STEP 8

E3A: Solar Hot Water Applications for the Home, Farm, or Ranch

Steps in the Solar Hot Water Series

E3A-SHW.8
Printed October 2011

Solar Hot Water Collector Sizing Worksheet

Step 1: Calculate Your Daily Hot Water Use

Example: A Water-Efficient Home in Helena–Daily Hot Water Use (Family of Three)			
Hot Water Use	Average Gallons Per Use	Times Per Day	Gallons Used Per Day
Shower	10	3	30
Automatic dishwasher	4	.5 (every 2 days)	2
Faucets (hand washing, food prep, etc.)	2	6	12
Automatic Clothes Washing Machine (if hot/ warm water used)	18	.5 (every 2 days)	9
		Total Daily Hot Water Use	*53 Gallons

* This equals 18 gallons of hot water per person per day. Installers may 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: www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=13050

Your Daily Hot Water Use			
Hot Water Use	Average Gallons Per Use	Times Per Day	Gallons Used Per Day
Shower			
Automatic dishwasher			
Faucets (hand washing, food prep, etc.)			
Automatic Clothes Washing Machine (if hot/ warm water used)			
Other			
Other			
		Total Daily Hot Water Use	

Step 2: Calculate the Energy Needed to Heat Your Water

Formula: Volume (in gallons) x Temperature Rise (°F) x 8.33 (a constant) = Energy Load (in Btu)

Helena Example: 53 Gallons x 80°F x 8.33 = 35,319 Btu/day

Your Home/Building: _____ Gallons X ____ °F X 8.33 = _____ Btu/day

- Volume = Total Daily Hot Water Use # from Step 1.
- Temperature Rise: the difference between the temperature of the cold water coming into your home or building and the temperature setting on your hot water heater. For Helena, Mont., and Cheyenne, Wyo., incoming water is 40°F; If the water heater is set at 120°F, the temperature rise (difference) is 80°F (120-40= 80°F). Go to: http://calc.rinnai.us/residentialapp.asp x?&SID=4vueps2a2uq04labawfxooy0 for the incoming temperature of your water. You only need your zip code.
- 8.33 is a formula constant; it represents the density of water multiplied by its specific heat.
- Btu – British Thermal Units

Step 3: 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 A: Solar Radiation Data for Flat-Plate Collectors (south-facing, fixed tilt at latitude angle)

Montana Cities	kWh/m²/day	Wyoming Cities	kWh/m²/day
Billings	5.0	Casper	5.3
Cut Bank	4.8	Cheyenne	5.3
Glasgow	4.7	Lander	5.6
Great Falls	4.8	Rock Springs	5.5
Helena	4.7	Sheridan	5.0
Kalispell	4.1		
Lewistown	4.7		
Miles City	5.0		
Missoula	4.3		

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

Step 4: Convert Your Answer into Btu/ft²/day

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

Helena Example: 4.7 kWh/m²/day x 317.1 = 1,490 Btu/ft.²/day

Your Site: _____ kWh/m²/day x 317.1 = _____ Btu/ft²/day

Steps 5-7 provide information that will be used when accessing the Solar Rating & Certification Corporation's (SRCC) website list of solar hot water collectors.

Step 5: Determine Your Site's Sky Type

Take your site's average daily solar energy number from Step 4, and using this table, determine your site's Sky Type.

SRCC "Sky Type" Rating Table

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

Using the Helena Example, 1,490 Btu/ft²/day is closest to 1,500 Btu/ft²/day; thus, Mildly Cloudy will be used as the Sky Type for sizing the collector.

Step 6: Finding the Appropriate Category Letter

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

A: Pool Heating (Warm Climates)
B: Pool Heating (Cool Climates)
C: Water Heating (Warm Climates)
D: Water Heating (Cool Climates) <— *Category used for the Helena example.*
E: Air Conditioning (space conditioning)

Step 7: Determine the Collector Type

Glazed flat-plate or evacuated tubes are typically used for residential solar hot water systems in Montana and Wyoming. Decide which one you will install for selecting the "Optic Type" option once on the website. For the Helena example, we will select a Glazed Flat-Plate collector, and Liquid as the "Fluid" option.

Step 8: Find Certified Solar Hot Water Collectors

Website: www.solar-rating.org

- Select -> Ratings (left-hand column)
- Select -> OG 100 Directory–for collectors. (The OG 300 Directory lists complete solar hot water systems)
- Select -> Certified Collectors and Ratings
- Select -> Glazed Flat-Plate under the Optic Type options, and Liquid under the Fluid Option.
- If you have a specific company or brand name you prefer, select those options.
- Select -> Show Selections

You will see a list of collectors that have been tested and rated by the SRCC. The complete page (not shown) provides the collector specifications, including gross area, as well as materials and technical information. *This is not an endorsement of the Rheem Company or its products; Rheem was chosen for the sole purpose of providing an example.*

SOLAR COLLECTOR CERTIFICATION AND RATING

SRCC OG-100

CERTIFIED SOLAR COLLECTOR

SUPPLIER:	**Rheem Water Heaters** 101 Bell Rd Montgomery, AL 36117 USA
MODEL:	Rheem RS40-BC
COLLECTOR TYPE:	Glazed Flat-Plate
CERTIFICATION#:	2009094C

COLLECTOR THERMAL PERFORMANCE RATING

Kilowatt-hours Per Panel Per Day				Thousands of BTU Per Panel Per Day			
CATEGORY (Ti-Ta)	CLEAR DAY	MILDLY CLOUDY	CLOUDY DAY	CATEGORY (Ti-Ta)	CLEAR DAY	MILDLY CLOUDY	CLOUDY DAY
A (-5 °C)	16.4	12.3	8.3	A (-9 °F)	55.9	42.1	28.3
B (5 °C)	15.1	11.1	7.0	B (9 °F)	51.6	37.7	24.0
C (20 °C)	13.0	9.0	5.1	C (36 °F)	44.3	30.7	17.3
D (50 °C)	8.5	4.8	1.5	D (90 °F)	28.8	16.5	5.0
E (80 °C)	4.0	1.1	0.0	E (144 °F)	13.7	3.8	0.0

A- Pool Heating (Warm Climate) **B**- Pool Heating (Cool Climate) **C**- Water Heating (Warm Climate) **D**- Water Heating (Cool Climate) **E**- Air Conditioning

Original Certification Date: 29-OCT-09

Using Mildly Cloudy and Category D, this collector will produce 16.5 thousands of Btu per panel (collector) per day. Divide by 1,000 to get kBtu units.

16,500 Btu/collector/day ÷ 1,000 = 16.5 kBtu/collector/day

Because there are inefficiencies in the complete solar hot water system (heat loss through storage tanks, pipes, etc.), a rule of thumb is to multiply the collector's rated output by 80% for a more accurate estimate of how much energy it will produce.

16.5 kBtu/collector/day x .80 = 13.2 kBtu/collector/day

Your Collector Choice: _____ kBtu/collector/day x .80 = _____ kBtu/collector/day

NOTE: The A – E Category letters are based upon the difference between the temperature of the water entering the collector (Ti) and the temperature around the collector (Ta). Category C may be more accurate during warmer months for most of Montana and Wyoming; thus, consider that using an average of several Categories may be needed for more accurate sizing.

Step 9: 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 2).

Helena Example (#'s from Step 2): 53 Gallons x 80° F X 8.33 = 35,319 Btu/day

35, 319 Btu/day ÷ 1,000 = 35.3 kBtu/day

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

35.3 kBtu/day ÷ 13.2 kBtu/collector/day = 2.6 collectors (round-up to 3)

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

Your Home/Building (insert #'s from Step 2): _____ Gallons x _____ °F x 8.33 = (a) _____ Btu/day

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

From Step 8: _____ kBtu/collector/day output x .80 = (c) _____ kBtu/collector/day

(b) _____ ÷ (c) _____ = _____ (# of collectors needed to provide 100% of your hot water).

NOTE: To take advantage of the current federal 30% 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 50% 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