Sizing a Solar Panel/Battery System

In an earlier article I talked about how to hook up one or two 100 watt panels with a simple PWM controller to keep your batteries charged up. One or two hundred watts will be sufficient for most casual boater's needs. But if you think you want more capacity, this article discusses how to size a larger solar panel system.

DC Requirements

When you hang out at anchor, you use power, right? First let's talk about AC power. Solar panels will not provide enough juice to power the big AC load on your boat- air conditioning. Use a genset for that. But other than that one big load, everything else can be powered by DC directly or indirectly with an inverter which converts DC to AC.

But first you need to figure out how much DC you use. If you are seriously reading this article, you are probably going to spend some serious money on panels, controller, inverter (maybe) and installation. So spend your first $200 or so on a good battery monitor to find out how much power you use. It is an investment that will pay off long term as it will let you manage your battery and solar system once installed.

Victron, Xantrex and others make good battery monitors that cost in the $200 range. These have a shunt (a device that creates a voltage proportional to current flow) that is installed in the negative wire of your house battery bank, between the battery and the negative buss. Then wire the shunt to the display and mount it near your DC panel.

Once you have set it up properly with your current battery capacity, hang out on the hook for a couple of days with no engine or genset running and see how much DC power you use. I have seen anywhere from 50 Ah/day with a very efficient refrigerator, led lights and little else to over 200 Ah for a big AC fridge run off of an inverter, TV use, hair dryer, microwave, etc- all the comforts of home.

Then you need to decide if you want to try to reduce that load or design a system to deal with it. Reducing a 200 Ah load is going to require a new refrigerator and maybe a lifestyle change, so deal with that first.

Other Considerations

With your daily Ah demand in hand, there are a couple of other data items you need to properly size a solar panel system: battery capacity, how long you want to hang out on the hook, propulsion engine charging capability and typical time to your next anchorage.

Another important factor is how many real world Ahs a solar panel system will produce.

These aren't hard and fast values, but they seem to hold up in the real world:

On a full sunny day, a solar panel will put out 40% of its wattage value in Ahs, more in lower lattitudes or summer time and less in higher lattitudes and winter time. Most parts of the country average about 50% full sun. This can vary widely depending on location and time of year. So in broad numbers, a solar panel will deliver 15-30% of its capacity in ahs on an average day, so lets use 25% for the examples below.

I could probably develop a 6 variable formula to calculate how much solar panel capacity you need, but in most cases you will juggle one parameter, ie battery capacity against another parameter, ie solar panel capacity to come up with your best solution. So lets work out a few examples.

Sizing example 1, heavy use full time cruiser

Let's assume you have a battery capacity of 400 Ah (which really means 200 Ah since you shouldn't discharge your batteries below 50%), you want to hang out on the hook for as long as three days, your daily amp hour requirements are 100 Ah, you have a typical engine alternator that has an internal regulator. You want to be able to hang out for three days, move to another anchorage with 4 hours of cruising and have your batteries fully charged up when you get there. So here goes:

Your simple internally regulated alternator probably will only put out 20 amps over the four hour cruise to your next anchorage. That is because even though you might have a 100 A rated alternator, the fixed voltage it puts out won't charge very fast. So you need to leave the first anchorage with at least 400-4*20 or 320 Ah in your batteries.

You will consume 3*100= 300 Ah during your three day anchorage. Part of that can be supplied by running down your battery by 80 Ah before you leave for your next anchorage. So your solar panel needs to put back 300-80= 220 AH during the three day period or about 70 per day. Using the 25% rule of thumb above, that means that you need about 70/0.25= 280 watts of solar panels.

Note that you can get the same result if your battery capacity is only 220Ah. As long as you don't routinely discharge more than 50% a 280 watt solar panel system will work fine.

Sizing example 2- weekend warrior with heavy Ah use

In this case you are a weekend cruiser who gets off from work early on Friday, sets out on your boat and cruises for a few hours to a nice anchorage, you hang out for two nights and go home to your dock on Sunday. You use more amp hours, say 150 Ah/day.

In this case you could just get by with a bigger battery bank, draw it down to 50% just before you head home, and charge it up at the dock when you get there. You use 300Ah for the two days so if you had a 600 Ah bank you wouldn't need any solar charging.

But lets say you only have room for two GC batteries or 220 AH nominal or 110 Ah real capacity. So your net requirement is 300-110= 190 Ah for the two days or 95 Ah per day. Dividing that by the 25% factor means you need 380 watts of solar panels.

Sizing example 3- my recent situation, with a genset

I have two GC house batteries with 220 AH nominal capacity. I use about 80 Ah each day. I want to be able to cruise continuously, one or two nights at anchor at a time and recharge my batteries fully each day for best life. But I do have a genset and a 100 watt panel. Let's see how that works.

I run the genset for 45 minutes or so morning and night for battery charging but also to heat hot water, use the microwave for reheating something for dinner, powering my wife's hair dryer, make coffee in the morning, etc. Watching the remote charger display I believe I am putting about 30 Ah for each 45 minute genset running period. This can vary a lot depending on how discharged the batteries are, but that is a good average.

So I am returning 60 Ahs each day with the genset, I use 80 Ah so I need my solar panel to contribute 20 Ahs. So my 100 watt panel does that nicely. If I didn't have a solar panel I could just run the genset longer, but the last 10% of charging takes several hours so the solar panel is a good solution to top off the batteries. A solar panel can be a great addition even with a genset- it minimizes genset running time and fully tops off your batteries.

Final example 4- full time cruiser, no genset

This example was me on a sailboat where I cruised full time and only stayed at an anchorage for 3 days max. I had a high output alternator on the propulsion engine which recharged the batteries fully by the time I made it to the next anchorage.

I used about 80 Ah daily so my total usage for three days was 240 Ah. I had 440 Ah of battery capacity or 220 real world. So my net solar need was 240-220= 20 Ah. A single 150 watt panel kept up with this nicely.

I also left the boat on a mooring for a week at a time. In that case since I wasn't using lights and opening the fridge, my usage dropped to about 50 Ah daily. The 150 watt panel produced about 40 Ah each day and the battery capacity easily covered the rest for a week.

My final article will talk about how to design and install a larger solar panel system.