Engineering Bulletin

SunWize
Power & Battery

Photovoltaic (PV) Array Sizing

Why won't a 100 watt solar module power a 100 watt load?

Our customer Joe Higgins knows how easy it is to configure solar systems for his remote power projects using SunWize's online Power Ready Specifier. When discussing the details of his current project with Bruce Wilson, SunWize sales manager in Maryland, he wanted to know how SunWize determines the size of a solar module array. He asked, "Why does my load require a solar array wattage that is many times larger than my load?" The answer lies in three basic factors:

Factor #1

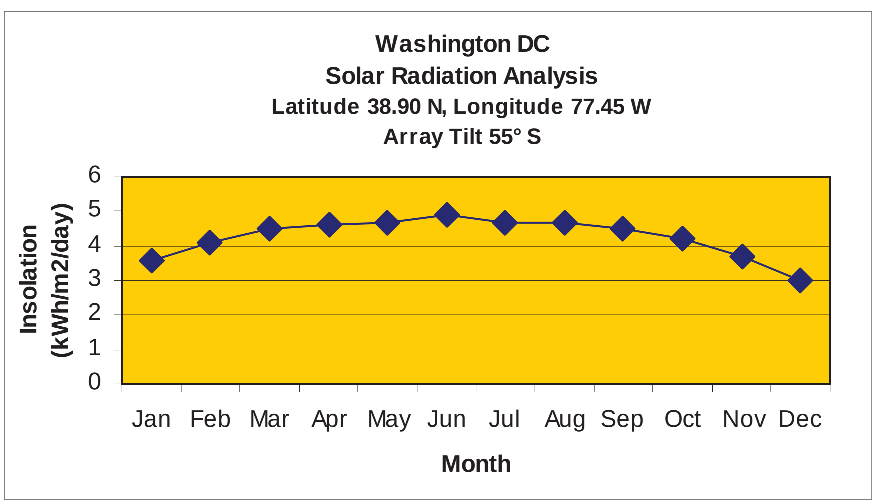
Most loads draw energy 24 hours per day from the battery bank. The PV module (or PV array) charges the battery bank during available sunlight. Since systems are designed to always have enough power to charge the battery bank, the worst-case solar day is used as a guide to design the array size.

A 'worst-case solar day' is the average day during a month of the year when solar radiation levels are at their lowest (usually December or January in the northern hemisphere). That worst-case day has a number of "peak hours", when the sun is shining directly overhead to produce enough energy to charge the battery bank. For example, there are 3 peak hours on average in Washington, DC during a typical December day. Therefore, the PV array has 3 hours to produce the same amount of energy used by the load in 24 hours. The result is a PV array 8 times the size of the load (24 divided by 3 = 8).

Factor #2

Nominal 12-volt DC PV modules actually operate at 16.5 to 17 volts DC. This insures the PV module has sufficient voltage to recharge a nominal 12 volt DC battery under high temperature conditions. PV module voltage and temperature are inversely proportional, so the hotter it gets, the lower the voltage of the module will be.

As an example, a 100 watt PV module has a peak current rating of 100 watts, divided by 17 volts equals 5.9 amps. Since batteries are recharged by current, the 5.9 amps is the key figure. A designer must use the 5.9 amps when calculating array size, not the 100 watts. The result is a PV array that is about 30% larger than it would be if the sizing could be based on watts.



Example of typical insolation chart. The system sizing tool contains thousands of locations around the world, one of which is Washington DC.

SunWize OEM Modules, rated output 5 to 40 watts.

Factor #3

No system is 100% efficient. A PV system has a variety of small losses that are taken into account such as wire losses, dirt or debris on the solar array, battery losses and equipment efficiencies (power converters and charge controllers). These losses add up to a 10% decrease in efficiency for the overall system.

In addition, the worst-case solar hours used to size the array will vary year-to-year from the historically measured information, so a safety factor of 10% is used to account for this "loss" factor. The result is a PV array with an "over-sizing" factor of 20%.

Conclusion

Taking the above three factors into consideration, we need a PV array of 1300-1400 watts for our 100-watt load operating year round in Washington, DC.

In general, array-to-load wattage ratios of 10 – 15 times are typical for most stand alone solar power systems. As you might expect, this ratio decreases as you move into more favorable solar areas, and increases for less favorable areas.

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