

SYSTEM SIZING 101

Before you begin to size a system for your existing building, Georgia Solar Power Company recommends that you implement several energy management techniques:

- Change all incandescent and halogen light sources to compact fluorescent lighting. Home Depot and Lowes are great source for these indoor or outdoor lamps and fixtures. Most compact fluorescent lamps will fit into existing lamp sockets.
- Add additional insulation to your attic walls and floors where possible. Use pipe insulation on heated water pipes.
- Add shading devices and/or solar screens to your east, south, and west-facing windows. The south-facing screens you may want to take off in the winter for solar heat gain.
- Purchase only Energy Star rated appliances and air conditioning equipment.
- Use natural gas or propane appliances where possible for cooking, central heating, water heating, and your clothes dryer.

Determine your power needs:

If your system is tied to the grid, simply look at your electric bill to find the number of Kilowatt-hours (kWh) you use in a month. Remember that your summer bills may be higher than winter, or vice versa. Multiply your kWh by 1000 to get watts. Divide by 30.5 days per month, and then divide by 6 (or however many hours of good sunlight you expect your site to receive). Finally, divide that number by the output of the solar module you intend to use (i.e. 175 watts) and your result is the number of modules you will need.

If your building is not connected to the utility grid, add up the amperage of all your anticipated electrical loads. Multiply this amperage by 120 (your AC voltage) to get your maximum wattage. Then divide by 4 to give you a rough idea of your hourly power needs.

Sizing a minimum battery bank:

Having a battery backup is essential if you're off the grid, but it can be a valuable accessory for your grid-tied home or business too. There are three important rules of electricity to remember for this discussion:

- Current is measured in amps, potential energy is measured in volts, and power is measured in watts. We find wattage by multiplying amps and volts. We can also find current by dividing watts by volts, and volts by dividing power by current.
- In order to add voltage, we connect batteries in *series* (negative to positive to negative, and so on). If we want a 48-volt system, we would connect four 12-volt batteries in series, or eight 6-volt batteries, for example. The amperage is not additive in series.
- In order to build current, we connect batteries in *parallel* (positive to positive, and negative to negative). If we want 200 amps per hour and we're using a 50-amp/hour battery, we need four rows of these batteries, connected in parallel. Voltage is not additive in parallel.

To determine how many batteries you would need, first calculate your average hourly watt needs, and divide by 120 volts AC to find amperage per hour. The minimum battery bank for off-grid use is typically designed for fourteen hours – the time from sundown to sunup. If you're on the utility grid, you need enough reserve to last through a power failure – usually four hours at most.

Your system can be 12-, 24-, or 48-volts DC. Of these, 48-volt is most common because of its greater efficiency. The type of system determines the multiple you will now find your DC

amp/hour requirement. This multiple is 10 for a 12-volt system, 5 for 24-volt, and 2.5 for 48. So, multiply your amps per hour from the last paragraph (let's assume 10 amps/hour) by the multiple for your system (assume 48-volt) to get your DC amp/hours (25).

Select the deep-cycle battery you will be using and determine the reserve amps for that battery. Multiply your amps per hour (from above) by 14 hours. This gives your battery reserve amp required. Divide that by battery manufacturer reserve amps, and you will know how many rows of batteries in parallel you need.

The number of batteries in series in each row is determined by the battery voltage. Batteries are most commonly 6 or 12 volts. Divide the system voltage (12, 24, or 48) by the voltage of your batteries (6 or 12). This gives you the number of batteries per row.

Finally, multiply the number of batteries per row by the number of rows to find the total number of batteries.

EXAMPLE:

Let's say we're building an off-grid system. Our monthly energy requirement is 576.45 kWh.

$576.45 \text{ kWh} \times 1000 = 576,450 \text{ watts per month}$

$576,450 / 30.5 = 18,900 \text{ watts per day}$

$18,900 \text{ Watts} / 6 \text{ hours sunlight} = 3150 \text{ watts per hour (minimum)}$

Solar Modules:

Assume we're using a 175 watt 12-volt module:

$3150 / 175 = 18 \text{ modules}$

A 12-volt system would require all 8 modules to be wired in parallel

A 24-volt system requires 9 arrays, 2 panels each

48-volt is 5 arrays, 4 panels each (20 Modules are required; must be divisible by 4)

Batteries:

$18,900 \text{ watts per day} / 120 \text{ volts AC} = 158 \text{ amps per day}$

$158 \text{ amps} / 24 \text{ hours} = 6.58 \text{ amps per hour}$

Assume a 48- volt DC system, and a 12- volt 105 amp hour battery

$6.58 \text{ amps DC} \times 2.5 \text{ (48 volt multiplier)} = 16.45 \text{ amps}$

$16.45 \text{ amps} \times 14 \text{ hours} = 230.3 \text{ amps}$

$230.3 \text{ amps} / 105 \text{ amps} = 2.19 \text{ battery rows (Round up to 3)}$

$48\text{-volt DC system} / 12\text{-volt battery} = 4 \text{ batteries per row}$

$3 \text{ rows} \times 4 \text{ batteries} = 12 \text{ batteries total}$