Green Energy for your Home ~ A Series ~ Part 5 Inverters

It was a dark and stormy night… but the good news was, you had a wind generator and your lights were still on. It was also bright and sunny earlier in the day and your solar panels had stored plenty of energy in your batteries (the off-grid gas tank). Now the question is, how are you going to put that battery power to good use?

In the early days of solar power; in the days when novels began with dark and stormy nights; you might have used the power stored in your batteries to run your 12v light bulbs and appliances. Because there wasn't a very big market for 12v appliances outside RV and automotive use the selection was limited and very expensive. For example a 12v DC energy efficient light bulb could cost more than $30 whereas you could buy the same bulb in 120v AC for about $1. As electronics became more sophisticated and less costly the device called an inverter began to populate the remote homes of renewable energy pioneers.

An inverter is a device that takes the stored energy in a battery and changes it from direct current DC into alternating current or AC. Early inverters generated square waveforms, which weren't that suitable for many household appliances and tools. The resulting power could cause long term deterioration in sensitive electronic devices like TV's, entertainment systems etc. A modified sine wave type of inverter improved the power characteristics quite a bit but true sine wave inverters that closely simulate grid power were eventually developed. Although very expensive at first sine wave inverters have become much more affordable now and are the inverter of choice for remote homes.

Typical home-based inverters also have a battery charger and an automatic transfer switch built into them. This allows a generator to be connected directly to the inverter providing power to the household when it is running and charging the batteries. The transfer switch recognizes when power is incoming from the generator and uses it instead of using battery power.

When you purchase an inverter be certain it will power all the loads you will use at one time. For example if you want to watch a TV that draws 250 watts while another family member uses a 300 watt computer and a third person is running water for a bath and the 325 watt well pump starts up then you will need at least an 875 watt inverter. As outlined in my first article in this series, a load analysis will help you understand your needs before choosing system components.

Some electrical loads require much more energy to start up than they use while they are running. A well pump or a motor on a vacuum cleaner or power tool will actually draw several times it's continuous power rating on startup and your inverter must be able to handle this brief surge of power. So a 1000 watt inverter may run the 875 watt loads listed above but an inverter capable of say 1500 watts of surge power will be needed to start the pump while the other loads are operating.

Inverters designed to power household loads are more complex than those meant for casual use like camping. In addition to having a charger and an auto transfer switch the full time inverter is designed to be hard wired into a household circuit. You should install over-current protection in the form of a fuse or circuit breaker between the inverter and battery. The internal charger must be sufficient to provide the minimum required charge current for the batteries when necessary.

Cheap inverters are false economy as they usually lack important features like reverse polarity protection (when you connect the batteries up backwards); over voltage protection (when you apply more loads to the inverter than it's rated for); efficient power conversion; over heat protection; and a good warranty. I've seen many installed inverters that are still running after twenty years so it's a long-term investment if you choose wisely.

An accessory usually included with better quality models, is the battery temperature sensor (BTS). It is a sensor that either connects to a battery negative terminal or sticks on the side of one of the batteries near the inside of the pack. The BTS conveys the temperature of the battery to the inverter so it can compensate the charging voltage accordingly. A precise charging regime for the battery is important to get the best performance and life and the difference of a few degrees in temperature between the inverter location and the battery location can result in incorrect charging and discharging.

A monitoring device for the inverter operation is highly recommended to allow you to see what's going on. A monitor can not only tell you what the inverter is doing, for example delivering power to the household loads; charging the battery; battery voltage; incoming/outgoing amps; but it may also allow you to program features of the inverter. In this way you can customize the settings for your particular needs which may change over time. Better quality monitors will also record historical data and allow you to see the battery 'state of charge', very important information. Other features can include automatic generator starting; on and off control; power saving mode; auxiliary load control; diversion load control and much more.

Cables connecting the inverter to the battery need to be a heavy gauge, usually 2/0 or 4/0 depending on the inverter rating and length of the cable. Cables must be of equal length (important). Rule of thumb is not to exceed ten feet long. The connectors on the cable must be secure and tight because of the high amperage that passes through them. A loose connection here will really play havoc with your system including potential arcing, overheating, battery imbalance and corrosion. An anti-corrosion coating should be applied to the battery terminals. You can pick up a tube of this at an automotive supplier and it works simply by keeping oxygen from interacting with the connectors and battery lugs. Even a thin coating of petroleum jelly will do the job.

Power for the household loads comes from the AC output terminals of the inverter. A wire is connected to the main electrical junction box, if available, or to a sub-panel that distributes the AC power to installed circuits. A convenient solution that has appeared in recent years is called an E-panel. The E-panel, also known by other names is a compartment that the inverter mounts on and it acts as a central clearing house for the incoming wiring from solar panels and generator and outgoing to AC & DC loads, monitor(s) and batteries – both in and out. The E-panel also has space for incoming and outgoing breakers so if you are using it in a cabin or small home there is no need for an additional breaker panel. It's a really neat solution and highly recommended.

In a cabin or remote home the gas, diesel or LP generator is usually a portable model located outside in a shed or 'doghouse' to protect it from the weather. The wire from the generator to the AC input at the inverter is often undersized or poorly protected or both. A three conductor outdoor rated wire colloquially known as cabtire is a good solution. It has a thick rubber outer insulation and comes in a 10 gauge size which, depending on the size of the generator and distance to the inverter is the minimum size you should use. The ideal solution for wiring from the generator to the inverter is a heavier cable called Teck, originally developed for use in Canadian mines. It has interlocking flexible armour; two layers of PVC; is resistant to corrosion, water, and mechanical abuse; and can be used in wet or dry locations. Teck cable can be buried but if that's not possible it's tough enough to live on top of the ground.

As a final note, lightning protection on both the AC and DC circuits of the inverter should be installed. The inverter should also have a ground wire that connects to a single grounding plate or rod for the residence and the ground should be bonded to the neutral of the inverter or household distribution panel, not both.

I can see the bottom of the page rapidly approaching so I'd better stop inverting before the editor puts my foot down. In future articles I'd like to talk about site analysis, wind generators, micro-hydro, solar hot water, grid-tied systems, and some new ideas in renewable energy… but not all at once. If you the reader have an interest in a specific subject drop me a line, email me at: info@solareagle.com. The complete series of articles is available at the earthRight Solar website: http://www.solareagle.com

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