2023-08-23 Hamlet Net - Solar Power

Announcements:

- Test Session Info
    - Next VE session is this Saturday, August 26th in the Clover Building at the Boulder County Fairgrounds, and starts at 10 am. It is an ARRL VEC exam session, so there will be a $15 fee to take the exam. For more info, see the Licensing/Testing page on the club web site, https://w0eno.org/, under the Education menu.

- There are state QSO parties going on this weekend in Hawaii, Kansas, and Ohio. For more information on these and other upcoming contests, go to https://www.contestcalendar.com/

- This Sunday, August 27th, is the Denver Amateur Radio Club hamfest at the Adams County Fairgrounds. For more info, see: https://w0tx.org/hamfest/

- Chuck is putting together a special event to celebrate the 105th anniversary of the Peak-to-Peak highway involving multiple area radio clubs on September 30th. They're currently looking for volunteers to work this special event. They will be operating HF SSB voice, CW, and FT8 stations from 8am to 4pm with three operators at each station. There is a signup link on the club web page at https://w0eno.org/, or contact him for more information!

- We have some volunteer opportunities available where you can help out LARC:

    - Photographer / videographer - record team activities and upload to web site / YouTube

    - LARC Fest Coordinator -

    - Newsletter Editor - put together the monthly Splatter newsletter

    - Activities Chairperson - member of the Board of Directors

- Our sister club up in Nederland is looking for some help with events they are running. They have a weekly Monday night net with no predetermined agenda, so you can lead it however you want. They are also planning a Field Day site at Golden Gate State Park and are welcoming anyone who wants to participate. Finally, they are looking for operators for the Ned Gravel run on July 8th. They have signup links for all these events, so head over to their web site https://w0ned.org/ for more information!

- You can start earning your 2023 membership or future renewal by acting as NCS for at least 5 nets this year. You can run either this Tuesday night net or the Thursday night net (or both). We have scripts available for both, so all you need is a good connection

into the repeater, and somewhere to keep track of names and call signs as people check in. If you're going to be on the net anyway, why not save some dough at the same time! There are four free memberships available for 2023, so don't wait to get started!

- Chuck has set a goal for the Club of running at least one activity a month. This can be a hands-on construction activity, an operating activity like Field Day, a fox hunt, or a special event station. The goal is to get people together to have fun with amateur radio! We have multiple locations at our disposal, as well as lots of Club equipment, so if you have an idea for something you think others hams would like to do, please let us know, and if you're willing to run it, even better!

- The Club is also looking for presentation topics for 2023. If you have any ideas, or better yet, would like to present, please let Chuck know and we'll get you on the schedule!

- All club activities are open to anyone - members and non-members. ~~If you have questions, ask them on a net or~~ **send email to elmer@w0eno.org**

Presenter: Bryan, AF0W

Topic: Solar Power

- One piece of energy technology that the club has utilized at Field Day is solar power

- This is where a device called a solar cell or photovoltaic cell is used to generate electricity from solar radiation

Construction

- A solar cell is made up of two types of semiconductors, called p-type and n-type silicon. These are the same classes of materials that are used in other semiconductor devices such as diodes and transistors

    a. The p-type silicon has one less electron in their outer energy level than regular silicon, while the n-type silicon has one more electron in its outer level

- A solar cell consists of a layer of p-type silicon placed next to a layer of n-type silicon

- When light strikes the cell, some of it is absorbed within the semiconductor material, knocking electrons loose and allowing them to flow freely

- The cells have an electric field that forces electrons to move in one direction, and if you recall from the Technician training material, a flow of electrons is called current

    a. A common single-junction silicon solar cell can produce a maximum open-circuit voltage of around 0.5 to 0.6 volts

- As this low of a voltage is not readily usable, multiple cells are typically connected together to form a module or solar panel, which may also include a protective frame for the cells.
- Similar to batteries, connecting solar cells in series results in increased voltage, while connecting them in parallel results in increased current
    a. A typical configuration for a solar panel would be 36 cells connected in series
- Solar panels themselves can also be connected in series and/or parallel
    a. Solar panels in series are optimal in unshaded conditions
        - Series connection allows your system to be more efficient, if shade covers a single panel in a series array, it will bring down the whole system's power output
    b. Solar panels connected in parallel operate independently, and are best for mixed-light conditions
        - Parallel connection allows you to use less expensive PWM charge controllers
    c. As an example, say you have three solar panels that each output 8A at 12V
        - If they are connected in series, the total output would be 8A at 36V
        - If connected in parallel, the total output would be 24A at 12V
    d. One thing to keep in mind is that batteries typically require a slightly high voltage than their rating to charge
        - For example, a 12 volt battery may require at least 12.6 volts to charge
- Most cells convert about 10-20% of the energy they receive into electricity.
- There is a theoretical maximum of about 30% for a single-junction, silicon solar cell
- Advanced third-generation technologies featuring multiple junctions and other materials can reach into the 35% range, while the very best cutting-edge laboratory cells can manage just under 50% efficiency
- For typical amateur radio use, especially portable setups, the amount of energy generated by the solar cells are not enough to allow a typical 100 watt HF radio to transmit at full power, so a common use is to have the solar cells charge a battery, which is then used to power the radios

Module Types

- You may see a few different types of solar modules on the market
- First-generation cells are made of crystalline silicon. There are two types of such cells.
- The first is monocrystalline. These have black-colored cells made of a single silicon crystal, and usually have a higher efficiency, although they also have a higher cost.
    a. Harbor Freight sells a 100 watt monocrystalline solar panel for $130, and a 100 watt briefcase version for $180
    b. On Amazon, a Renogy 100 watt 12 volt bundle kit featuring a monocrystalline solar panel plus charge controller runs $110, and a 100 watt "solar suitcase" with panel and controller runs $160
- Polycrystalline panels have blue-colored cells made of multiple silicon crystals melted together. These panels are a bit less efficient, but also more affordable.
    a. There are a few polycrystalline solar panels on Amazon for around $80 to $90
- Second-generation solar cells are made in a thin film which is about 100 times thinner than first-generation cells
- They are made from amorphous silicon, which has randomly-arranged atoms
- One benefit is that panels can now be made lighter, thinner, and flexible
- A drawback to these second-generation cells is that they sacrifice efficiency - clocking in at around 7% compared to the 15-20% of good-quality first-generation cells
    a. Harbor Freight has a 100 watt amorphous solar panel kit which includes a 10 amp charge controller for $190 (they don't mention the type of charge controller)
- There is also a third generation of cells - these use different materials and provide higher efficiency than second-generation cells
- As with laptop and phone batteries, note that the advertised power output of a solar system is very likely the theoretical maximum which you'll likely never reach in real-world conditions, which will include things like clouds and dust in the air, non-optimal facing of the panels and so on.

Issues

- Voltage

a. Many panels are designed to output 24 volts DC, and even a 12 volt panel can output around 17 to 19 volts in direct sunlight

b. Since most amateur equipment uses 12 volts, a device called a "controller" or "charge controller" is needed to step down the voltage and provide functionality to manage charging batteries from the solar energy

c. The reason you won't see panels that put out exactly 12 volts is that the output can change quite a bit depending on light levels, temperature, and other factors

d. One other function of the controller is to prevent your batteries from discharging back into the solar panel, which could otherwise happen at night

e. Depending on how long the run is from your solar system to your radio, keep in mind that there will be voltage losses in the cables, so make sure you use an appropriate cable gauge

- Controller RFI

    a. The biggest downside of controllers is that they can generate RFI

    b. This includes controllers used by home solar systems, and can be exacerbated if the system is not installed and grounded properly

    c. There are two main types of charge controllers

        - The first, referred to as PWM, uses pulse-width modulation to regulate the voltage going into the battery - similar to a switching power supply.

        - This switching action can generate a lot of RFI, but as they have been around for a long time and are generally cheaper, there are a lot of them out there.

        - One caveat is that they cannot be used where solar panel voltage is significantly different than load voltage - for example, with 12 volt ham equipment connected to a 24 or 48 volt solar panel.

        - The other type is called MPPT or Maximum Power Point Tracking

        - These are generally more efficient and expensive, but give more flexibility in terms of the number of panels, and are better for varying solar panel output conditions, such as cloudy days.

        - However, they are more complicated devices, and can also produce RFI

        - To reduce the chances of issues, stay away from super-cheap controllers, and check reviews on radio-related sites such as eham.net for actual owner experiences before buying
        - Some more expensive systems even have the ability for the user to change the switching frequencies to further reduce RFI

- Needs Sunlight
    a. One obvious limitation of a solar power system is that it needs sunlight to produce power
    b. This means that bad weather, clouds, and night time will severely impact their power output
    c. The typical way around this is to have your solar system charge a battery, and then run your equipment off of the battery
    d. Note that since your controller is also responsible for charging your batteries, you need to make sure that it is compatible with the battery technology you are using, such as lead-acid or lithium iron phosphate
- Maintenance / Lifespan
    a. There really isn't a lot of maintenance that has to be done on a solar power system
    b. You do have to be careful to prevent damaging them, although portable systems are able to be quickly torn down in the event of approaching hail, heavy snow, or strong winds
        - Some of the solar modules and charge controllers advertise varying levels of protection for moisture and dust
    c. The front of the panel must be kept clean, which is a lot easier to do with a portable system than with a home roof-mounted setup!
    d. Solar cell output does decrease over time. The typical advertised lifespan of a solar panel is 25 to 30 years
        - This doesn't mean that your panel will suddenly stop producing electricity - what will happen is that the power output of the system will decrease over time
        - Studies have indicated that on average, output falls by about 0.5 to 0.8 percent per year

Summary

- As with many things in amateur radio, there is a lot to learn, and many available choices
- You can purchase pre-made systems which include all the parts needed to run your shack, or you can construct a more DIY system where you select and integrate the various components
- If you want to see what solar operating is all about, the LARC GoBox has everything you need - solar panel, charge controller, and battery.
    a. Remember that it's free to check out as part of your LARC membership, and all you have to do is take a short online test to make sure you are familiar with how it all works.
- The type of operating you do will also have a huge impact on the system that will best fit your needs.
    a. A QRP operator won't need a high-capacity battery like the one we have with the GoBox
    b. Nor will a SOTA operator want to pack in the full-size solar panel we've got
- You may also have other non-ham equipment that you want to power from the system, such as lighting or appliances, in which case you may need an inverter to take the 12V DC output of the solar system and convert it to 110 volts AC
    a. We also have an inverter in the GoBox that is used with the power supply for the laptop, although we have noticed that it does produce RFI on HF
- One thing that is especially nice about solar power is that you do not have the loud engine noise of a fuel-powered generator.

Questions:

- **The question for the week is:** Do you have or have you investigated a solar power system for your equipment, and if so, what are you using?
- **In my case,** the only solar equipment I have are a couple of roll-up panels with USB chargers in them meant for charging cell phones and tablets.
    a. It might also be possible to charge an HT off of them, but they're pretty small and likely don't have a very high power output.

b. I do have an extended battery for my Baofeng that has a charge port on it into which you can plug a cable that connects to USB

c. I've seen some newer radios, such as the Kenwood TH-D75 come with a USB C charging port on the radio itself

More Info:

- Harbor Freight 100 watt monocrystalline solar panel briefcase (no charge controller): https://www.harborfreight.com/100-watt-solar-panel-briefcase-57991.html
- Harbor Freight 100 watt monocrystalline solar panel (no controller): https://www.harborfreight.com/100-watt-monocrystalline-solar-panel-57325.html
- Renogy 100 watt 12 volt portable solar panel with waterproof 20A charge controller (Amazon): https://www.amazon.com/Renogy-Portable-Solar-Panel-Efficiency-dp-B079JVBVL3/dp/B079JVBVL3/?th=1
- Renogy monocrystaline 100 watt 12 volt panel with 10A PWM controller (Amazon): https://www.amazon.com/Renogy-High-Efficiency-Monocrystalline-Negative-Controller/dp/B09YQ8V15V/ref=sr_1_8
- Harbor Freight 100 watt amorphous solar panel kit with 10A charge controller: https://www.harborfreight.com/100-watt-amorphous-solar-panel-kit-63585.html
- MPPT vs. PWM Charge Controllers: https://www.jackery.com/blogs/knowledge/mppt-vs-pwm

- If you have ideas for net topics or general meeting topics / presenters, please let us know! Tell us on a net, or send email to k0itp@w0eno.org

Email to elmer@w0eno.org

1. K0ITP - Chuck - Firestone EchoLink
2. KE0EE - Don - Longmont
3. WA0JJC - Bob - Boulder
4. KF0MXH - Art - Longmont
5. AF0W - Bryan - Longmont -
6. KM6SJA - Steve - Longmont -

7. K0CLM - Lynn - Boulder -

Have notes on club web site - w0eno.org, select Repeaters/Nets then Tuesday Hamlet Net then Hamlet Net Topics. Have links to the solar equipment I mentioned for pricing, and also a page that compares MPPT and PWM controllers

Solar "generators" - appear to have a charge controller and battery integrated into one package, likely along with USB ports

Stranded at Longmont Civic Center with two bad vehicles. Couldn't reach any of our neighbors - turns out our HOA was having their annual meeting, and both of our nextdoor neighbors were on the Board. I did not have a radio with me, but was able to connect to the LARC repeater system via EchoLink at about the same time we finally contacted a friend for a lift. Amateur radio *could* have saved the day (well, night at that point - was around 10:30 pm or so by the time we figured out the AAA tow truck was not going to come).