Portable Battery Power Systems – for Home Backup

It is right for my needs? How to select one?

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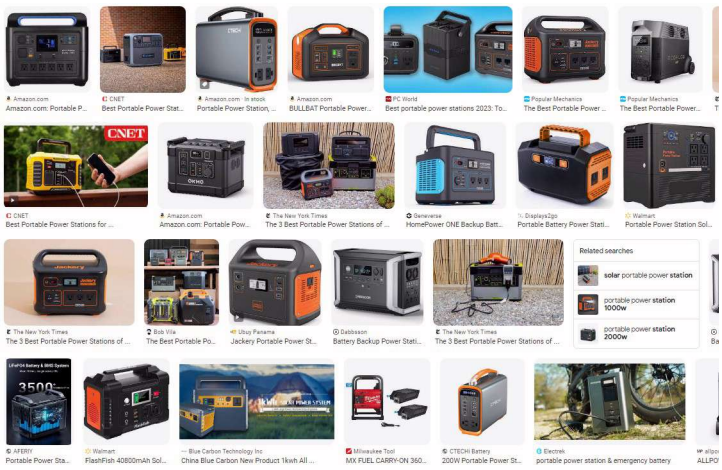


There seems to be a wide selection of Portable Power Systems now coming to market. With new widely available battery technologies these battery backup systems can be a good alternative to fuel guzzling, exhaust producing, noisy engine-generators. But you have to be aware of what they can and cannot do to see if they will really meet your needs. Since many new brands have entered the market, prices are becoming more competitive. This article will focus on home backup power, although much of the information presented here can also apply to recreational vehicle and camping use.

First let's cover a little semantics. Often these battery power systems have been marketed using the word, “generator.” That is wrong and misleading. That word has traditionally been used for a rotating piece of electrical equipment that converts shaft input power to electrical output. It is also more generally used for an engine-generator combination that converts a fuel to electricity. These Battery Power Systems simply store electricity and do not generate it. Once the stored electricity is depleted, the system shuts down and must be recharged from another source of electricity.

Great characteristics, but some limitations

These battery power systems do have some great characteristics. Here are some of them:

- quiet operation
- no flammable fuel required
- instantly available in less than a second
- virtually zero maintenance
- can be installed and operated indoors
- LCD display provides many statuses
- new batteries much better than lead-acid
- lighter weight
- better cycle life – up to 10 years
- some models can be connected to breaker panel for home automatic backup

However there are some important limitations:

- electricity storage limited to size of battery
- not suitable for high demand electric loads such as space heating, water heating, electric range, central heat pumps or central A/C
- must be sized carefully for motor inrush
- recharging time is much longer than filling a fuel tank – usually hours
- unless there is another recharging power source such as solar, not suitable for long grid outages beyond a couple days

How to size a system

In view of the above, does it look like one of these systems will meet your needs? If so then you will first need to estimate what size battery in kilowatt-hours is needed. A kilowatt is 1,000 Watts. A demand of 1 kilowatt for a duration of 3 hours is 3 kilowatt-hours (kWh). List the electrical loads you want to power and next to each one record the Watts. Look on the appliance nameplate for the Watts. If no Watts is shown then multiply the Amps by the Volts to get an estimate for the Watts of the appliance. Then in the next column write the number of hours per day the load might operate during a power outage. (This might be less than on normal days). Then multiply the Watts by the hours and divide by 1,000 to arrive at the kWh usage per day for that item. Write that in the last column. Add all the numbers in the last column to get the

total kWh electricity usage for one day. You can also total all the numbers in the second column to get total Watts. But this number will be explained more later. Here is an example of what part of your list should look like. It is recommended that you use a pencil to record all the figures as they may change. More on that further below.

Estimating Inverter and Battery Ratings

Electrical Load or Appliance	Watts or Volts x Amps	Operating Hours per Day	kWh = Watts x Hrs / 1000
Living Room Lights	*100*	*3*	*0.3*
Entertainment System	*80*	*4*	*0.24*
Microwave oven	*1000*	*0.3*	*0.3*
Refrigerator	*200*	*see below*	*0.2 §*
Window A/C unit 5,000 Btu	*500*	*3 **	*1.5*
Totals	*1,880 Watts*		*2.54 kWh*

** The largest part of the load in the A/C unit is the compressor which usually cycles on and off. Assumed here that it runs 1/3 of the time. So for 9 hours A/C operation the compressor might run 3 hours.*
§ Average electricity consumption for mid-size refrigerator per day per the internet is 200 Wh.

If you conclude that the total kWh usage per day is too high resulting in a large battery size that is too costly then there are some adjustments that can be made. You might decide that you will not use the microwave but rather use a charcoal grill for cooking. If you still have the old inefficient incandescent light bulbs those should be changed out to LED bulbs for an electricity cost savings all the time. Refrigerators usually will stay cold for at least 6 hours if the door is not opened frequently. If your power outages are short then you might not even need to power the refrigerator at all. Be creative in how you use appliances during a power outage and you should be able to reduce the total.

Finally consider your power outage history in terms of how long they usually last. And based on that duration multiply the Total kWh usage per day by the number of days you want to plan for the outage to last. Using the total kWh per day above, if you want to size for a half day outage then a 0.5 x 2.54 = 1.27 kWh battery is needed. If you need to design for a 2 day outage then a 2 x 2.54 = 5.08 kWh battery is required.

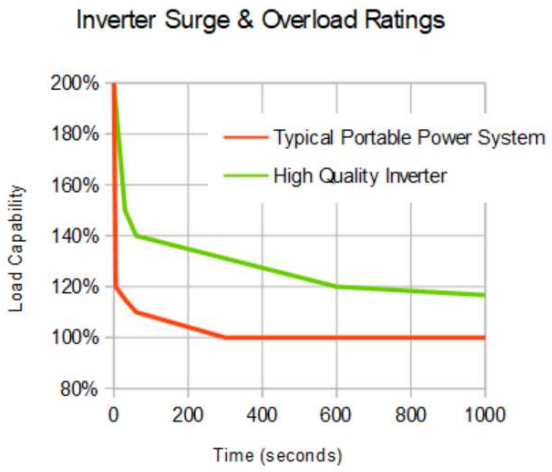
The Watt total for the second column is not an accurate number because this assumes all the loads are running at full power at the same time. That probably will never happen. And if it ever does happen, it will last only for a short time, maybe just minutes. However, there is another factor that has not been considered here. Any motor loads when starting will draw a higher Wattage, usually for just a split second. This starting inrush can be 3-5 times the motor running Watts. This will be the case for the compressor motor in the window air conditioner, and in the refrigerator, unless they have built-in soft starting. Since all the inverters used in these Portable Power Systems have a surge rating that is significantly higher that the continuous rating, they will normally be able to handle these appliances when they start, as long as they are not a large part of the total load.

Pick a system to buy

Here are some features to look for and things to consider when evaluating the various models..

1. Select a continuous power rating in Watts adequate for the estimated loads.
2. Try to find the inverter surge rating and short-time overload ratings. These should be listed as Watts or percent of full load for a time period in milliseconds or seconds. For example, a 2000 Watt continuous output rating may show 4000 Watts for 100 ms (0.1 sec). The best inverters will also

have short-time overload ratings such as 150% for 30 seconds and 110% for 30 minutes. A good overload rating means you can safely overload the unit without risk of damage or shutdown, and it can also mean you don't have to oversize the unit. These consumer Portable Power Systems seem to never publish overload ratings, which probably means they do not have that capability. This would be a good question to ask about when testing their tech support line. (See below.)



3. Battery type, currently Lithium Iron Phosphate (LiFePO4) is the best technology recommended for these systems. This is due to their excellent cycle life, light weight, and safer operating history.
4. Select a battery size in kWh greater than calculated. Over the life of the battery its capacity will slowly degrade to 80%. So, if you want to compensate for this aging, multiply the calculated kWh by 1.25 for sizing the new battery.
5. Most brands also sell external battery modules to increase the battery capacity. That expansion feature is desirable. Verify that the model you are considering has that capability.
6. Check the charging details to determine how the external battery modules are recharged. Must they be charged only through the main unit? Or do they have separate chargers? How does the recharge time change if more external modules are added? Capability for lots of modules with a large kWh capacity may be advertised but that might result in unacceptably long recharge times.
7. If you will be using solar as one of the charging sources, can that be used simultaneously with AC charging? Or must only one source be used at a time?
8. How fast can the batteries be recharged? Faster is normally considered better. But high recharge rates can stress and shorten the battery life. Are there settings allowing the user to pick the charging rate?
9. Is the AC charger built into the unit? Or is there an external “brick” that has to be handled?
10. Are any of your electrical loads that need to be powered 240VAC? If yes, then you will need a split phase system with 120/240VAC output. Otherwise just 120VAC output is sufficient.
11. Nearly all systems now come with a pure sine wave output inverter. Don't settle for modified sine wave.
12. The harmonic distortion spec describes how “pure” the ac sine wave output really is. Typical figures are 3% to 5%. A lower distortion number is better as it results in lower losses in loads and a less chance for noise in audio equipment.
13. For automatic backup operation with system continuously connected (plugged in a wall socket) and connected to the critical load circuits, select a system with UPS capability.
14. If you are relying on the UPS function to keep a load operating during the switchover from grid power to inverter power, then you will need a fast transfer time. Depending on the type of load, this transfer time may need to be 15-20 ms, or even less. The exact number will depend on the “ride through” capability of the power supply in the device, be it a desktop PC, or whatever. It is difficult to guarantee a fast enough transfer time without testing. If it turns out the system transfer time is not fast enough, an alternative is to purchase a separate minimum size UPS to bridge this transfer for that particular load rather than relying on this larger system. The little UPS can then be backed by this larger system.

15. Some systems come with a manual transfer switch option to allow direct connection to a home breaker panel. If you want a fully automatic system that keeps certain branch circuits powered in your home during a grid outage, then this is the best way to go. This switch will allow you to select which branch circuits are backed or powered with the UPS function. If the system does not include a transfer switch verify that the system can be used with one.
16. If you plan on operating the system in a hot or cold environment, check those temperature specs carefully.

17. Make sure the system allows dc charging from an external source, such as solar. Check the requirements in terms of the maximum Watts allowed and what the allowed Voltage range is. Some systems use a 12Vdc internal battery bank. Others use a 24Vdc bank. If you already have an external dc source that you plan on using make sure the Voltage is compatible with the allowed range. Some systems will even have a built-in MPPT solar controller allowing for a much wider range of solar input Voltages.
18. If you plan on using the system mostly off-grid then the idle power consumption is important. You will want that number in Watts to be as low as possible to prevent idle discharge of the battery bank.
19. If portability is important for your anticipated use, how heavy is the unit? Does it come with wheels? Note however, that a lighter weight does not necessarily mean it is a better quality unit. Batteries with the same capacity and technology will have nearly the same weight. So any weight reduction is being achieved elsewhere, possibly in the inverter or the case. That may not be good.
20. Can the unit be monitored and controlled with a mobile app compatible with iOS and Android devices?
21. Nearly all consumer Portable Power Systems are manufactured in China. However, it is recommended that a brand is selected that has a headquarters in the USA.
22. View the user manual for the system being considered. Make sure it is complete and intelligible.
23. Call the tech support phone number or use the tech support email address to see if they are reachable and responsive. Is the call center based in North America?
24. Many brands are new companies with a short history and a warranty of 2 years. Select a brand with a longer history and a warranty of 5 years. Check the warranty terms.
25. Read user reviews for the model you are considering. If it is a new release with few reviews, check reviews of similar models of the same brand.
26. Find the best price. Look for price promotions.

Or build the perfect system yourself?

Not finding the system you need or want? Are you a DIY type person with some electrical experience? There is another alternative. Build your own system! With the new battery technologies, this might seem to be a daunting project at first. But many have done it. And there are youtube videos that provide lots of helpful technical details. All the components of a system are individually available. Plus, there are advantages to to designing your own system. Consider the following:

Select the exact inverter/charger you want:

- continuous Watt rating
- good surge and overload ratings
- wide choice of battery charging profiles
- full control over all Voltage and delay settings
- local or remote control panel
- coordinate charger and BMS settings
- if repairs are ever required, only the component has to be shipped to manufacturer

Design the exact mounting you want:

- wall mounted
- stationary enclosure
- movable cart mounted

Select the exact LiFePO4 battery bank you want:

- small quantity prismatic rectangular cells rather than huge number of cylindrical cells with lots of connections and limited monitoring
- optimum battery bank Voltage
- battery management system (BMS) with all settings user adjustable
- BMS ability to monitor all cells
- increased battery safety and life
- a weak cell is easily detected
- a cell failing early can be easily replaced
- full BMS display and control through mobile app with optional LCD screen
- upgrade or replace battery bank at any time

The possible disadvantages of the DIY option are the assembly time and physical size. The DIY system will not be as compact as a complete factory assembled system. The individual components may cost more or less than the completely factory assembled unit depending on the quality of the components selected. And if you have to pay someone to do any of the work that also would add to the cost. But in most cases you

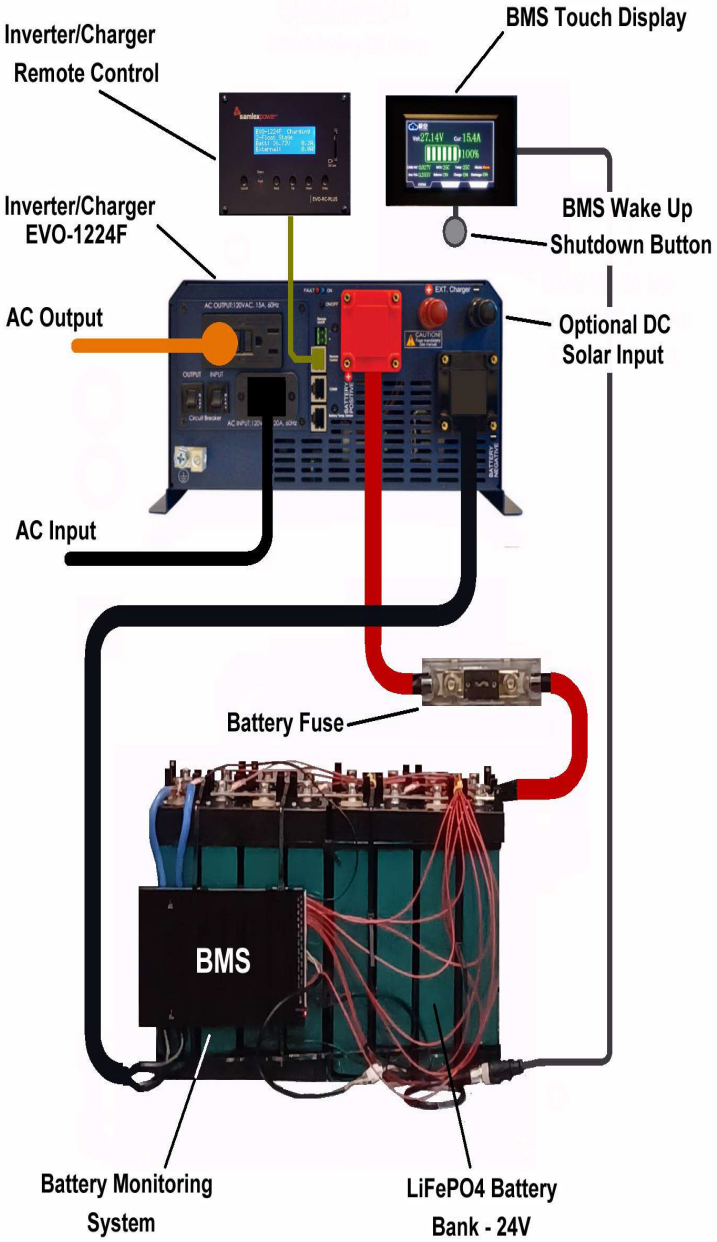
will end up with a better system.

There is also a simplified DIY system approach. Rather than purchasing individual battery cells plus a separate BMS, and making all the cell sensing connections, you purchase the whole battery bank with the BMS already integrated inside. Some of these battery banks even come with an LCD screen on the outside and a mobile app that shows all the parameters.

DIY System using individual battery cells

Here are pictures of a DIY system assembled using individual battery cells plus a BMS. It is mounted in a custom designed enclosure made of 3/4” plywood. Wheels provide mobility and the interior is lined with sheet metal for extra protection against fire in case of electrical failure.

The LiFePO4 battery bank is composed of eight 100 A-h cells connected in series for 24 V total. This is equivalent to 2.4 kWh of storage. The enclosure is over sized to allow for larger batteries.

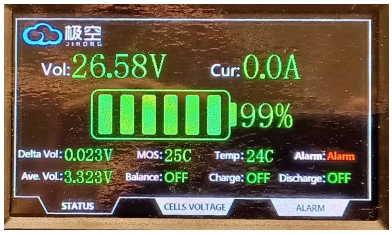


The inverter is rated at just 1200 Watts continuous but also has excellent overload capability of 2400VA for 0.1 sec, 1800W for 30 sec, 1680W for 1 min, 1440W for 10 min, and 1320W for 30 min. The built-in charger is rated to 40 Adc at 24V and can be programmed for six different charging profiles.

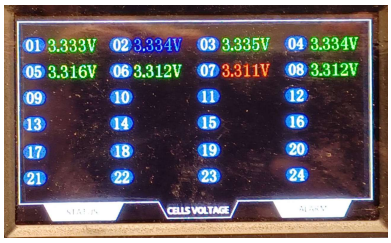
A 30 A ac transfer relay is included, and in UPS mode will transfer to the inverter in 18 ms max.

Front view with screen cover removed

Access for inverter connections



Inverter/charger display



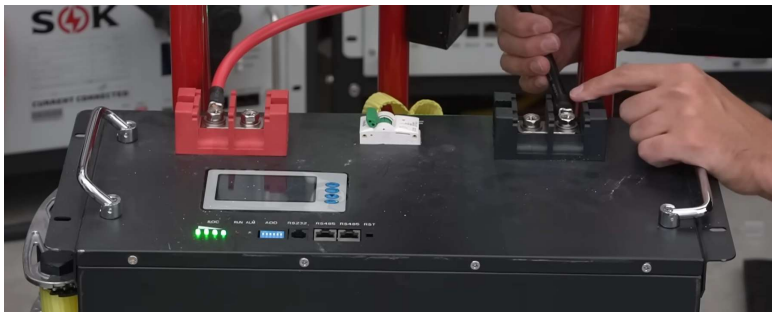
BMS touch screens

BMS mobile app

DIY System using single battery bank

Here is a good example of a simple DIY system mounted on a hand truck. It is well explained in the linked youtube video. The only information not mentioned in the video is about programming the charging settings to match the battery bank, and connecting to the breaker panel. But the programming instructions are on his web site.

DIY Solar Power with Will Prowse
Build a Mobile 48V Solar Power System in 10 Minutes!
published in May 2023
https://www.youtube.com/watch?v=PjdB5m38MTs



Conclusion

A Battery Portable Power System can be a good solution for short frequent power outages, if your electrical loads are not too large. Compared to the alternatives of a portable engine-generator, or an automatic standby generator, these type systems are as close to plug-n-play simplicity as you can get.

NoOutage.com LLC now sells Battery Portable Power Systems at the following link...
https://www.nooutage.com/houseups.htm