For more energy information, go to http://energy.tennessee.edu.

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System Sizing

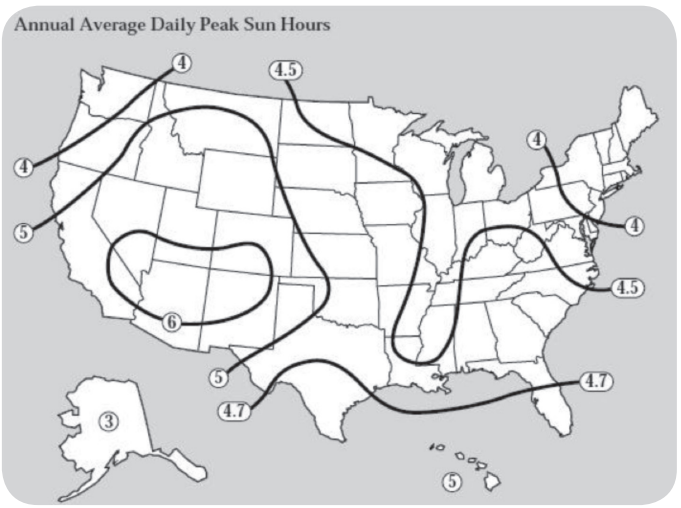
The size of your solar electric system depends on:

- How much electricity is used and the percentage of solar electricity to be generated.
- Type of PV material used (crystalline silicon or thin-film).
- Roof or other PV material mounting surface orientation, tilt, area and condition.
- Local solar resource (solar radiation) and peak (direct) hours of sunlight.
- Budget.

Review your utility bills to determine how much electricity you use -- show in kilowatt-hours (kWh).

One method for approximating system size is using **Daily Peak Sun Hours**:

1. Determine your average monthly electricity use in kWh.
2. Divide by 30 for average use per day.
3. Find the Peak Sun Hours for your location on the map. Peak sun hours are the hours of direct sunlight that fall on a PV panel (not total hours of daylight).



This diagram illustrates the annual average daily peak sun hours for the United States. Courtesy of DOE/NREL

4. Divide the answer calculated in #2 by your Peak Sun Hours. #4's answer is a rough estimate of the solar electric system size you will need (in kW) for 100 percent of your electricity.

Example:

1. A Tennessee home's monthly average electricity use is 1,217 kWh/month.
2. 1,217 kWh ÷ 30 = **40.6 kWh** average per day.
3. Nashville is near the diagram's "4.5" line = 4.5 annual average peak sun hours per day.
4. 40.6 ÷ 4.5 = 9.02 kW PV system would be needed to produce 100 percent of this home's electricity.

Note: This method provides a rough estimate and should not be used to size a system. The actual system will most likely be larger due to many system-related factors including inefficiencies of system components. It also does not take into account conservation and efficiency measures you put in place before installing a solar electric system. For more accurate sizing, use the worksheet on the following page, since it takes into account conservation and efficiency measures and system component inefficiencies. However, an installer should do the final sizing and make the final recommendations.

Courtesy of DOE/NREL

Solar Electric PV Panel/System Worksheet *Based on a South-Facing PV Module at a Fixed Tilt (Latitude Angle)*		
Steps	Example: Home in Nashville, TN	Your Home/Building
1. Average monthly electricity used in kilowatt-hours (kWh).	1,217 kWh/month	
2. Multiply by 1,000 to convert to watt-hours used per month.	1,217 x 1,000 = 1,217,000 watt-hours/month	
3. Divide by 30 for total average watt-hours used per day.	1,217,000 ÷ 30 = 40,567 watt-hours/day	
4. Subtract daily watt-hours eliminated through energy conservation and efficiency.	40,567 – 8,953* = 31,614 watt-hours/day	
5. Multiply by the percent of electricity you want provided by the sun.**	For 50%: 31,614 X .50 = 15,807 watt-hours/day; for 100%: 31,614 watt-hours per day	
6. Divide by the average monthly solar radiation for your city or the city nearest you. Find in **Table A** (on next page).	15,807 ÷ **4.9 kWh/m²/day** (Nashville) = 3,226 watts	
7. Multiply by 1.2 to account for system inefficiencies (wire losses, etc.)	3,226 x 1.2 = 3,871 watts	
8. Divide by 1,000 for the size of the overall system in kilowatts (kW). Will be used to approximate system cost.	3,871 ÷ 1,000 = **3.87 kW** PV array/ "system" size	
9. Divide #7's answer by the Peak/Max Power (in watts) of the PV panel you will install. (230 watts is a typical average)	3,871 watts ÷ 230 watts = 16.8 (17) panels	
10. Round up to a whole number. This is the number of PV panels needed to provide electricity based on the selected criteria.	**17**, 230-watt PV panels (17 x 230 = 3,910 watts) or **16**, 250-watt panels (16 x 250 = 4,000 watts)	

*Example of potential energy savings in watt-hours/day. Re-run the calculation after you have implemented conservation and efficiency measures.

**Omit this step if you wish to provide 100 percent of electricity - carry value from #4 down to #6.

Worksheet Notes:

1. Tennessee homes used an average of 1,217kWh/month of electricity in 2012.
2. 1 kilowatt-hour (kWh) = 1,000 watt-hours.
3. 365 days/year divided by 12 months = 30 average days in one month.
4. Energy conservation and efficiency measures can reduce the size of your system.
5. PV panels can be added to a system over time.
6. The solar radiation value used to rate panels is 1 kW/m^2 and thus the results are in watts.
7. The amount of PV-produced electricity decreases as it flows through wires, the inverter and other system components. NREL's PV Watts online tool addresses this using a de-rate factor.
8. Converts watts back to kilowatts (the units used to describe a system's "size").
9. If you know what PV panel you will use, divide Box 7's watts by the Peak Power (in watts) of the panel to determine the # of panels needed. Do you have enough space on your roof?

After the number of panels is determined, the remaining balance of system components (inverter, etc.) can be sized accordingly. While the kW output calculated in Step 8 above is specific to the PV panels/array, the kW number is also referred to/used as the "system size."

Find your city or city nearest your site for your average daily Solar Radiation (Solar Resource):

Table A: Solar Radiation Data for Flat-Plate Collectors/ Panels (south-facing, fixed tilt at latitude angle)	
Tennessee Cities	kWh/m²/day
Bristol	4.6
Chattanooga	4.7
Knoxville	4.7
Memphis	5.0
Nashville	4.9

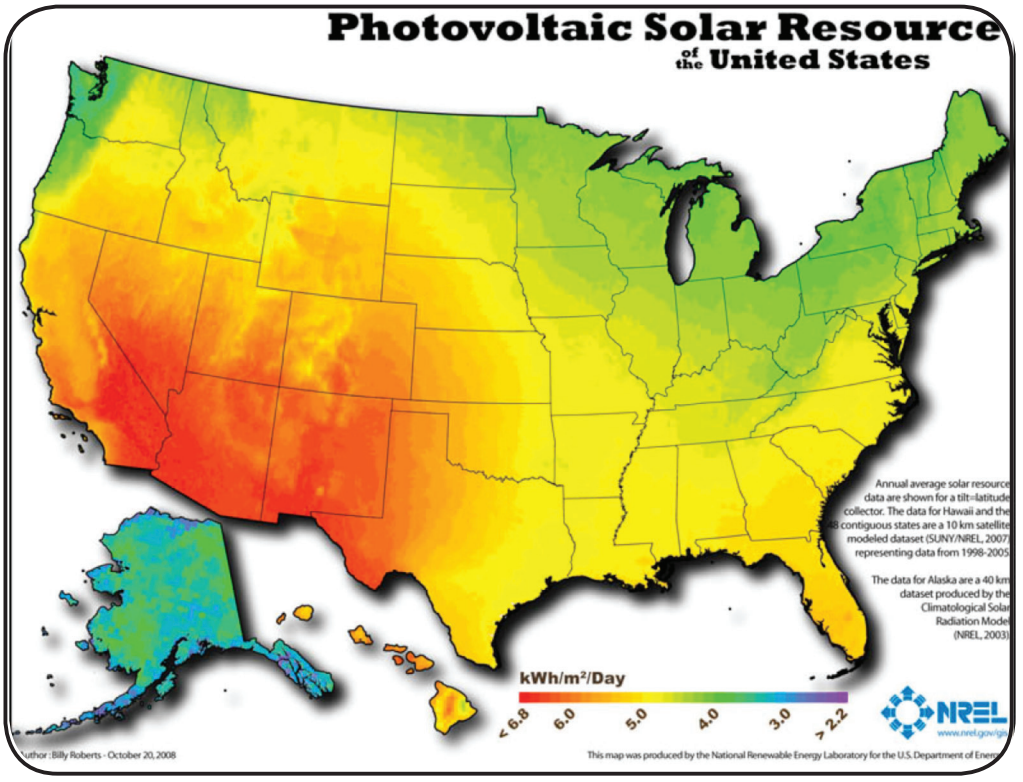
Source: U.S. DOE/National Renewable Energy Laboratory (NREL): http://rredc.nrel.gov/solar/pubs/redbook

These Tennessee cities have National Solar Radiation Data Base collection stations. The NREL web link provides adjusted panel angles and tracking system data.

If your city is not listed in the table or is not near the listed cities, find your solar resource/radiation number from the map below. You can also access the map at http://www.nrel.gov/gis/solar.html.

Computer/On-Line Sizing Tools allow you to consider a combination of PV system options for specific locations using your address or zip code. Know how much electricity you use in one year (in kWh) and the approximate PV system size you are considering before you access the free program.

- **PV Watts** is an online calculator that provides energy production and cost savings estimates for grid-tied systems: http://www.nrel.gov/rredc/pvwatts. *NOTE: After you type in your zip code and select "Send to PVWatts," a screen will appear that allows you to make selections. Under PV System Specifications, "DC Rating," change the default (set at 4.0) to 1.0. After you select "Calculate," two tables appear. Under the "Results" table, look for the "Year" result (in kWh) under the "AC Energy" column. Divide your yearly electricity use (in kWh) by the "Year" number from the "AC Energy" column to determine the PV system size needed to provide 100 percent of your electricity from the sun. The "Energy Value" column shows electricity cost savings.*



Are you interested in solar electricity because you want to reduce your **environmental footprint**? To determine the amount of greenhouse gases you are preventing by installing a solar electric system, use Option 1 (insert the kWh provided by the solar electric system) with the **U.S. EPA's Greenhouse Calculator**: www.epa.gov/cleanenergy/energy-resources/calculator.html.

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Notes

Original work created by Montana State University Extension and the University of Wyoming. Adapted for use in Tennessee by Elizabeth Gall, Department of Biosystems Engineering and Soil Science.

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