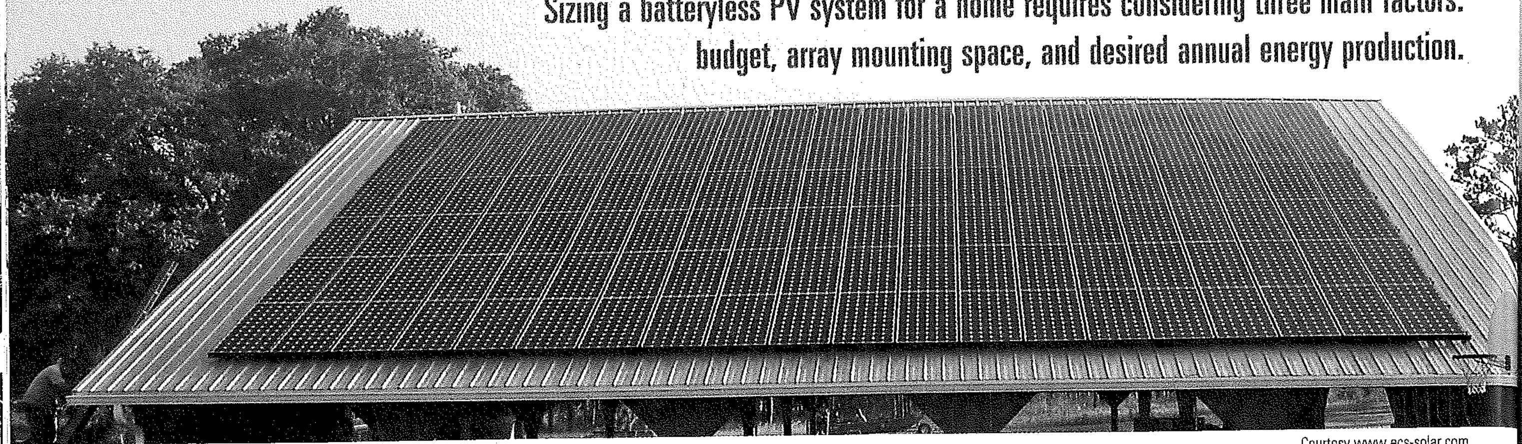
System Sizing for Residential Grid-Tied PV

Sizing a batteryless PV system for a home requires considering three main factors: budget, array mounting space, and desired annual energy production.



Courtesy www.ecs-solar.com

Budget-Based System Sizing

Currently, batteryless grid-tied PV systems cost $7 to $9 per installed watt (before incentives). For the example below, we assume a $15,000 budget.

$15,000 ÷ $7/W = 2,143 W
$15,000 ÷ $9/W = 1,667 W

Given this budget, system size would likely range from 1,700 W to 2,100 W.

Available incentive programs can help offset system costs, allowing you to invest in a bigger array. For example, the federal tax credit for solar-electric systems allows for a 30% tax credit. Factoring this in allows you to increase array size, but also requires additional dollars up-front to pay for the larger system—and enough tax liability to take full advantage of the credit.

Roof Space System Sizing

System size also an be estimated based on "usable" square feet of mounting space. Crystalline PV modules generate about 9 W to 17 W per square foot (averaging 12 W per square foot), while amorphous silicon products generate about 6 W per square foot.

To find "usable" area for PV array mounting, there are several things to consider. (For more information, see "Solar Site Assessment" on page 46.) After accounting for aesthetics and working space around the array, typically only 50% to 80% of sunny roof space can be used. For this example, we will assume a usable area of 300 square feet.

300 sq. ft. x 12 W/sq. ft. = 3,600 W (crystalline silicon)
300 sq. ft. x 6 W/sq. ft. = 1,800 W (amorphous silicon)

Desired Annual Energy (kWh) System Sizing

System size can be based on annual energy production goals as well. Given your household's annual electricity consumption, peak sun-hours for the array location, and an average 70% system derate factor (to account for temperature losses, dust/dirt, wiring losses, inverter efficiency, module production tolerance, etc.), you can calculate the array size needed. For this example, we'll assume the system will be located in Flagstaff, Arizona, and oriented to true south and tilted at 35° (an angle equal to Flagstaff's latitude). It will be designed to produce approximately 3,000 kWh per year, which will meet about half of the household's annual electricity needs.

- Find the average daily peak sun-hours for the site (see Access). For Flagstaff, it's 6 sun-hours per day.
- Divide the annual PV production goal by the number of days in a year. Divide this total by the number of average daily sun-hours to arrive at your estimated initial array size.

3,000 kWh/year ÷ 365 days/year = 8.219 kWh/day
8.219 kWh/day ÷ 6 sun-hours/day = 1.37 kW

- To account for system inefficiencies, divide the result by 70% (0.7) to calculate the total system size.

1.37 kW ÷ 0.7 system derate = 1.96 kW or 1,960 W

Alternatively, the PVWatts online program (see Access) can be used to find annual kWh production values for various PV array sizes. Variables such as non-optimal orientation and tilt angles can be factored in easily.

Efficiency First

Reducing annual energy consumption through the use of energy-efficiency strategies (such as replacing incandescent lights with compact fluorescent lighting) will yield a smaller PV system, lower system cost, and less required space.

Access

Photovoltaics Design & Installation Manual, Appendix B (New Society, 2007) • Solar data, including peak sun-hours

PVWatts • www.nrel.gov/rredc/pvwatts/ • PV production estimator

—Justine Sanchez