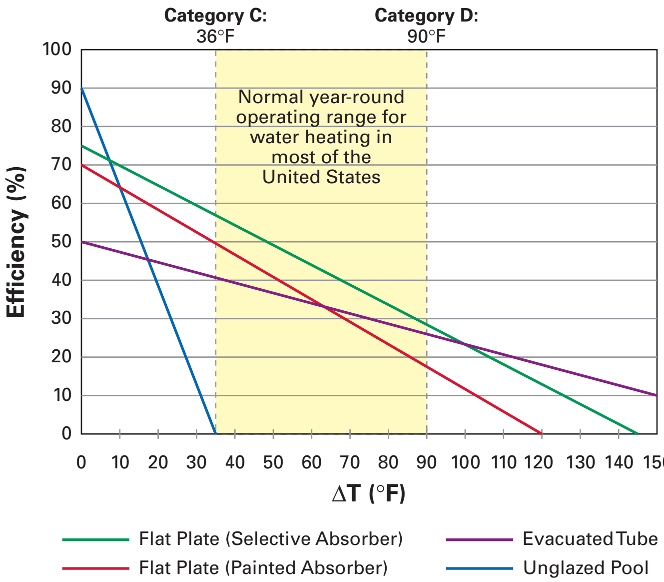
Heat Gain…

For heat gain efficiency, unglazed swimming pool collectors come out on top. Collectors used for swimming pool heating consist of a simple absorber plate without any glazing or insulation, so there's nothing to impede heat gain compared

Why Y?

The Y-intercept values for collectors are from calculations based on the gross area of the collectors, which includes parts of the collector that are not collecting heat (insulation, enclosures, manifolds, etc.). This has been the standard for almost three decades and will likely remain so for years to come, since it best reflects real-world practices in sizing a system to fit a certain space. But what really counts is the output for the buck—Btu produced per dollar invested. This, along with durable construction and a pleasing cosmetic appearance, should be the deciding factors for an informed buyer.

Typical Collector Performance Slopes



to other collector types. When no difference exists between the collector inlet and ambient temperature, unglazed pool collectors have the greatest gain.

Although the single pane of glass cuts the energy received by roughly 10%, for collection efficiency, flat-plate collectors with a selective absorber come in a close second to unglazed pool heaters, at nearly 75% efficiency (75% at the Y-intercept). The collector's selective surface allows for a greater retention of radiation compared to black-painted absorbers. Black paint has high absorption properties but also has high emissivity. Flat-plate collectors with black-painted absorbers have efficiencies of about 70%.

Evacuated-tube collectors lag behind the others in heat absorption, with an average efficiency of about 50%. The double glass in the thermos-type collector designs is responsible for some of this gap on the Y-axis because each layer of glass cuts the light by at least 10%. Other variables, like the absorber coating, integrated heat exchangers, and the bonding of the tube to the absorber plate may also play a role in the lower efficiencies at a ΔT of zero (the Y-intercept).

…Heat Loss

But efficiency at a ΔT of zero doesn't give the whole picture, and collectors perform more or less efficiently depending on their ability to retain heat as the temperature gap widens. Take unglazed pool collectors as the most radical example. Even small temperature changes between the ambient temperature and collector inlet temperature cause a pool collector's efficiency to plummet: A 35°F difference can drop the collector's efficiency to near zero, while this same ΔT can cause only a minor shift in efficiency (about 10%) in an evacuated-tube collector. Collectors with selective surfaces, which have high absorption and low emissivity properties, and those with superior insulation, which also limits heat loss, have a relatively flat slope compared to the steep slope of an unglazed pool collector.

When it comes to limiting heat loss, evacuated-tube collectors come in first. The insulation properties of a vacuum are undeniable, and the performance numbers prove it. Selective surface coatings on the absorber further limit the collector's heat loss by limiting the high radiant heat loss that is common for any black surface.

The best choice of collector type depends on the local climate, as well as your household's hot water temperature and quantity needs.

Courtesy www.synergysolar.com

Thermal Collector

Flat Plate

Manufacturer	Model	Length (In.)	Width (In.)	Depth (In.)	Gross Area (Ft.2)	Dry Weight (Lbs.)	Warranty (Yrs.: Full/Ltd.)
ACR Solar www.solarroofs.com	20-01	72.2	20.0	3.0	10.0	19	0 / 20
	20-01	144.3	20.0	3.0	20.1	38	0 / 10
Alternate Energy Technologies www.aetsolar.com	AE-21	85.2	35.2	3.1	20.8	74	0 / 10
	AE-24	97.2	35.2	3.1	23.8	84	
	AE-26	77.2	47.2	3.1	25.4	90	
	AE-28	85.2	47.2	3.1	28.0	99	
	AE-32	97.2	47.2	3.1	31.9	113	
	AE-40	121.2	47.2	3.1	39.8	153	
	MSC-21	86.0	38.5	3.1	21.5	82	
	MSC-24	98.0	38.5	3.1	24.5	102	
	MSC-26	78.0	50.5	3.1	26.0	102	
	MSC-28	86.0	50.5	3.1	28.7	120	
	MSC-32	98.0	50.5	3.1	32.7	133	
	MSC-40	122.0	50.5	3.1	42.2	159	
Conergy www.conergy.com	F4000	79.1	42.1	3.5	23.2	97	5 / 0
EnerWorks Inc. www.enerworks.com	COL-4X8-NL-SG1-SH10US	46.3	96.3	3.3	30.9	111	0 / 10
	COL-4x8-TL-SG1-SD10US	48.0	96.0	3.0	30.9	111	0 / 10
Genersys www.genersys.com	1000-10	N/A	N/A	N/A	21.9	86	0 / 20
Heliodyne www.heliodyne.com	Gobi 3366	88.6	43.6	4.0	26.8	108	10 / 0
	Gobi 408	97.6	47.6	4.0	32.3	133	
	Gobi 410	121.6	47.6	4.0	40.3	160	
Marathon International www.wallhungboilers.com	Baxi S-SPC 18	76.5	38.6	3.7	20.6	72	0 / 10
R&R Solar Supply 808-842-0011	Sunpro 21	85.1	35.1	4.0	20.5	88	12 / 0
	Sunpro 24	97.1	35.1	4.0	23.4	97	
	Sunpro 32	97.1	47.1	4.0	31.4	123	
	Sunpro 40	121.1	47.1	4.0	39.2	170	
Radco Products www.radcosolar.com	308C-HP	97.1	35.1	3.0	23.7	78	5 / 10
	308P-HP	97.1	35.1	3.0	23.7	75	
	408C-HP	101.6	45.8	3.0	32.3	105	
	408P-HP	101.6	45.8	3.0	32.3	102	
	410C-HP	125.6	45.8	3.0	39.9	129	
	410P-HP	125.6	45.8	3.0	39.9	125	
	412C-HP	152.1	45.8	3.0	48.3	155	
	412P-HP	152.1	45.8	3.0	48.3	150	
Schuco USA www.schuco-usa.com	Premium V, H, LA	84.7	49.3	3.6	29.1	121	0 / 10
	Slimline V, LA	80.3	44.9	2.2	24.9	90	
Sensible Technologies www.jtgmuir.com	STS 410BC	122.3	48.1	3.3	40.9	138	0 / 10
	STS 410BP	122.3	48.1	3.3	40.9	138	
	STS 48BC	98.3	48.0	3.3	32.8	105	
	STS 48BP	98.3	48.0	3.3	32.8	105	
Solahart Industries www.solahart.com.au	Bt	76.6	40.2	3.0	21.4	69	0 / 10
	J	76.6	40.2	3.0	21.4	90	5 Ltd. w/J, 10 Ltd. w/F 5
	Kf	76.6	40.2	3.0	21.4	90	5 Ltd. w/J, 10 Ltd. w/F 5
	L	76.6	40.2	3.0	21.4	69	0 / 10
Solar Development www.solardev.com	SD8-21	N/A	N/A	N/A	20.8	74	N/A
	SD8-26	N/A	N/A	N/A	25.4	90	
	SD8-28	N/A	N/A	N/A	28.0	99	
	SD8-32	N/A	N/A	N/A	31.9	113	
	SD8-40	N/A	N/A	N/A	39.8	153	

1) 2,000 Btu / Ft.^{2} / Day; 2) 1,500 Btu / Ft.^{2} / Day; 3) 1,000 Btu / Ft.^{2} / Day; 4) Btu / Hr. / Ft.^{2} / °F; 5) Warranty varies with system configuration

Comparison Table

Materials					Thousands of Btu Per Day				
Absorber									
Tube	Plate	Coating	Glazing	Frame	Clear [1]	Mildly Cloudy [2]	Cloudy [3]	Y- Intercept	Slope [4]
Copper	Copper Fin	Selective Surface	Lexan Polycarbonate	Aluminum	8	6	3	0.602	-0.663
					17	11	6	0.604	-0.657
Copper	Copper Fin	Selective Surface	Low-Iron Tempered Glass	Anodized Aluminum	21	14	8	0.706	-0.865
					24	16	9	0.706	-0.865
					25	17	9	0.706	-0.865
					28	19	10	0.706	-0.865
					32	22	12	0.706	-0.865
					40	27	15	0.706	-0.865
					21	15	8	0.706	-0.865
					24	17	9	0.706	-0.865
					26	18	10	0.706	-0.865
					29	20	11	0.706	-0.865
					32	22	12	0.706	-0.865
					42	29	16	0.706	-0.865
Copper	Copper	Selective Surface	Tempered Glass	Aluminum	24	17	10	0.667	-0.629
Copper	Aluminum	Vapor-Deposition Selective	Low-Iron Tempered Glass	Galvanized Steel	37	26	15	0.768	-0.711
					32	22	11	0.726	-0.901
Copper	Aluminum	Metallic Oxide	Low-Iron Tempered Glass	Aluminum	19	13	7	0.591	-0.704
Copper	Copper	Black Chrome	Low-Iron Tempered Glass	Extruded Aluminum	30	21	12	0.734	-0.825
					37	25	14	0.737	-0.805
					46	31	18	0.737	-0.805
Copper	Copper	Selective Surface	Low-Iron Tempered Glass	Extruded Aluminum	20	13	7	0.696	-0.785
Copper	Copper	Mod. Selective Black Paint	Low-Iron Tempered Glass	Anodized Aluminum	20	13	6	0.708	-1.077
					23	15	7	0.708	-1.077
					30	20	10	0.708	-1.077
					38	25	12	0.708	-1.077
Copper	Copper	Black Chrome	Low-Iron Tempered Glass	Aluminum	26	18	10	0.778	-0.875
		Flat-Black Paint			23	15	8	0.764	-1.323
		Black Chrome			36	25	13	0.779	-0.841
		Flat-Black Paint			30	20	9	0.768	-1.276
		Black Chrome			45	30	16	0.779	-0.841
		Flat-Black Paint			38	25	11	0.768	-1.276
		Black Chrome			54	37	20	0.779	-0.841
		Flat-Black Paint			46	29	13	0.768	-1.276
Copper	Copper	Sputtered Cermet	Low-Iron Tempered Glass	Aluminum	31	22	12	0.718	-0.754
					27	19	11	0.715	-0.704
Copper	Copper	Black Chrome	Low-Iron Tempered Glass	Extruded Aluminum	42	29	16	0.714	-0.727
		Mod. Selective Black Paint			40	28	15	0.682	-0.800
		Black Chrome			34	24	13	0.714	-0.727
		Mod. Selective Black Paint			32	22	12	0.682	-0.800
Copper	Copper	Titanium Oxide	Low-Iron Tempered Glass	Aluminum	23	16	8	0.750	-0.858
None	Steel	Polyester Flat-Black Paint			22	14	7	0.772	-1.473
None	Steel	Black Chrome			23	16	9	0.759	-1.045
Copper	Aluminum	Polyester Flat-Black Paint			15	10	4	0.625	-1.316
Copper	Copper Fin	Selective Surface	Low-Iron Tempered Glass	Anodized Aluminum	21	14	8	0.706	-0.865
					25	17	9	0.706	-0.865
					28	19	10	0.706	-0.865
					32	22	12	0.706	-0.865
					40	27	15	0.706	-0.865

Flat Plate (cont.)

Manufacturer	Model	Length (In.)	Width (In.)	Depth (In.)	Gross Area (Ft.^{2})	Dry Weight (Lbs.)	Warranty (Yrs.: Full/Ltd.)
Solar Energy www.solarenergy.com	SE-21	84.0	36.0	2.9	21.9	90	0 / 10–15
	SE-24	96.0	36.0	2.9	24.9	102	
	SE-28	84.0	48.0	2.9	27.0	109	
	SE-32	96.0	48.0	2.9	30.9	124	
	SE-40	120.0	48.0	2.9	38.6	154	
Solene www.solene-usa.com	SLCO-30	74.4	47.4	4.0	24.5	78	10 / Life
	SLCO-32	96.5	47.4	4.0	31.8	106	
	SLCO-40	118.0	47.4	4.0	38.9	132	
	SLCR-30	86.5	50.4	3.6	30.3	110	
	SLCR-32	97.4	47.1	3.6	32.0	108	
	SLCR-40	121.6	47.4	3.6	40.1	152	
Stiebel Eltron www.stiebel-eltron-usa.com	Sol 25 Plus	87.9	48.1	3.1	29.4	108	5 / 0
SunEarth www.sunearthinc.com	Empire EC-21	76.1	40.1	3.3	21.2	71	0 / 10
	Empire EC-24	98.3	36.1	3.3	24.7	81	
	Empire EC-32	98.3	48.1	3.3	32.8	105	
	Empire EC-40	122.3	48.1	3.3	40.9	138	
	Empire EP-21	76.1	40.1	3.3	21.2	71	
	Empire EP-24	98.3	36.1	3.3	24.7	80	
	Empire EP-32	98.3	48.1	3.3	32.8	105	
	Empire EP-40	122.3	48.1	3.3	40.9	138	
Synergy Solar www.synergysolar.com	TC-19.78	78.0	36.0	N/A	19.8	78	12 / 0
	TC-26.52	78.0	48.0	N/A	26.7	108	
Thermo Dynamics www.thermo-dynamics.com	G Series G32-P	97.4	47.4	3.4	32.1	96	10 / 0
Viessmann Manuf. Co. www.viessmann-us.com	Vitosol 100 SV1, SH1	94.0	41.8	3.5	27.2	97	10 / 0

Evacuated Tube

Manufacturer	Model	Length (In.)	Width (In.)	Depth (In.)	Gross Area (Ft.^{2})	Dry Weight (Lbs.)	Warranty (Yrs.: Full/Ltd.)
American Solar Works www.americansolarworks.com	ASW52B	75.0	64.0	5.0	30.8	138	10 / 0
	ASW52B Stretch	75.0	84.0	5.0	42.0	188	
Apricus Solar www.apricus-solar.com	AP-10	77.9	31.3	6.1	14.5	77	0 / 10–15
	AP-20	77.9	58.8	6.1	29.2	125	
	AP-22	77.9	64.4	6.1	32.1	157	
	AP-30	77.9	86.4	6.1	43.6	182	
Beijing Sunda Solar Energy Technology www.sssolar.com	10-10 AS/AB	76.2	36.6	7.4	18.1	88	10 / 0
	10-20 AS/AB	76.2	73.2	7.4	36.5	165	
	1-16	83.7	75.6	6.9	43.0	221	
	1-8	83.7	37.8	6.9	21.5	104	
	2-16	83.7	75.6	5.9	44.1	221	
	2-8	83.7	37.8	5.9	21.9	110	
	5-16 AS/AB	83.7	75.6	6.9	44.1	232	
	5-8 AS/AB	83.7	37.8	6.9	21.8	108	
BTF www.btfsolar.com	Solar Patriot SP-20	77.9	65.3	6.6	33.1	122	5 / 0
Oventrop www.oventrop-na.com	OV 5-16 AS/AB	87.9	76.4	7.4	44.1	232	10 / 0
	OV 5-8 AS/AB	87.9	38.6	7.4	21.8	108	
Solargenix Energy www.solargenix.com	Winston Series CPC WS0503	81.5	41.9	3.4	24.1	107	3 / 10
Thermo Tech./Thermomax www.solarthermal.com	Mazdon TMA-600-20	80.0	59.0	6.3	32.9	135	0 / 5
	Mazdon TMA-600-30	80.0	87.0	6.3	49.3	197	
Viessmann Manuf. Co. www.viessmann-us.com	Vitosol 300 Type SP3, 2 m^2	78.5	55.8	4.8	31.0	127	10 / 0
	Vitosol 300 Type SP3, 3 m^2	78.5	83.8	4.8	46.2	150	

Unglazed Flat Plate

Manufacturer	Model	Length (In.)	Width (In.)	Depth (In.)	Gross Area (Ft.^{2})	Dry Weight (Lbs.)	Warranty (Yrs.: Full/Ltd.)
Typical pool collector	Average model	–	–	–	47.0	25	–

1) 2,000 Btu / Ft.^{2} / Day; 2) 1,500 Btu / Ft.^{2} / Day; 3) 1,000 Btu / Ft.^{2} / Day; 4) Btu / Hr. / Ft.^{2} / °F

Materials: Absorber: Tube	Materials: Absorber: Plate	Materials: Absorber: Coating	Materials: Glazing	Materials: Frame	Thousands of Btu Per Day: Clear [1]	Thousands of Btu Per Day: Mildly Cloudy [2]	Thousands of Btu Per Day: Cloudy [3]	Y- Intercept	Slope [4]
Copper	Copper Fin	Selective Surface	Low-Iron Tempered Glass	Aluminum	22	15	8	0.704	-0.790
					25	17	9	0.704	-0.790
					28	19	10	0.704	-0.790
					32	22	12	0.704	-0.790
					39	27	15	0.704	-0.790
Copper	Copper Fin	Black Chrome	Low-Iron Tempered Glass	Extruded Aluminum	27	18	10	0.782	-0.811
					35	24	13	0.785	-0.810
					42	29	15	0.787	-0.810
				Aluminum	33	23	14	0.735	-0.945
					35	25	14	0.735	-0.945
					44	31	18	0.735	-0.945
Copper	Copper	Sputtered Titanium Nitride	Low-Iron Tempered Glass	Extruded Aluminum	30	21	12	0.660	-0.755
Copper	Copper	Black Chrome	Low-Iron Tempered Glass	Extruded Aluminum	22	15	9	0.714	-0.727
					26	18	10	0.714	-0.727
					34	24	13	0.714	-0.727
					42	29	16	0.714	-0.727
		Mod. Selective Black Paint			21	14	8	0.682	-0.800
					24	17	9	0.682	-0.800
					32	22	12	0.682	-0.800
					40	28	15	0.682	-0.800
Copper	Copper Fin	Sputtered Aluminum Nitride	Low-Iron Tempered Glass	Aluminum	19	13	7	0.686	-0.809
					26	18	10	0.697	-0.806
Copper	Aluminum	Mod. Selective Black Paint	Low-Iron Tempered Glass	Aluminum	29	19	10	0.700	-0.870
Copper	Copper Fin	Sputtered Cermet	Tempered Glass	Aluminum	30	21	12	0.720	-0.616
Copper	Aluminum	Sputtered Aluminum Nitride	Glass Vacuum Tube	Stainless Steel	22	16	10	0.481	-0.291
					29	21	13	0.481	-0.291
Copper & steel	Glass	Sputtered Aluminum Nitride	Glass Vacuum Tube	Stainless Steel	12	8	5	0.418	-0.206
					23	17	11	0.418	-0.206
					26	19	12	0.418	-0.206
					35	25	16	0.418	-0.206
Copper	Aluminum	Sputtered Aluminum Nitride	Glass Vacuum Tube	Stainless Steel	14	10	6	0.462	-0.276
					28	20	12	0.462	-0.276
					35	26	16	0.529	-0.299
					18	13	8	0.529	-0.299
		Sputtered Selective			48	35	22	0.628	-0.303
					24	17	11	0.628	-0.303
		Sputtered Aluminum Nitride			36	26	16	0.492	-0.339
					18	13	8	0.492	-0.339
Glass	Aluminum	Sputtered Aluminum Nitride	Glass Vacuum Tube	Stainless Steel	23	17	11	0.345	-0.203
Copper	Aluminum	Sputtered Aluminum Nitride	Glass Vacuum Tube	Stainless Steel	36	26	16	0.492	-0.339
					18	13	8	0.492	-0.339
Copper	None	Mod. Selective Black Paint	Low-Iron Tempered Glass	Aluminum	18	12	6	0.600	-1.001
Copper	Copper Fin	Black Chrome	Iron-Free Glass Vacuum Tube	Stainless Steel	26	19	12	0.530	-0.250
					40	29	18	0.530	-0.250
Copper	Copper Fin	Sputtered Cermet	Glass Vacuum Tube	Aluminum	26	19	12	0.509	-0.193
					39	29	18	0.509	-0.193
Polymer	None	None	–	None	23	11	0	0.800	-2.900

Operating Categories

Most locations will not fit precisely into a single SRCC operating category. Collectors will typically operate in the B and C categories in the morning, when cooler ambient temperatures are closer to the inlet temperatures. As a typical day progresses, inlet temperature outpaces the ambient temperature, and the collector operates in the C and D categories.

As a general rule, if you must pick a single category of operation in any location, the C category will be most accurate year-round in all but the very coldest climates in the United States. Many systems will operate closer to the D category in the winter, but will predominately be closer to the C category in the spring, summer, and fall. For collector performance in other operating categories, refer to an individual collector's SRCC data sheet.

An important consideration in examining how the collector types perform is the intersection of the slope lines in the graph. As ΔT increases, all three of the glazed collectors quickly surpass the unglazed collector in terms of performance. As the temperature difference continues to increase, the evacuated-tube collectors pass both types of flat-plate collectors at a ΔT of approximately 100°F. This indicates that the evacuated-tube collectors will perform better than the flat-plate collectors in conditions of extreme cold and/or when an application requires elevated temperatures.

Regional Choices

Because they have high efficiencies at low ΔTs, unglazed collectors are optimal for heating swimming pools only in certain seasons when temperatures are warm and don't fluctuate. In places where the weather is consistently warm—for instance, in parts of Florida or Arizona—this characteristic means solar pool heating can occur almost year-round.

Flat-plate and evacuated-tube collectors can be tougher to evaluate in colder or cloudier locations. For heating domestic water to 130°F, glazed flat-plate collectors can produce more heat than evacuated-tube collectors of similar size, during most of the year, in almost all of the contiguous United States. This is shown in the table as Btu output (sunny, mildly cloudy, and cloudy). It is also reflected by the graph, as the evacuated-tube collectors don't outproduce flat plates until after a temperature difference of about 100°F or so. If you want to make exact comparisons, review the complete SRCC data sheet for each collector you're considering.

In solar water heating applications, evacuated-tube collectors start to outperform their flat-plate cousins in northern latitudes and colder climates like Canada and Alaska. They are less affected by larger temperature differences than flat-plate collectors. Because evacuated tubes can also get fluids hotter, they are well suited for higher temperature, less common applications such as absorption-cycle air conditioning.

Choosing Your Collector

The bottom line (or X-axis to rocket scientists) is that you can get some real-world performance data from the intercepts and slopes when you factor in the collector size. The specifications table includes three columns of performance data extracted from SRCC data sheets. SRCC's Category C "warm climate" classification, which assumes a temperature difference between ambient and collector inlet of 36°F, is the category used in the table since it best represents the "average climate" in most of the United States. The Sunbelt (southwest United States and Florida) predominantly has sunny conditions. The Midwest and middle coastal areas generally fit into the "mildly cloudy" category, and the northern coastal areas are typically classified as "cloudy."

A collector's output is an important consideration in collector selection, but it isn't everything. Also factor in a manufacturer's reputation and track record, as well as the materials used in collector construction. With few exceptions (i.e., pool collectors), all the hot water collectors in this guide are made with durable metals, glass, and high-temperature insulation—materials with proven track records.

Collector Costs

The one thing missing from the specifications table is price. That's because the cost of collectors is difficult to nail down. Prices vary by dealer and whether the cost includes installation. Plus, the cost of key materials—copper, aluminum, and glass—has fluctuated nearly as much as gasoline prices. Btu produced per dollar (output per cost) is the criteria I recommend for the best value. Don't be impressed with gizmos or claims of performance other than the SRCC catalog data. SRCC provides the best source of independent testing data for all certified collectors and, like it or not, the U.S. Congress has made the SRCC the authority by requiring their certification for receiving federal tax credits.

Access

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