SunWize Power & Battery

Power vs. Energy

Determining System Loads

A key step in defining the size of a photovoltaic (PV) system is to first determine the size of the load. These two elements have a direct, linear relationship. If the load doubles, the sizes of the PV array (solar modules) and battery bank also double.

Customers and PV system designers must speak the same language to determine the correct load. A common area of confusion is the difference between the terms 'power' and 'energy'. These two terms are often mistakenly used interchangeably. They are not the same and misunderstandings may lead to improperly defined loads. Stated mathematically:

Power (P) x Time (T) = Energy (E)

Energy is the result of Power supplied over a period of Time. Power is the instantaneous output rating of an energy-producing device. The power output of a PV array is rated in watts. The array will only provide energy to the load when it produces wattage (power) over a period of time (watt-hours). Energy from the array can also be expressed as amps (current) over the same period of time. Since amps x volts = watts, then amp-hours x volts = watt-hours.

When analyzing your load, a PV designer will ask you for either the wattage (power) or the amperage (current) AND how many hours a day the load is operating. The load can now be defined in terms of its daily energy requirement (P x T = E). The daily energy usage is the key in determining the size of the PV array and the battery bank. See the examples in the box below.

In addition to the daily energy requirement, the voltage of the load is added to the analysis because the voltage determines the electrical configuration of the array and battery. A 24-volt DC system, for example, must have two solar modules wired in series, each at a nominal 12 volts DC, and two 12-volt DC batteries to power a 24-volt DC load. In comparison, a 12-volt system of the same wattage will require two solar modules and two 12-volt DC batteries wired in parallel.

In summary, when defining your load requirement, you must consider your daily energy requirement and your system voltage. Together those two elements properly define your load, allowing your PV designer to determine the correct size of the PV array and the battery bank, and to correctly configure the array and battery to match your load voltage.

How to Determine Daily Energy Requirement

Power X Time = Energy

Where load is:

Example 1: 100 watts continuous (24 hours/day) at 24 volts DC
⇒ 100 x 24 = 2,400 watt-hours/day at 24 volts DC

Example 2: 100 watts for 14 hours/day and 15 watts for 10 hours/day at 12 volt DC
⇒ [100 x 14] + [15 x 10] = 1,550 watt-hours/day at 12 volts DC

Example 3: 2.5 amps continuous (24 hours/day) at 48 volts DC
⇒ 2.5 x 24 = 60 amp-hours/day at 48 volts DC

Example 4: 2.5 amps continuous (24 hours/day) at 115 volts AC
⇒ 2.5 x 115 = 288 watts
⇒ Using a 24 volt DC to 115 volt AC inverter with an 85% efficiency: 288 watts/0.85 (efficiency factor) = 339 watts
⇒ 339 watts/24 volts DC = 14.1 amps
⇒ 14.1 x 24 hours/day = 339 amp-hours/day at 24 volts DC

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