# Choosing a Portable Renewable Energy Generator

When choosing any piece of equipment, many variables come into play. When that piece of equipment is a generator or power supply system, the variables may include size, output power, noise, energy source, and endurance. However, many of those variables get defined just by first defining the equipment's application (its purpose and how you plan to use it), therefore simplifying the choices.

Power generation systems have hundreds of applications. This article will focus on portable generators in specific and a range of their applications and sizing considerations in general. The intent is to address the frequently-asked questions, "What will this generator run?", "For how long?", and "Will it run my house?" Those questions usually have to be answered with the question, "What do you want (need) to run?" which defines the application.

To start, some basic electricity concepts are required. First off, Watts equals Volts times Amps. Watts (1000 Watts = 1 kiloWatt) is the power required by a device and is basically related to endurance. This equation is true whether working with Alternating Current (AC) or Direct Current (DC) voltage. If AC, typical voltage numbers are 110-120V or 220-240V at 60 Hz in the US and 220-240V at 50 Hz internationally. If working with DC voltage, 12 and 24 VDC are common. Amps are device-specific and relate to the electrical load a device will require to first start up (surge) and then to continue running.

And beware, there is an inherent time unit (almost always "hours") on both sides of the W = V x A equation, sometimes stated, sometimes not, sometimes appearing in the numerator (i.e. Whr and amp-hour), but often inferred in the denominator as W/hr and Amp/hr. If a device spec sheet, data plate, or owner's manual said 1000 Watts, it means that device's power consumption will be 1000 Watts to run continuously for <u>one hour</u> at its highest power setting.

Your coffee maker might be such a 1000 W device. However, it is only using 1000 W (per hour) <u>while brewing</u> and possibly only 200 W after with the hot plate on. If it brews for six minutes and warms for 54 more before shutting off, you have used 1000(0.1)+200(0.9) or 280 W. Later, to reheat a cup in your 1000 W microwave for 1.5 minutes on high, you use another 1000(1.5/60) or 25 W. A refrigerator might be rated 6 amps (660W), but that's with the door open, defrost on, and running the ice maker, but average hourly power consumption may be under 100 W as the compressor cycles. A working rule of thumb for <u>variable</u> power devices is 20% or $1/5^{th}$ the stated maximum power consumption.

Now, looking from the other side, is a generator's ability to provide that power required. Its power output is limited by any combination of the inverter, circuit breaker, fuse, or plug receptacle amp limit. The outlets in a house powered by the grid are often protected to 15 amps. A generator's output will be defined by its outlet limitations and/or its inverter's surge and continuous power capability.

Gas generators are generally labeled by this power output number and their specs (endurance, fuel usage) are often given with respect to a percentage of maximum. Low-Watt gas generators will run lower-Watt devices at low power at a relatively low decibel level and for a relatively long time per fuel fill-up. Industrial, higher-Watt gas generators are able to run air conditioners, large power tools, etc while louder and requiring more fuel. However, since one of the applications of generators is to provide power during an outage and because fossil fuel may not be available during an outage (either no electricity to run pump or high consumer demand), alternative energy generators are becoming popular. No matter its fuel source, a generator requires budgeting of the usage (Whrs) and of "fuel" (whether measured in gallons or hours of sunlight/wind).

When comparing renewable energy generators, some basic functionality (application, design, location) questions should be answered to help choose your make/model and determine the three important energy specification requirements - input, storage, and output.

- What are your portability requirements or weight limitations? Hand-carried, wheeled unit, carry in pickup truck, …?
- What source of energy generation do you wish to use? Solar, wind, kinetic (bicycle), water, grid, …?

• If solar, where will panels be located? Attached to or separated from generator unit? Mounted?
• What is the voltage of the equipment to be powered? (110V/60Hz, 220V/50Hz, 240V/60Hz, 12VDC,…)
• What is the maximum amperage (or Wattage) of any of the equipment to be powered?
• Is your primary goal **solar backup** or do you want to use the generator as constant additional power?
• Duration/endurance/time is essentially a function of battery capacity, usage, and recharge rate.

A few more basic electricity concepts are helpful in furthering this discussion toward solar generator product comparisons:
• Energy input from photovoltaics (solar PV) can range from tiny 10 W solar-powered calculators to small 60 W foldable solar sheets to larger 200 W stand-alone panels to kilowatt panel arrays.
• Energy storage capacity in a rechargeable battery often ranges from 50 to 400 amp-hrs using lead acid absorbed glass mat technology. Current battery technology is in desperate need of innovative breakthroughs, but for now, the more a battery stores, the more it weighs. Capacity in amp-hrs is multiplied by battery voltage (i.e. 12 VDC) to get battery storage in Watt-hrs.
• Energy output through a DC-to-AC inverter is measured in Watts and may be 200-3500 continuous with short-term surge being about twice that.

In other words, it is important to pay attention to product specifications regarding the rate at which energy is coming in, the amount of energy stored, and the rate at which that energy is being consumed. Budgeting the generator's stored energy is not unlike maintaining a bank account balance or a vehicle's gas tank level. Before choosing a renewable energy generator, researching and filling out a table similar to the one below may be useful.

| | **Inverter, kW cont (surge~x2)** | **Stored Capacity, Whr** | **Solar, W** | **Non-solar option?** | **Expand-able System?** | **Pure sine?** | **220VAC option?** | **Wt, lb** | **Price** | **$/kW** |
|---|---|---|---|---|---|---|---|---|---|---|
| Brand E | 200 | 1200 | 72 | | | | | 82 | 2459. | 2.0 |
| Brand H | 600 | 1260 | 80+ | | | | X | | 3739. | 3.1 |
| Brand X | 1500 | 1200 | 135+ | | | | | | 1600. | 1.3 |
| Brand S | 1500 | 3600* | 135+ | | | avail | | 300 | 3950. | 1.1 |
| Brand M | 1800 | 600 | 90 | X | | | | | 1600. | 2.7 |
| Brand P | 3000 | 12000? | avail | X | | X | X? | | ? | |
| Brand Z | 3000 | 12000? | 700 | X | X | X | | 1750 | ? | |
| SUNRNR | 3500 | 2900 | 135+ | X | X | | X | 260 | 3800. | 1.3 |

*Beware: gel cell + Can add solar panels

Other options, characteristics, specifications to consider:
• Number/amp limit of receptacles. Lower-rated inverters have fewer outlets. Power strips for expansion are acceptable, but the load on any one receptacle must stay under its amp limit and the total load (all used receptacles combined) must stay under continuous/surge limits to avoid automatic shutdown.
• Is 12VDC output available and at what amp limit? Many models have the "cigarette-lighter" socket available, but with a special link cord, a SUNRNR can provide 12VDC at 30 amps.
• Modified sine wave inverters are most common, least expensive, and work perfectly for most equipment. However, certain equipment such as high-end audio/video or water makers may require a pure sine wave option.
• Distance desired between unit and panels (some are combined and inseparable).

Finally, the questions "What will it run?" and "How long?" are best answered with examples:
• Without recharging, a 50 W (average) EnergyStar refrigerator, 44 W ceiling fan (low speed), and 2 "60W" 6 W LED lights (100W total) would run about 5 hours with Brand M, 10+ hours using Brand H, and 20+ hours using a SUNRNR.
• Again, without recharging, a 1200 W chainsaw could run continuously for one hour with Brand X, over two hours using a SUNRNR, and would most likely fault the inverter of Brands E and H.
• One brand above is best known due to their extensive advertising campaign, but when you do the math for daily usage as a **solar backup**, it only offers 350W/day, equivalent to a 60W lightbulb for 6 hours. The table at the end of this article shows a SUNRNR can provide four times that amount.

With sun/recharge available, usage time increases about 10%. These examples deplete the stored energy, so that energy is not available again without recharging. (Another broad rule of thumb is to either plan on having half the power described above so that the other half may be recharging or to have a second unit for use while the first is recharging.) More examples are available on www.sunrnr.com, but it is best to determine your requirements then calculate your own scenarios.

Lastly, "Will it run my house?" The easiest way to calculate your household electrical power consumption is to look at your monthly utility bill. It has all the information to calculate average hourly use either by month or over the past year. In 2008, the average US household consumed 920 kW/month or roughly 1300 W/hr. That means it would take 15 SUNRNR generators to run an average house for one day. Then, based on the depletion/recharge rule above, another 15 would be needed for the next day while the first 15 recovered. Will a SUNRNR run my entire house? Not likely. Can I power a small cabin? Possibly. Can one or more SUNRNRs decrease my grid-usage and be available as **solar backup** during power outages? Absolutely.

Daily/Constant Electrical Load – One SUNRNR, Two Panels, 7 hours moderate sunshine/day

The following demonstrates the constant load that may be drawn from a SUNRNR.
Day Three, Four, Etc would be equivalent to Day Two.
Averaging 58 Watts per hour is equivalent to 1392 Watts per day (5% of average US household usage).
Please notice, this table is based on average hourly usage. Recharging is very dependent on whether more power is used during sunlight which takes away from future stored power or whether more is used from currently stored power when recharge unavailable.
Every additional SUNRNR main unit or power module increases the Watts available for constant use by 100%. Although the units would share duty load through linking, it is similar to having one set recharge while another set is in use.

| | **Day One** | | | **Day Two** | | |
|---|---|---|---|---|---|---|
| | **stored Watts** | **generated Watts** | **used Watts** | **stored Watts** | **generated Watts** | **used Watts** |
| **9 am** | 2000 | 200 | 58 | 1014 | 200 | 58 |
| **10 am** | 2000 | 200 | 58 | 1156 | 200 | 58 |
| **11 am** | 2000 | 200 | 58 | 1298 | 200 | 58 |
| **noon** | 2000 | 200 | 58 | 1440 | 200 | 58 |
| **1 pm** | 2000 | 200 | 58 | 1582 | 200 | 58 |
| **2 pm** | 2000 | 200 | 58 | 1724 | 200 | 58 |
| **3 pm** | 2000 | 200 | 58 | 1866 | 200 | 58 |
| **4 pm** | 2000 | 0 | 58 | 2000 | 0 | 58 |
| **5 pm** | 1942 | 0 | 58 | 1942 | 0 | 58 |
| **6 pm** | 1884 | 0 | 58 | 1884 | 0 | 58 |
| **7 pm** | 1826 | 0 | 58 | 1826 | 0 | 58 |
| **8 pm** | 1768 | 0 | 58 | 1768 | 0 | 58 |
| **9 pm** | 1710 | 0 | 58 | 1710 | 0 | 58 |
| **10 pm** | 1652 | 0 | 58 | 1652 | 0 | 58 |
| **11 pm** | 1594 | 0 | 58 | 1594 | 0 | 58 |
| **midnight** | 1536 | 0 | 58 | 1536 | 0 | 58 |
| **1 am** | 1478 | 0 | 58 | 1478 | 0 | 58 |
| **2 am** | 1420 | 0 | 58 | 1420 | 0 | 58 |
| **3 am** | 1362 | 0 | 58 | 1362 | 0 | 58 |
| **4 am** | 1304 | 0 | 58 | 1304 | 0 | 58 |
| **5 am** | 1246 | 0 | 58 | 1246 | 0 | 58 |
| **6 am** | 1188 | 0 | 58 | 1188 | 0 | 58 |
| **7 am** | 1130 | 0 | 58 | 1130 | 0 | 58 |
| **8 am** | 1072 | 0 | 58 | 1072 | 0 | 58 |
| | | | **1392 W/day** | | | |