Roger's Looms
Offgridlife.com

Solar/Alternative Energy

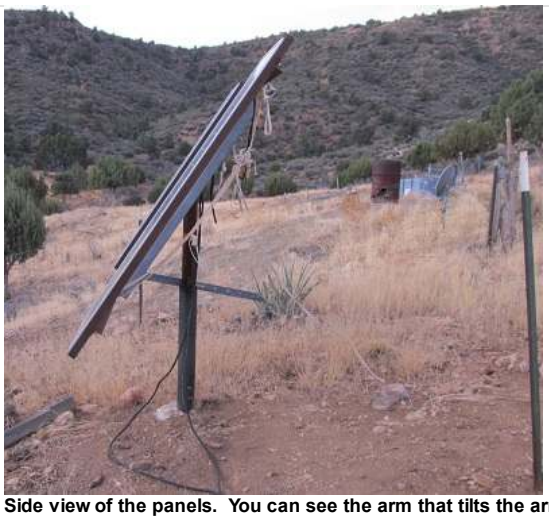
Off grid power - on the cheap! *APU - Auxiliary Power Unit* - Alternator info below updated 12-19-2012

This is my solar array. When we first moved on to our bare land with the travel trailer, we only had a smaller solar panel to help charge the RV batteries. I still use that one for my shop. I bought it used about 20 years ago. The two center 85w panels were purchased first and mounted on this rack that can be turned to face the sun and tilted also. Then later when the house was built, I added the other two 120w panels. The rack addition was done with bolted angle iron, no welding. In fact, the whole thing is done without welding. Total 410 watts. This is a rated output, the actual output will not match the rated output in most cases.

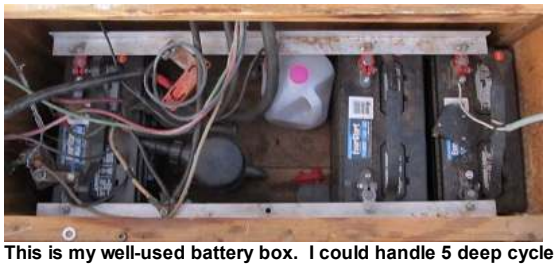
I have the smaller center panels on one circuit at the breaker box that feeds the power to the batteries, the outer two panels use the other cable seen here to get to the other breaker. I got used extension cord wire with 4 conductors from a scrap yard and used 2 wires for negative, 2 for positive for each circuit. This multi-stranded wire from used heavy duty extensions cords was cheap, sold by the pound, because it would have to have required much labor to strip it down to bare copper. I wasn't able to get it the last time I looked. Single strand wire house wiring isn't supposed to be as good for low voltage direct current as fine, muli-strand wire generaly used in vehicles or extension cords. For my windmill, I soldered the ends of the 3 or 4 conductor heavy duty extension cord wires together to make one larger capacity conductor. For large diameter stranded wire for connecting the batteries to an inverter, welding lead (say leeed) cable is good. It has very fine wires (good) and is flexible. They have it a welding supply stores, but I got the best deal at Tru Value.

More solar panels would be a good investment, up to a point. I could use more for my shop. On sunny days (most days here), after a while my charge controller isn't letting a full charge get to the batteries because the battery voltage is already up there. Today I started the alternator/engine this morning so that has the batteries up to where the panels are only putting out half of what they could with a low battery. More solar panels with the same number of batteries would not get me all that much more charging on full sun days. My wind turbine doesn't add that much to my power supply, but is more audible and visual and more interesting; and can put out power after dark. More Fun.

Mikes Windmill Supply in AZ has windmills and parts, including the permanent magnet alternator like I have on my windturbine. Permanent magnet alternators are more efficient at all wind speeds. In fact, they would be used on motorcycles and cars if it weren't for the fact that too much vibration will degrade the magnetism. Excellent for home windpower.



Side view of the panels. You can see the arm that tilts the array. It is now in the lowest position to meet the rising sun. In the summer the panels can face almost straight up. I turn the array several times a day to get the most out of them. In the winter this is more important because there is less energy to be had. The rope is for tying the panels to the T post in higher winds to keep them in position. A hands-on solar tracker that is good exercise. These are 12v solar panels, charging 12 volt batteries. I started out with this 12v system but for larger systems you could get the larger 24v panels and have a 24 or 48 volt battery bank. That would require a more expensive 24v inverter to get AC; and would be more of a 120v ac system only. I like being able to run some 12v lights, 12v radio, cell phone charger, etc. directly off the battery voltage without using an inverter.



This is my well-used battery box. I could handle 5 deep cycle batteries but I only have 3 now. The more batteries you have, the more it costs to replace them eventualy. And, it you can't keep them properly charged, they don't last as long. A catch 22? These particular batteries, the best from Walmart, seem to be a good match for the amount of power I use and the charging abilities I have. At the lower left in the picture is the shunt for the 24/7 digital amp meter inside the house. It will read up to 100 amps input. It tells me how much the batteries are being charged by the 3 charging sources. If I use the 40 amp battery charger powered by a propane or gas generator, I clamp onto the battery posts on the right and that charging rate doesn't show up on the meter. But the solar, wind, and the small engine alternator do show up in the house alongside the automotive type lighted digital volt meter. I used aluminum angle to connect the batteries in parallel, it makes a larger capacity battery that remains a 12v battery. I learned about series vs parallel back in grade school, don't know what they teach nowadays. The orange thing is a fuse holder for a 125 amp fuse (upside down so you don't see the fuse). This is for the incoming line from the alternator. There is one also for the outgoing line to my large inverter in the house. Lately I get large fuses like this from the auto parts store. They evidently sell them for use in those boom boom car stereo amplifiers. They don't come with a fuse holder so I have made one with strips of plexiglass to protect the fuse from mechanical stress from being in-line. You can find in-line fuse holders at solar stores on the internet.

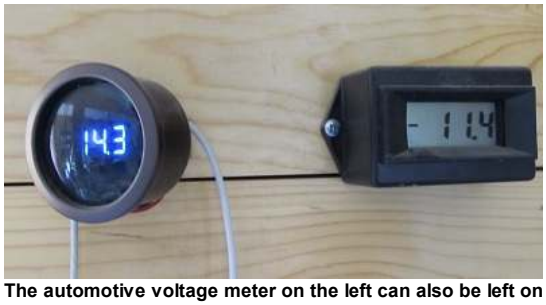
The best deal on stranded wiring for lights and lighter-duty 12vdc has been the 12 guage wiring intended for low voltage landscape lights. I bought it at Home Depot, I think in 100' or 200' rolls. Probably not code, but I built my house before full building permits required any kind of inspections other than septic system.

APU Auxiliary Power Unit. One thing to know about an alternator is that it works when rotated in either direction.

This 6.5hp small engine powers a GM type alternator. When I started it this morning before the sun came up, it was putting out 54 amps to the batteries. Now after an hour, it is down to 32 amps, partly because the batteries have charged up from 11.9v to 14.1v, partly because the input from the sun has raised the battery voltage. The alternator 'reads' the battery voltage and charges accordingly. The lower the batteries, the more it charges at first

until the voltage comes up. Just like in your car. In fact, I could take this alternator off this set-up and it put it back in a 1973 thru the 80's chevy truck or car; nothing is modified with the alternator. This alternator puts out so well I had it rebuilt at a shop. When the motor is cold, I wait about a minute before touching the exciter wire to the + terminal to put a load on the engine. Otherwise, it could kill the cold engine. This used to happen when I used 5hp engines.

This is a battery/alternator tester from the auto parts store. Now it shows that my house batteries are being charged at over 14v. When batteries are not being charged, it shows approx. battery voltage with the bottom 3 led's. I started out using one of these in my house at least 15 years ago. When the batteries get so low there is only the one red light showing, it is time to get charging. You can even make judge battery charge by how bright a LED is. I had this one set up to plug into a cigarette lighter type 12vdc outlet. It's other function is a polarity checker. It will not light up at all if you have the red probe on the negative side of 12vdc and the black alegator clip on positive. I can also use this to see if my vehicles are charging properly and to test any 12v battery voltage. Will not do the things a multimeter will do, but is visual and uses almost no energy so can be left connected.



The automotive voltage meter on the left can also be left on 24/7. I started using this in the house rather than the LED tester. Makes a night light too. On the right is the digital amp meter. Left on 24/7, it is not lighted. Shows only the input current to the batteries, not any usage. You can get meters that show both and usage history, etc. This one allows me to see what the solar panels or windmill, or alternator are doing. The 11.4 amps tells me it is time to shut of my alternator/engine because it isn't doing much good now that the batteries are charged up. Better to save fuel for when the output will be over 40 amps. Even though it is overcast this morning, the solar panels can do this much by themselves. A few minutes after this, after I shut down the engine/alternator, the voltage reads 14.5v and the amps 8.7 under partial overcast. Because I have this C-35 charge controller now, the output of the solar panels goes down later in the day even with full sun. This is because the controller lets the batteries get full charge at first, then less at the battery voltage rises, then even lower when it considers the batteries charged. It is not good for the batteries to get fried.

So when I see the lower amperage going into the batteries, it is normal considering the state of charge of the batteries. I used to not have a controller, I just monitored the battery voltage and we used up the power before there was excess battery voltage. The freezer and constant TV in the workplace took care of that.

These alternators can be modified to be self-exciting (one-wire alternator), but then they would start charging before the engine warmed up at all. When I really need this power, it is usually cold weather. I do recommend one-wire (self-exciting or energizing) alternators for vehicles or tractors. I have one for my Toyota pickup because I had a short somewhere that kept blowing a fuse that prevented the alternator from charging even though it had nothing to do with the actual function of the alternator. A one-wire alternator hooks up to the + of the battery, starts charging when it starts spinning, and automatically regulates the charge with an internal regulator just like the stock 3 wire alternators.

Most of these alternators I bought cheap or got for free from the scrap bin at the junk yard actually work OK. They have little value for scrap without someone taking them apart to sort the metals in them. Sometimes they just have stripped threads on the adjustment tab. That was the case on this one in the photo. It is easy to put a bolt in there to lock down the tension adjustment. I use a very short v-belt, this being a 26" belt, but it could use a 27" or maybe 28". Both these pulleys, alternator and engine, are made for this automotive type v-belt. The alternator pulley came with the alternator, the engine pulley is a modified alternator pulley. The double pulleys are made of solid steel, better for machining or welding on.

The industrial v-belts used for rototillers, etc., have a different profile than the automotive belts. That is, if you look at a cross-section, the 'V' has different angles. Belts will not last as long or grip as well when used with un-matched pulleys. The mantra is: automotive-grip, industrial-slip. They are made for different purposes. Using all automotive pulleys and belts, the belts last longer.

If you want to use a small engine/alternator set up First: mount the alternator and engine to a base. Very heavy plywood works good; dampens vibrations. I have a way of building the alternator base using angle iron, with no welding. I will get photo of this. Line up the pulleys and get the spacing between the two units figured, then drill the holes for the mounting bolts. If you already have the belt you want to use, you can put it on the pulleys to get alignment and spacing. Leave room on the adjustment arm to allow for re-adjusting for belt stretching and using other, longer or shorter belts if necessary. Get this mechanical work done so the alternator can be spun and the belt tension held tight. Then try out the charging function. You will be able to hear the engine lug down when energized, telling you that the alternator works. A fully charged battery is the only exception, you might not notice the alternator lugging down then because the voltage regulator inside the alternator senses that no charge is needed. Another way to prove or disprove alternator functioning is to check battery voltage before energizing, then after. Alternator is not working if voltage stays the same.

How to wire an alternator to a battery and energize it. Hook up a larger diameter wire from the Bat. terminal of the alternator to the battery positive terminal. This wire, and the Negative wire that connects from the alternator metal frame to the negative terminal of the battery, needs to be a heavy wire. I have heavier wire because I have seen up to 90 amps going to the batteries. In an automobile, #10 wire is used, but in that case the alternator generally would not be putting out as much current as it might in your home power situation; and the distance to the battery in a vehicle is short. A big factor in wire size is the distance from the alternator to the batteries. Refer to a wire sizing chart, such as this: www.backwoodssolar.com/reference/wire_size.htm Heavy wire needs to be used from the batteries to a larger size inverter also.

The only other wires to deal with come from the plug-in terminal. You can buy new connector plugs at the auto parts store if you don't have one. Hook up a jumper wire from plug terminal 2 to the Bat. terminal and leave it hooked up; electricity will not drain back out of the batteries. Leave the wire from plug terminal 1 hanging loose to use as the energizing wire, touch it briefly to the Bat. terminal when you are ready to energize the alternator. I have used a cheap horn button mounted on the base plank as a fancy way to complete this circuit. Does the same thing when pressed.

Testing an alternator If your alternator doesn't seem to be charging, you can get it tested for free at an auto parts store. If it is bad, they can sell you another. Or have it rebuilt at a good alternator repair shop. Or get another at the junkyard. The parts inside the alternator are easy to replace yourself. You can order regulators online. I haven't done used one, but I have seen that they sell 15.1v regulators to use instead of the more stock type 14.8v regulators. If you have any questions about which alternator you have, research online or go to an alternator repair or auto parts store where thy know these things. Toyota, Ford, etc. will work too, I just don't know exactly how to hook up the energizing part, but you can find that out I am sure.

A myth that I first bought into was that the alternator has to spin faster than this one-to-one ratio shown here by having a larger pulley on the motor. That would really put a load on a cold engine. The load does vary with different alternators, and changes according to how many batteries in your parallel battery bank; but I can't explain that with my lay knowledge. You experiment. Having another way to charge your house battery bank other than solar lets you get 100% from your solar, then add just the amount of additional energy you choose to have. On cloudy days you can still watch the football game or whatever. This small engine cost $150, alternator was free. Harbor freight sometimes has the same size engine for $99. To get the 50 plus amps of charge from solar, I would have to spend $4000 or so on panels. And that would not be there on cloudy days, or in the middle of the night.

A situation where I might use a larger pulley on the motor would be if I had to use the industrial, rototiller type pulley on the motor. Then the larger circumference of the pulley mighty help keep that pulley/belt connection from slipping because of the fit of the belt to the pulley. I would still use an automotive v-belt so that the grip on the alternator pulley was optimal. Belt dressing in a spray can can help but I don't use it with my setup that has the good automotive pulleys and good belt. I had to have these alternator pulleys modified to fit on the 3/4" engine shaft; not something readily available like a pulley from the hardware store would be. Or one off an old rototiller etc.

Another tip: Hard to find these days are the curved, slotted tensioning arms for generators from old cars and trucks. So if you can find one, hang on to it. Hard to make from scratch. I tried keeping the belt tension tight with a spring, did not work. The modern serpentine belt tensioner might work, but is made for flat belts. Flat belts might work with a battery charging setup like this, but don't think they make them in a short belt. Long belts would cost more, probably flop around more and draw energy because of their mass.

Pumping water off the grid

I have a 240vac, 1hp submersible pump in my well. The well is not deep, but the pump pushes the water up the hill, past the house to the tanks at the top of the hill. So it requires a 5500 watt generator to operate. I run it about once a week. I have so much storage that I could go for months, but I like to see from the overflow line that the 2500 gallon tanks are topped off. I recommend using a generator to power any 120 or 240 volt AC water pump. Getting this power from solar would be very expensive. If you have any up-hill property and install a storage tank, you don't have to pump water up there that often.

I have used 12v RV on-demand pumps for pumping water out of ponds or streams; and for transferring water from a truck up to my tanks. They can do a lot of work, and can suck water through an empty hose. It is remarkable how much water can be moved with a charged-up deep cycle battery. The battery could be charged from any source, doesn't have to be solar. These pumps have a switch that shuts them off when the pressure gets up so high, some at 45psi. Then when the pressure drops, they start up again. So when I used one to transfer water uphill to a tank, since the height up there was less than 90 feet, the pump would not shut itself off. When using a pump like this for your RV or house, you want it to shut off as designed, then when you start to use water from the tap, it turns on and keeps going as long as you need water.

They make submersible 12v pumps designed to go down in a well. My neighbor has one of these. He pumps water from the bottom of his well up to his 1500 gallon tank as needed. Then he has gravity pressure water. You could have float switches at the tank that managed when the pump needed to run to keep it topped off. However, using the manual hands on system is free and you will know when you have forgotten to transfer the water up to your tank.

Here in ranch country, they still use wind-powered pumps. They can be used for deep wells. The pump piston is at the bottom of the well and is pulled up and down by a rod that is attached to the mechanism at the top of the

tower that is turned by the blades. These pumps operate when the wind is blowing and put water in a tank for storage for when the wind doesn't blow. There are businesses that sell and maintain these windmills to this day.