Basics of Off-The-Grid Solar ~ Part 3

As I write this old man winter is lurking like a Halloween ghoul ready to pounce on us without a moment's notice. On many days it seems the sun has forsaken us and gone on vacation to the beaches of faraway places and some would say solar energy has gone too so why should I waste time reading this article. Well if you got past the last sentence without tearing up the paper to start your morning fire then you'll learn one of the best kept secrets about life in the northern latitudes, the temperature can be thirty below but you can still get free power and heat from old Sol, plenty of it!

I installed my rooftop solar hot water panels two years ago and when we activated the system the outside temperature was -25. Yes, look closely that's a minus sign in front of the number. It was not a sunny morning but at 10 a.m. the pump that circulates the freeze proof glycol through the panels and down into the heat exchanger at the hot water tank was humming its morning anthem. By early afternoon the hot water storage tank was at +30.

There are many types of solar energy that we can employ and solar hot water heating is one of the least expensive. The very lowest cost solar energy is passive solar like you get when you stand in front of a window with the sun on your face. Even though the outside temperature may not be warm you can feel the caress of the sun's radiant energy. This type of energy can easily be captured with solar air heating panels that move cooler household air through an insulated box located on an outside south facing wall and deliver it at a much higher temperature back into your house…and it's free. DIY plans on building these types of solar air heaters are available online, just do a Google search on "solar air heater".

In this article I will continue with our discussion on providing electricity, not heat, from renewable energy sources, specifically solar. You learned how to accurately determine your energy consumption in earlier articles and subsequently how to size a battery and the charging component for the battery (solar panels). In this article I will talk about the solar charge controller and the inverter, what they do and how they work.

Advances in off-grid battery technology have been almost non-existent over the last few decades but technology for PV[i] solar cells has become a little more refined. Where significant advances have been made are in the electronic control devices called charge-controllers that regulate the current[ii] generated by the solar panel into the battery. Advances have also been made in the inverters that take the stored electricity from your batteries and change it from DC or direct current into AC or alternating current that is used in your household appliances.

Connecting a PV solar panel directly to a battery without a charge-controller is a very bad idea unless the panel is 10 watts or less because it will just continue to send current into the battery as long as the sun shines, even after the battery is fully charged. This results in overheating and boiling of the battery and possible catastrophic failure if the battery electrolyte[iii] evaporates.

Old style charge-controllers are basically a switch. They allow electricity (current) to flow from the solar panel to the battery until the controller detects that the battery has reached a fully charged voltage. But voltage alone is not a good indicator of state of charge in a battery and the switching type of controller leaves a lot on the table because it spends a lot of time being off.

The next advance in solar charge controllers came with a technology called pulse width modulation (PWM). It's a somewhat daunting term but basically what a PWM controller does is taper the current down as the battery becomes more charged. The controller doesn't just switch off but instead slows down the charge and continues to return the maximum possible amount of energy into the battery. The PWM type of controller is a little more expensive but vastly improves battery charging and gives you more benefit from your expensive battery investment.

The newest technology that is now available in solar charge controllers is called Maximum Power Point Tracking (MPPT). Explanation of MPPT technology is more complex than I want to get into in this article but I'll try to simplify the concept without breaking it. If you look at the back of a 12v solar panel you will see that the actual operating voltage of the panel, stated as VOC, is anywhere from 17v to 22v depending on the brand and wattage of the panel. Older switching controllers and PWM controllers can only use about 13.8v for charging a 12v battery and they lop off the extra volts, which really wastes a lot of power. The MPPT type of controller uses all that voltage above 13.8 and essentially converts it to amps for charging the batteries.

The increase in current from the solar panel using an MPPT controller can be as much as 35% depending on various conditions. That's a very nice bonus but, to borrow a quote from the amazing Steve Jobs, "Wait… there's one more thing!" The MPPT controller can also work with much higher incoming voltages. Depending on the controller model, you can deliver up to 250 volts from a solar array into a 12v battery. The benefit of doing this may not seem immediately obvious so I'll explain.

With a switching controller and a PWM controller you have to use a 12v controller for a 12v solar panel and battery, a 24v controller for a 24v solar panel and battery and so on. However with an MPPT controller you can hook a lot of solar panels in series and make any voltage up to 250 volts and the controller will automatically sense the battery voltage and down convert to the appropriate charge voltage. This allows you to use higher voltage panels, which are much cheaper and it also cuts down on the size of the home-run[iv] wire needed.

Copper wire can be very expensive when you use lower DC voltage over a long distance. Because of higher voltage possible with the MPPT controller you can use smaller wire diameter. Result: big savings in wire cost.

So buying the cheapest controller is obviously false economy because you will get much less benefit from the solar panel in terms of power output; you will have less choice and pay higher prices for the solar panels; and you will pay much more for the home-run wire. It's a no-brainer but it took a lot of brains to arrive at this conclusion. Good work!

The next big decision in designing your home power system is a device called an inverter. The inverter performs several functions but its big job is to take the energy stored in the batteries and delivers it to your household loads. In the process of doing this an inverter changes the direct current of 12v, 24v or 48v in the batteries to 120v or 240v alternating current required by your appliances.

An inverter used in a household renewable energy system also has a battery charger. The battery charger interacts with the incoming power from your power utility (like BC Hydro) or power from your gas or diesel generator if you're off-grid. The charger in the inverter is highly specialized and capable of delivering a computer-controlled current that operates in three charge stages called bulk, absorb and float. There will also be an option for an equalizing charge rate. I'll discuss these terms in a later article.

The two questions you have to answer when choosing an inverter is: how big does it need to be (in watts) and, do I want a sine-wave or modified sine-wave model? Because it's well after midnight and I'm about to turn into a pumpkin I'll leave the answers to those questions for next time. But as always, if you have specific questions you'd like to ask please feel free to email me at: info@solareagle.com.

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[i] A PV (photovoltaic) cell is a cell that converts solar radiation into direct current (DC) electricity

[ii] Electrical current is a measure of the amount of electrical charge transferred through a conductive material.

[iii] Electrolyte is a liquid, paste, or other conducting medium in a battery, in which the flow of electric current takes place.

[iv] Home-run wire refers to the wire run from the solar array to the charge-controller.