Portable Backup Solar Generation Systems for Hams

By Rusty, KJ6AMR

Have you heard about **Kessler Syndrome?** It is a space scenario in which the number of satellites and orbital debris is so high that collisions occur, each one generating more and more space debris and, in turn, cascading collisions. Could this knock out crucial communications satellites? Or what about the disastrous fires in the west, the flooding down south and the tornados in the Midwest? These disasters remind me why we conduct field day exercises. With the unpredictability of disasters such as these, it's always good to be at the ready. Maybe it's time to consider being able to operate your ham radio and other gear off-grid or in an alternate location. Let's look at the options.

Gasoline Generators

While gasoline generators can generate a lot of power, they may not be a great choice for radio gear. In my experiences with field day operations, the environmental noise can not only be an annoyance to you and your camping neighbors, but they also tend to generate a lot of RF noise. So, the question is, do you have high power requirements, such as a refrigerator or heater? Can you keep plenty of gasoline on hand?. I myself have one, mainly for emergency situations, such as an extended power outage at my home.

Battery Backup

On the other hand, the newest generation of batteries such as LiFePO4, have long lasting power, but do require charging. If you have a battery that will sustain overnight and a reliable source to recharge during the day, this may be a more affordable option for you. They are a great choice of noise-free energy.

Renogy 72Ah Portable Battery

Solar Generation System

I personally believe the best solution is a good backup battery that will operate through the night and replenish during the day using a Photo Voltaic (PV) panel. You may elect to build from scratch or purchase a compete backup, like this unit available from Amazon or Home Depot. These units are compact and ready to deploy, but typically more expensive than a homebuilt solar generator system. Be cautious; the wattage rating of many commercial systems, describes the inverter output only. You should also determine your battery Ah capacity and solar panel wattage rating.

Jackery 2000-Watt Solar Generator ($1,299.00 at Home Depot)

Did you know that you HF operating mode affects battery life? Below are HF mode power estimates from K6EV "Portable-Power-How-Much-Do-You-Need". The IC-7300 consumes 21A transmit and .9 in standby at 100% duty. At 20% duty using SSB, transmit only draws 4.2A. **It should be noted that for CW, average key-down % while sending is 44% or less. Duty Factor = 44%. For SSB, Average power varies with your voice, mic gain, compression, density of speech, etc.**

Your IC-7300 set for 100W PEP may use an AVERAGE of **18-21 Amps FT8 or FM**, probably about **11-14 Amps transmitting CW**, and **8-10 Amps for SSB**, including allowance for current that flows in the transmitter even at zero watts output.

Results may vary!

HF Mode Duty Chart

Total Activity	SSB Ah (20% Duty)	CW Ah (44% Duty)	FT8 Ah (100% Duty)
1 Hour	2.95 Ah	3.91	4.15
6 Hours	17.7 Ah	23.5 Ah	24.9 Ah
10 Hours	29.5 Ah	39.1 Ah	41.5 Ah
20 Hours (Field Day)	59 Ah	78.2 Ah	83 Ah

ICOM IC-7300 @ 100W PEP, 25% TX 75% RX. (Based on MFR Specs)

Total Activity	SSB Ah (20% Duty)	CW Ah (44% Duty)	FT8 Ah (100% Duty)
6 Hours	22.7 Ah	28.8 Ah	30.3 Ah
10 Hours	37.8 Ah	48 Ah	50.5 Ah
20 Hours (Field Day)	75.5 Ah	96 Ah	101 Ah

Yaesu FT-991A @ 100W PEP, 25% TX 75% RX. (Based on MFR Specs)

For a Dual-Band 50-Watt mobile, count on about .5A squelched and 9A transmit @ 13.8V. Based on 25% TX 75% RX, we will consume just under 3.0 Ah. If we operate for 10 hours, we would need a minimum of 30 Ah of battery power.

Which size battery would I buy? Unless you are contesting, I would buy a unit based on **25/75 Tx/Rx chart.** Or, you can base it on an Ah calculation. **How many Amps will you draw x how long do you plan to operate and how much of that time will you spend transmitting and receiving?** Let's say we are **operating SSB for 5 hours**. SSB has a **duty factor of 20%**. So, when we are transmitting, we are drawing **21A(100% Duty) X .20(SSB)** = **4.2A.** Based on 75/25 Rx/Tx standard usage, that would be **4.2A (20% Duty) X 25%(Tx time) = 1.05A**. Now add the **standby** power consumption of.9A X 75%(Rx time) = **.68A**. That's a **total of 1.05A(TX) +.68A(Rx) = 1.73 Amps per hour**. In this case, a unit with a 50Ah a 50Ah battery would last **50(Ah) / 1.73 = 28.9 hours of operation**. Select a PV panel set that will provide your daytime needs, plus enough to replenish the 50Ah battery. An extra 10 Amps will recharge your battery at a rate of 10 Amps per hour of sunlight. **For a 50Ah battery, that is 5 hours of sunshine needed**. Don't forget to account for everything that you plan to connect to your power station before choosing a unit.

Building your Own Solar Generation System

I decided to build my own system, because it allowed greater control over battery and panel output. In addition, I found a cheap source of used solar panels (more on that later). Let's break down the requirements of a solar generation system one-by-one.

What Type of Battery to Use?

There are many battery options for backup power including Lead Acid, Sealed Lead Acid, Nickel-Cadmium (NiCd), Lithium (LiPo) and Lithium Iron Phosphate (LiFePO4).

● While **Lead Acid batteries** are affordable, they are most suitable for fixed installations and have the lowest energy density of 30-50 Wh/kg. In addition, they have a relatively short lifespan of 200-300 charge/discharge cycles. If you plan to use a lead acid battery in the field, a sealed (gel cell) is your best bet.

● **Nickel-Cadmium (NiCd)** is a convenient choice but comes in second to lowest in Watt Hours per Kilogram, at just 45-80 Wh/kg. However, their lifespan is very good at 1000 charge/discharge cycles.

● Next on the list we have **Nickel-Metal Hydride** (NiMH). While generally a safer option than lithium, has an energy density of 60-120 Wh/kg and a relatively short lifespan of 300-500 charge/discharge cycles.

● **Lithium batteries** (LiPo) have the highest energy density, but they are the least safe and prone to thermal runaway. Their energy density comes in at the top at 140-200 Wh/kg and has a very good lifespan of 500-1,000 charge/discharge cycles.

● Last, we have **Lithium Iron Phosphate** (LiFePO4). It is not prone to thermal runaway like other lithium battery types which make it a safe choice and a great performer at 150-190 Wh/kg. In addition, you can expect a lifespan of as many as 4,000–6,000 charge cycles (6-10 years) when properly maintained. For this reason, this is my preferred battery for solar generation stations. The Bioenno battery company makes great batteries with some having Anderson power pole connectors tailor made for hams!

Power Requirements

First, the power requirements for your gear must be determined. I will use my ICOM IC-7300 as an example. Icom reports the IC-7300 consumes 21A (at full output power), or 0.9A at standby. It should be noted that manufacturer specs are not always accurate, so you may experience more or less battery life than your calculations indicate. In actual real-life tests, QST's lab reported that the ICOM-7300 consumed 18.5A at full power.

In addition, to the other factors, the mode that you operate on will make a big difference in power consumption! For example:

● **FM and most Digital** modes average **duty factor is 100%.**
● **SSB phone**, depending on your voice, mic gain and compression, it is typically around **15-20% duty factor**.
● **CW** has average duty factor of **44%**.

For this reason, an IC-7300 set for 100W PEP may use an AVERAGE of **18-21 Amps in FT8 or FM**, about **11-14 Amps transmitting CW** and **8-10 Amps while operating on SSB phone**.

In addition to equipment amperage requirements, we must determine how long you would like your rig to operate. This rating is called Amp hours (Ah). To calculate Amp Hour Requirements:

Amp Hours (Ah) required = Current (I) x Time (T). (A battery rated at 100 Ah can provide 1 amp of current for 100 hours, or 10 amps for 10 hours).

I can now put you to sleep with more basic Ohms Law, but I propose a simpler solution. Bioenno Power has a couple of useful charts to help with your LiFePO4 purchase.

BIOENNO POWER MOBILE TRANSCEIVER DUTY CYCLE GUIDE: *20/80*

The Bioenno Power 20/80 Guide approximates standard consumption values based on average benchmark figures across the various radio models and assumes median calculated values, actual runtimes may vary depending on make, model, and vintage of radio.

BIOENNO POWER 20/80 STANDARD DUTY CYCLE FOR MOBILE TRANSCEIVER *(Compatible with all 12V Mobile Radio Transceivers)*

TRANSMIT (W)	RECEIVE (W)	TOTAL (W)	MODEL	VOLTAGE (V)	CAPACITY (AH)	CAPACITY (WH)	RUNTIME (HOURS)
100	5	24	BLF-1212A/AB/AS	12	12	144	6
			BLF-1215A/AS	12	15	180	7.5
			BLF-1220A/AS	12	20	240	10
			BLF-1230A/AS/LB	12	30	360	15

This chart in its entirety can be found at:
https://static.dxengineering.com/global/images/chartsguides/b/bip-blf-1203ab_sv.pdf

BIOENNO POWER MOBILE TRANSCEIVER DUTY CYCLE GUIDE: *50/50 HEAVY DUTY*

The Bioenno Power 50/50 Heavy Duty Cycle Guide approximates higher Field Day/Event consumption values based on increased transmit percentage benchmark figures across the various radio models and assumes median calculated values, actual runtimes may vary depending on make, model, and vintage of radio.

BIOENNO POWER 50/50 FIELD DAY HEAVY DUTY CYCLE FOR MOBILE TRANSCEIVER *(Compatible with all 12V Mobile Radio Transceivers)*

TRANSMIT (W)	RECEIVE (W)	TOTAL (W)	MODEL	VOLTAGE (V)	CAPACITY (AH)	CAPACITY (WH)	RUNTIME (HOURS)
100	5	52.5	BLF-1230A/AS/LB	12	30	360	6.8
			BLF-1240A/AS	12	40	480	9.1
			BLF-1250A/AS	12	50	600	11.4
			BLF-1260AS/L	12	60	720	13.7
			BLF-1280AS	12	80	960	18.2
			BLF-12100AS	12	100	1200	22.8

This chart in its entirety can be found at:
https://static.dxengineering.com/global/images/chartsguides/b/bip-blf-1203ab_st.pdf

One last consideration is if you will need to add more capacity to power other equipment operating on your back-up system. Below is a list of current draw common devices. (For a complete list visit Jackery.com).

CPAP 3A	LED Light 1A
Crock Pot 3-5A	Mini Cooler Fridge 3.75A
Digital Television 1.5-4A	Oscillating Fan 0.5-1A
Satellite DVR .8A	Portable AM/FM Radio .4A
Laptop Computer 2-3 Amps	Phone Charger 1-2A

(Need Amps? Amps = Watts / Volts)

Jackery has a nice appliance wattage chart at: https://www.jackery.com/blogs/knowledge/appliance-wattage-chart?gad_source=1&gclid=Cj0KCQiAs5i8BhDmARIsAGE4xHyA-pi2gu15Z8Pv8HsVlNuKOF8ghCe19aBvlK0CHmkbuAZJ5_UcVVIaAsbxEALw_wcB

Caution: In addition to battery Ah requirements, be sure that the battery can sustain the **peak current** required. The peak amperage rating is often near the Ah capacity of the battery. My 50Ah battery has a peak output of 50A.

To determine the battery required Ah rating, add the required current of the desired radio mode that you would like to operate and add the number of hours that you would like to operate. Do the same for any appliances that you would like to operate. **Amps x Hours will give you the minimum battery rating required.** In my examples, I use several 50Ah batteries. If it were me, I would buy nothing less 50Ah.

Housing the Battery

Before purchasing a battery, select a case to **make sure that your battery will fit**! I have several. A smaller case is more compact, and a larger case can allow you to accommodate other devices like a **solar battery controller or an inverter**. Many of these cases include volt-meters, external posts, cigarette lighter sockets and Anderson power pole connectors. I purchased a Powerwerx PWRbox2 and an ALL-TOP Smart Battery Box. The ALL-TOP has enough room inside for my charge controller and AC battery charger. Before selecting any box, make sure any pre-installed wiring or circuit breakers are suitable for the planned load.

Going Solar

Now that we know the battery Ah rating, let's add solar so that we can replenish our backup battery. How many watts will I need to supply my equipment demand and to simultaneously recharge my battery when the sun is up? How long will it take to recharge the battery?

Nighttime Operation

First, we need to determine the load. I plan to use the IC-7300 transceiver. The duty cycle values for the IC-7300 are an AVERAGE of **18-21 Amps transmitting FT8 or FM**, about **11-14 Amps transmitting CW**, and **8-10 Amps transmitting SSB**, including allowance for current that flows in the transmitter even at zero watts output.

If I want to use my Icom HF rig for SSB for 6 hours. Remember, the duty cycle for SSB is only about 20%, which will **draw about 8A**.

Based on **75/25 Rx/Tx standard usage**, that would be **8A X 25%(Tx time) = 2.0A**. Now add the **Rx** power consumption of **1.2A X 75%(Rx time) = .9A**. That's a **total of** 2.0A(TX) +.9A(Rx) **= 2.9 Amps per hour.** or 2.9Ah. if we operate for 6 hours, that will be 6 X 2.9Ah=**17.4Ah total**.

Or, to make it easy, we could go with the worst-case scenario. The IC-7300 uses a maximum of 21 Amps while transmitting. So, if we use 21 Amps for 1 hour, that's 21Ah required to transmit. Using the same 75% Rx / 25% Tx ratio, we would need 5.25Ah for transmit and .9Ah for receive per hour. That's a total of **6.15Ah**. If we operate for 6 hours, that's 6.15 X 6 = 36.9Ah total. Of course, we would have to add any other equipment drawing from our battery. Would a 50Ah battery work for the radio? Yup!

Daytime Operation

If we operate during the day for the same time and in the same mode above, we add that Ah demand to the **current required to replenish our battery**. The monocrystalline panels that I purchased are rated at 30.3v loaded, 8.85A and 250W. First, determine the total current needed by adding all of the radios and equipment that will be in operation. Now add another (**10-20% of the battery Ah rating**) to **recharge the battery**. If we consume **2.9A** in the nighttime example above, add another **10A to charge the battery**. Our panels will need to output 2.9A+10A=**12.9 Amps** of PV panel output. But wait, remember that good electrical practice dictates the 120% rule, which adds an extra 20% to electrical demand to prevent electrical overload. That is **12.9 X120% = 15.48A** of PV panel output required. Because my 250W solar panels produce 8.85A per panel, it will require 2 - 8.85A PV panels providing a total of 17.7A.

Since we have a surplus of 10A to recharge our 50Ah battery, it will take (50Ah/10A), **5 hours to recharge a completely depleted 50Ah battery**. In this case, we only used **15.4Ah**. That is only **30% depleted, requiring about 2 hours to recharge.**

Photo Voltaic (PV) Panels

There are different types of PV panels that you may choose from. These are the most common.

Monocrystalline Solar Panels

Monocrystalline solar panels are made from a single, continuous silicon crystal. They have a consistent, uniform and efficient molecular structure. Monocrystalline panels high purity allows it to **perform well in low-light environments** and maintain efficiency over time.

Polycrystalline Solar Panels

Polycrystalline solar panels consist of multiple silicon crystals that are melted together during manufacturing into a mostly seamless silicon sheet. Because polycrystalline is not a single uniform crystal, there are more boundary areas between the silicon crystals that can **impede electron flow**. As light hits these boundaries, it gets reflected reducing overall electrical output. These panels require less silicon and **reduces costs** compared to monocrystalline construction.

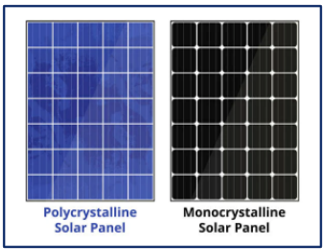
Bifacial Panels

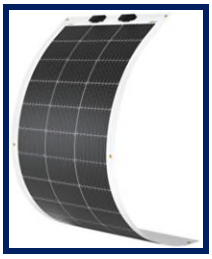
Standard non-bifacial solar panels are primarily composed of three layers. On top, a layer of transparent glass which protects the solar panels and allows the sunlight to pass through. Below that, a layer of silicon converts this solar energy into solar power. Below the silicon sits an aluminum frame that gives the panel strength and rigidity. Bifacial panels differ from these standard panels in that Instead of a bottom frame, there is another layer of glass that allows for the reabsorption of reflected light from the backside of the panel.

Bifacial panels can **boost energy production by up to 30%** compared to their monofacial counterparts.

Thin-Film Solar Panels

Rather than using a rigid silicon base, thin-film solar panels deposit ultra-thin photovoltaic layers onto a substrate backing like plastic or metal. The photon-absorbing layer is only a few micrometers thick, comprised of materials like amorphous silicon. Thin-film allows for **flexible panel shapes and tolerates high temperatures better than crystalline silicon**.





	Monocrystalline	Polycrystalline	Bifacial	Thin-Film
Lifespan	25-30 years	25-30 years	25-30 years	15-20 years
Appearance	Black	Blue	Black	Various

Full-size panels range in size from 250W to over 500W or more. They are typically over 40 lbs. and about 5 1/2’ tall. While these panels will work for field day operation, they are large, heavy and cumbersome.

That said, San Tan solar in Gilbert, Az. sells used and blemished panels. I purchased three, **250-Watt (8.85A), blemished panels for only $50.00 apiece**. I have them temporarily installed to operate off-grid.

Though mixing different solar panels is not recommended, it is possible and would be okay, as long as each panel’s electrical parameters (voltage, wattage, amps) are carefully matched.

For more portable operations, Renogy, who is a quality manufacturer of solar products, sells a wide variety of portable panels with kickstands included for stand-up operation. There are many options, such Renogy , BougeRV as well through Amazon. I purchased a portable 400-watt panel with controller for about $419.00 through Amazon. Expect many portable **PV panels to cost about $1.00 per Watt**.

Renogy Portable 100W Panel

Full-Size Panels in the Field

Solar Charge Controllers

Charge controllers **prevent your batteries from being overcharged** by limiting the rate of charge to your batteries. They also **prevent battery drainage** by shutting down the system if stored power falls below a preset percentage and charge the batteries at the correct voltage level. This helps preserve the life and health of the expensive batteries.

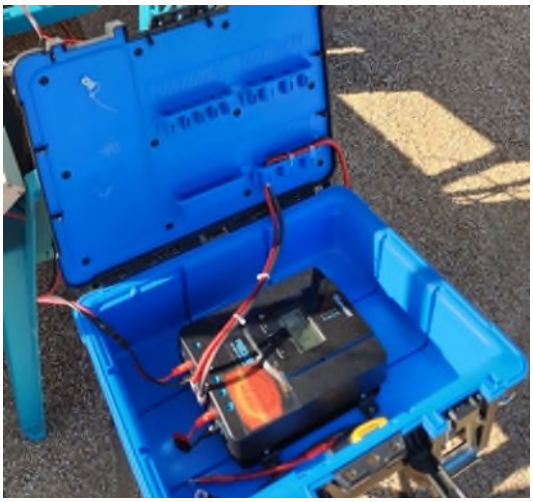
There are two main types of charge controllers to consider:

● **Pulse Width Modulation** (PWM) is cheaper, but **less efficient (75-80%)**. They regulate the flow of power to the battery by reducing the current gradually, called "pulse width modulation", which provide a series of short charging pulses to the battery. PWM controllers are best for **small scale applications** because the solar panel system and batteries must **have matching voltages**. They are common with **cheaper solar panel kits** online.

● **Maximum Power Point Tracking** (MPPT) is much **more efficient (94-99%)** and is also **more expensive**. They have two key features. One is that they can **accept a high input voltage** and step this voltage down to match your battery bank voltage. Second, they have the ability to boost current, when voltage drops. Typically, MPPT **controllers can be set to charge 12V/24V/36V/48V battery systems**. If you can afford this type of controller, it has higher efficiency, is more versatile and is of higher quality.

To reduce the risk of damage to the controller, its **Amperage rating must be higher than the total output of your panel(s)**. Since the sum of my PV panels output totals about 26A, a 30A controller would be all that is required. The BougeRV 40A has a **150V maximum input PV Voltage**. This must be considered when arranging the panels in **series or parallel**.

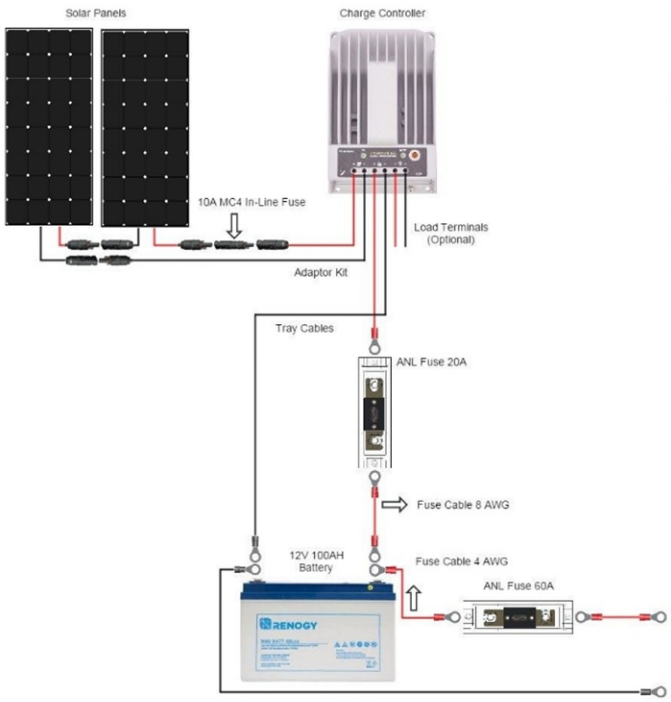
BougeRV 40A MPPT Charge Controller



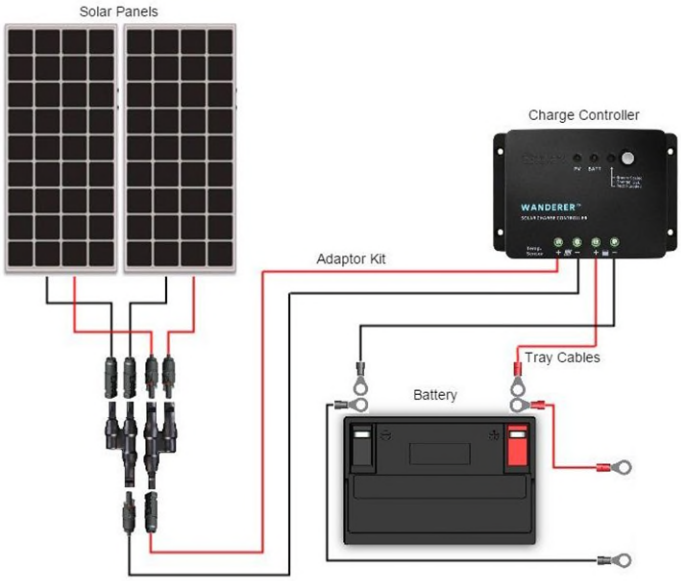
Renogy 40A Charge Controller in the Field

System Interface

Now that have our panels, battery (or batteries) and charge controller. How do we connect everything together?



Series Connected Panels



Parallel Connected panels

Our first consideration, is do we connect the panels in **series or parallel**? The main difference in wiring your system for series or parallel is the effect it will have on voltage and current. **Series connections increase overall voltage while maintaining constant current**. This is beneficial for **long wire runs** and can **reduce wire gauge requirements**. **Parallel wiring maintains voltage, but increases current**, which may require a **larger wire gauge**. This fundamental difference impacts system efficiency and power output.

Remember that **PWM controllers** must always have panels that **match battery voltage**, therefore multiple panels must be connected in a way to match the battery volage. If we have a 12V PWM controller with two-12v panels, they must be connected in **parallel** with the 12V PWM controller and the 12V battery system.

If we have a 24V PWM controller with two-12v panels, they must be connected in **series** with the 24V PWM controller and the **24V battery system**.

Maximum Power Point Tracking (MPPT) charge controllers **perform better with higher voltage inputs**. Series wiring can therefore **enhance the efficiency** of your solar power system. This configuration is commonly used in both residential and back-up solar installations, particularly when dealing with longer wire runs, to minimize power losses. In larger panel installations **series/parallel panel installations are commonplace**. This configuration is typically used to keep wire sizes as small and increase efficiency and also to limit the maximum current and voltage on each array of panels.

Wiring Considerations

When determining wire size for the feeder wires (panels to the charging controller), **current and wire length must be considered**, (Reference the chart below). With full size panels, 10AWG feeders are common.

The battery box has two 50 Amp Powerpole connectors for solar input connection or high current output and accessory outlets are fused to 16 Amps.

Current(A)	0-13	13-18	18-23	23-28	28-40	40-50	50-60	60-70	70-80
0-18	18AWG	16AWG	14AWG	14AWG	14AWG	12AWG	12AWG	10AWG	10AWG
18-24	16AWG	14AWG	14AWG	14AWG	12AWG	12AWG	10AWG	10AWG	10AWG
24-35	14AWG	12AWG	12AWG	10AWG	10AWG	8AWG	8AWG	6AWG	6AWG
35-40	12AWG	12AWG	10AWG	10AWG	8AWG	8AWG	6AWG	4AWG	4AWG
40-55	10AWG	10AWG	8AWG	8AWG	6AWG	4AWG	3AWG	2AWG	2AWG
55-80	8AWG	6AWG	6AWG	4AWG	3AWG	2AWG	2AWG	1AWG	1AWG
80-105	6AWG	6AWG	4AWG	3AWG	2AWG	1AWG	1/0AWG	2/0AWG	2/0AWG
105-140	4AWG	3AWG	2AWG	1AWG	1/0AWG	2/0AWG	2/0AWG	3/0AWG	3/0AWG
140-165	3AWG	2AWG	1AWG	1/0AWG	2/0AWG	2/0AWG	3/0AWG	3/0AWG	4/0AWG
165-190	2AWG	2AWG	1AWG	1/0AWG	2/0AWG	2/0AWG	3/0AWG	4/0AWG	
190-220	1AWG	1AWG	1/0AWG	2/0AWG	3/0AWG	3/0AWG	4/0AWG		
220-260	1/0AWG	2/0AWG	2/0AWG	3/0AWG	4/0AWG				
260-300	2/0AWG	3/0AWG	3/0AWG	4/0AWG					
300-350	3/0AWG	4/0AWG							
350-405	4/0AWG								
Renogy	Length(ft.)								

Wire Chart Courtesy of Renogy

Don’t forget a circuit breaker! Since my battery is capable of producing more than 50A output, I Installed a 60A resettable circuit breaker to the 50 Amp Powerpole input/output of the battery. This also allows for manual disconnection of the battery from the panels or an external load. The accessory outlets use a 16A resettable circuit breaker switch, which allow for the use of smaller wiring.

60A Resettable Circuit Breaker

Connectors

If you use full-size panels, Most are equipped with MC4 type connector. I purchased an extension cable complete with MC4 connectors and 10 AWG wire.

MC4 PV Panel Connectors

MC-4 Extension

MC-4 Crimp Tool

On the opposite end of the MC-4, I installed a 50 Amp Anderson connector (SB50), to allow quick disconnect from the battery box.

Anderson SB50 Disconnect

For all other connections, I used standard 30A Anderson Powerpole connectors.

30A Anderson Powerpole Connectors

Anderson Powerpole Distributor Block

Anderson Powerpole Crimp Tool for 15-40-45A Connectors

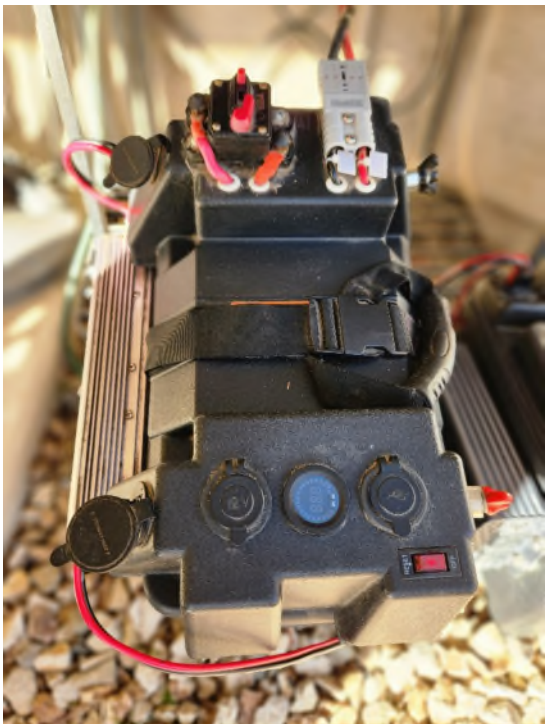
Got AC?

Finally, I purchased a 1000W “Pure Sine Wave” inverter for accessories that would not accept 12VDC. I mounted it to the side of my battery box. The **Pure Sine Wave inverters are more efficient (90-95%)** and **operate with more electrical and electronic equipment than “Modified Sine Wave” inverters.** While modified sine wave inverters are cheaper, they are **less efficient, (75-86%) and are generally not suitable for sensitive electronics, AC motors, or devices requiring a clean, consistent power source**

While I did purchase a pure sine wave inverter, I went for something more affordable on Amazon. I would like to stress that **many less expensive inverters generate a lot of Radio Frequency Interference**. My recommendation is that if you will be using the inverter while operating your radio, don’t shop for low price. Go with a company that specializes in inverters. High quality brands include **Samlex, Exceltech & Renogy**. Ham Radio Outlet and DX Engineering only sell Samlex brand. Also make sure the device is returnable in case you do experience RFI issues.

1000W Pure Sine Wave Inverter

Later, I added a second box, with another 50Ah LifePo4 battery. I now have a total of 100Ah of capacity which my controller and panels work well with. The equipment is ready to go in case of emergency.



50Ah Battery & Controller

Go Boxes in Dry Outdoor Shelf

Verify your calculations with this DC Wattmeter with installed Anderson Powerpole connectors (available at Amazon.com).

Cost

My DIY system components:

2 - 50 mAh PifePO4 batteries	$200.00 ($100.00 ea.)
2 - Battery boxes	$260 ($100.00+$160.00)
1-BougeRV 50A battery controller	$160.00
3-250W PV panels (Fixed)	$150.00 ($50.00ea.)
1 400W PV Panel (Portable)	$420.00
1-1000W inverter	$85.00
20A LifePO4 AC battery charger	$60.00
Wire & connectors	$60.00
Total cost was	**$1390.00**

What would a similar commercial Soar Generation System cost?

- **Jackery 1000 v2 with 200W Solar Panel,** 90Ah LiFePO4,1500W Inverter $1299
- **Jackery 2000 v2 with 2x200W Solar Panels**, 150Ah LiFePO4 2200W Inv. $2499

In Summary:

The above are my calculations. Actual values are dependent upon:

- The Maximum current draw of the radio.
- The duty cycle of the transmit mode being operated.
- The ratio transmit time to monitor time (Light is 80/20, Field Day 50/50).
- Hours of operation.
- Other accessories.
- PV Panel size.
- Hours of sunlight.
- Battery Ah.
- Charge Controller Type MPPT (94-99% efficient) vs. PWM (75-80% efficient).
- Efficiency of an inverter (Pure Sine Wave about 90%. Modified Sine Wave, 70-80%).
- Wire length and AWG (voltage drop).

There are some great online resources including:

- Renogy
- Jackery
- BougeRV

Links:

LifePo4 Batteries
https://www.bioennopower.com/collections/12v-series-lifepo4-batteries

Batteries, Panels & Accessories
https://www.bougerv.com/

Bueno 80/20 Battery Recommendations
https://static.dxengineering.com/global/images/chartsguides/b/bip-blf-1203ab_sv.pdf

Bueno 50/50 Battery Recommendations
https://static.dxengineering.com/global/images/chartsguides/b/bip-blf-1203ab_st.pdf

Here is a pretty good video on the subject: https://www.youtube.com/watch?v=i07Y6buLLuw

Panels in Series or parallel
https://www.renogy.com/blog/solar-panel-series-vs-parallel/

Rengy solar panels
https://www.renogy.com/solar-panels/?Rng_ads=e85f99e9f41f82d8&kw=renogy%20sale&ad=728242894038&gr=140991734329&ca=17600054826&pl=ga&gclid=Cj0KCQiAy8K8BhCZARIsAKJ8sfQk0Du8-Ndhne2IDpuaNDJ-kbtDAg4idscIF0b7Iy_nSY-VNyL1JFoaAmnTEALw_wcB&r_u_id=9188094281&gad_source=1

Used Solar PV Panels:
https://www.santansolar.com/

https://www.youtube.com/watch?v=i07Y6buLLuw

Appliance Wattage Chart
https://www.jackery.com/blogs/knowledge/appliance-wattage-chart?gad_source=1&gclid=Cj0KCQiAs5i8BhDmARIsAGE4xHyA-pi2gu15Z8Pv8HsVlNuKOF8ghCe19aBvlK0CHmkbuAZJ5_UcVVIaAsbxEALw_wcB