Solar hot water collector sizing worksheet

Step one: Calculate your daily hot water use

Table 1. Daily hot water use for a family of three in a water-efficient home in Columbia.

Hot water use	Average gallons per use	Times per day	Gallons used per day
Shower	10	3	30
Automatic dishwasher	4	½ (Once every two days)	2
Faucets	2	6	12
Automatic clothes washing machine (hot or warm water used)	18	½ (Once every two days)	9
		Total daily hot water use:	53 gallons[a]

[a] *This equals about 18 gallons of hot water per person per day. Installers might assume inefficient water use and use 30 gallons of hot water per person per day to size systems. For tips on reducing hot water use and how to determine showerhead flow, visit* http://energy.gov/energysaver/articles/reduce-hot-water-use-energy-savings.

Step two: Calculate the energy needed to heat your water

Table 2. Your daily hot water use.

Hot water use	Average gallons per use	Times per day	Gallons used per day
Shower			
Automatic dishwasher			
Faucets			
Automatic clothes washing machine (hot or warm water used)			
Other			
Other			
		Total daily hot water use:	

Total daily hot water use (in gallons) × temperature rise (°F) × 8.33 (a constant) = Energy load (in Btu, or British thermal units)

Columbia home example:
53 gallons × 65 degrees F × 8.33 = 28,697 Btu per day

Your energy load:
_____ gallons × _____°F × 8.33 = _____ Btu per day

Temperature rise is the difference between the temperature of the water coming into your home or building and the temperature setting on your hot water heater. For most areas in Missouri, incoming water is 55 degrees F. If the water heater were set at 120 degrees F, the temperature rise would be 65 degrees F (120 – 55 = 65 degrees F).

There is a formula constant of 8.33 that represents the density of water multiplied by its specific heat.

Step three: Determine your site's average daily solar energy (radiation)

Find your city or the city nearest your site for your average daily solar radiation.

Table 3. Solar radiation data for flat-plate collectors (south-facing, fixed tilt at latitude angle)

City	kWh/m²/day
Columbia	4.9
Kansas City	4.9
Springfield	4.9
St. Louis	4.8

Source: U.S. DOE/National Renewable Energy Laboratory (NREL). http://rredc.nrel.gov/solar/pubs/redbook

Step four: Convert your answer into Btu/ft2/day

Steps five through seven provide information that will be used when accessing the Solar Rating and Certification Corporation's (SRCC) website that lists solar hot water collectors at *www.solar-rating.org*.

Conversion formula:
1 kWh/m²/day = 317.1 Btu/ft²/day

Columbia example:
4.9 kWh/m²/day × 317.1 = 1,554 Btu/ft²/day

Your site:
_____ kWh/m²/day × 317.1 = _____ Btu/ft²/day

Step five: Determine your site's sky type

Take your site's average daily solar energy number from step four, and determine your site's sky type using this table.

Table 4. SRCC sky type rating.

Btu/ft²/day	Sky type
2,000	Clear
1,500	Mildly cloudy
1,000	Cloudy

Using the example, 1,554 Btu/ft²/day is closest to 1,500 Btu/ft²/day, so the sky type will be mildly cloudy for the purposes of sizing the collector.

Step six: Find the appropriate category

The SRCC's collector listing allows you to choose from the following categories:

- A: Pool heating in warm climates
- B: Pool heating in cool climates
- C: Water heating in warm climates
- D: Water heating in cool climates (This is the category used for the Columbia example.)
- E: Air conditioning for open spaces

Step seven: Determine the collector type

Residential solar hot water systems in Missouri typically use glazed flat-plate or evacuated-tube collectors. For more information on these types of collectors, see the *System Options* guide in this module. The SRCC's website, *www.solar-rating.org*, has information on collectors that have been tested against their standards and allows you to compare different brands.

Step eight: Find certified solar hot water collectors

Go to *www.solar-rating.org* for a list of collectors that have been tested and rated by the SRCC. The site shows the collector specifications, including gross area, as well as materials and technical information.

- Click "Ratings" in the column on the left.
- In the drop-down menu for "Request Type," select "Glazed Flat Plate." In the drop-down menu for "Fluid," select "Liquid." Finally, click the Search button to view the results of your search.

Using the sky type rating for mildly cloudy and category D (water heating in cool climates), this system will produce 16,500 Btu per collector per day, or 16.5 kBtu per collector per day.

To account for inefficiencies, such as heat loss through pipes and storage tanks, in a complete solar hot water system multiply the collector's rated output by 80 percent for a more accurate estimate of how much energy it will produce.

16.5 kBtu/collector/day × 0.80
= 13.2 estimated kBtu/collector/day

Your collector choice:
_____ kBtu/collector/day × 0.80
= _____ estimated kBtu/collector/day

The SRCC category letters are based on the difference between the temperature of the water entering the collector (T_i) and the temperature around the collector (T_a). Category C might be more accurate during warmer months for most of Missouri, so consider that using an average of several categories might be necessary for more accurate sizing.

Step nine: Determine how many collectors are needed to provide your hot water

This will be based upon how much energy is needed to heat your water (Calculated in step two).

Example (numbers from step two):
53 gallons × 65° F × 8.33 = 28,697 Btu/day

28,697 Btu/day ÷ 1,000 = 28.7 kBtu/day

Next, divide the home's hot water energy requirement by the chosen panel's output.

28.7 kBtu/day ÷ 13.2 kBtu/collector/day
= 2.2 collectors (round up to three)

Therefore, three of the selected collectors would be needed to produce 100 percent of the home's hot water. Two collectors would provide 75 percent of the home's hot water needs.

Your site (insert numbers from step two):
_____ gallons × _____ °F × 8.33
= (a) _____ Btu/day

(a) _____ Btu/day ÷ 1,000 = (b) _____ kBtu/day

From step eight:
_____ kBtu/collector/day output × 0.80
= (c) _____ kBtu/collector/day

(b) _____ ÷ (c) _____ = _____ (number of collectors needed to provide all of your hot water)

According to the Department of Energy's Database of Incentives for Renewables and Efficiency, to take advantage of the federal 30 percent Residential Renewable Energy Tax Credit, "solar water heating property must be certified by SRCC or a comparable entity endorsed by the state where the system is installed. At least half of the energy used to heat the dwelling's water must be from solar."

Reference

Bickford, Carl. (2007, April/May). *Sizing Solar Hot Water Systems*. Home Power, 118, 34-38.

Notes

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