# How Emergency Power Systems Work

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## Inside this Article



Emergency Engine

A wide variety of natural disasters can cause long-term power outages. Things like tornadoes, hurricanes, flooding, lightning, ice storms and blizzards can take out the power for hours or days at a time. Even something as simple as a blown transformer or a car running into a utility pole can knock out the electricity in an entire neighborhood for a day or two.

We are all dependent on electricity, so a power outage of more than a few minutes becomes pretty annoying. As the duration of a power failure stretches beyond an hour, there are more severe problems that can cause things to get expensive or dangerous:

- During the winter, a power failure normally disables your home's heating system. As the house cools, (depending on where you live) it can become uninhabitable. In addition, frozen pipes can cause thousands of dollars in damage.
- A power failure means that refrigerators and freezers stop running. In the summer, frozen food melts and can make a real mess. If you have invested in a side of beef, losses can reach $1,000 or more during a multi-day power failure.
- If you have a medical condition that requires special equipment, a power failure can create a life-or-death situation.

- If you live in a rural area with a private well, a power failure cuts off your water supply.

It is now easy to buy an **emergency power system** to avoid all of these problems. In this article, we will look at several options and also discuss different ways to wire them into your home so that you will never have to worry about a power failure again.

# Emergency Power Options and Goals

To generate normal 120-volt power on an emergency basis, you have two options:

- You can buy an engine-powered generator. The engine can burn gasoline, diesel or propane.
- You can buy an inverter and power it from your automobile battery or a deep-cycle battery you have purchased for the inverter.

To decide which alternative is best for you, you need to decide what your goals are during a power failure. There are perhaps four different ways to think about emergency power:

- *I want to provide a very minimal set of creature comforts -- I want to be able to power a few lights so I don't have to burn candles, power my cell phone, power an emergency radio and operate a fan.*
  **You can do this with a small generator or with a small inverter that plugs into your car's lighter socket.**
- *I want to be able to operate a microwave oven, a TV, some lights and my computer so I can eat and get some work done.*
  **You can do this with a small 1000-watt generator and plug things into it with an extension cord.**
- *My main goal is to keep my refrigerator and/or freezer running, but I would also like to run some lights and small appliances.*
  **You can do this with a 2,500- to 3,500-watt generator and plug things into it with extension cords.**
- *I want to be able to power my well pump and water heater, the blower in my furnace, a room air conditioner, my refrigerator and other basic appliances.*
  **You can do this with a 5,000-watt generator that is wired into your home's circuit panel.**

We'll talk more about understanding your power needs in the next section.

# Understanding Your Power Needs

In order to choose the right emergency power source and to size it properly, you need to understand something about the power requirements of the devices you plan to operate.

The basic unit of power measurement is the **watt**, and with an emergency power source there are two wattage ratings that are important: **steady-state wattage** and **surge wattage**. A normal 60-watt incandescent light bulb requires, as you would expect, 60 watts, and it requires that wattage both when you turn it on and while it is running. A ceiling fan motor, on the other hand, might require 150 watts to get it started and 75 watts while it is running. That extra wattage to start the motor is called the **surge** wattage and is typical of anything that contains an electric motor. Here are the usual wattages of some of the devices found in a typical household:

| Device | Typical wattage | Surge Wattage |
|---|---|---|
| Light bulb | 60 watts | 60 watts surge |
| Fan | 75 watts | 150 watts surge |
| Small black/white television | 100 watts | 150 watts surge |
| Color television | 300 watts | 400 watts surge |
| Home computer and monitor | 400 watts | 600 watts surge |
| Electric blanket | 400 watts | 400 watts surge |
| Microwave oven | 750 watts | 1,000 watts surge |
| Furnace fan | 750 watts | 1,500 watts surge |
| Refrigerator | 1,200 watts | 2,400 watts surge |
| Well pump | 2,400 watts | 3,600 watts surge |
| Electric water heater | 4,500 watts | 4,500 watts surge |
| Whole-house A/C or heat pump | 15,000 watts | 30,000 watts surge |

One thing you can see from this chart is that the heat pump or air conditioner for an entire house has a huge appetite for power. If your house has a heat pump and you want to be able to keep the house warm during a power failure in the winter, then you will either need to purchase a very large generator (which costs a whole lot) or you will need a backup heat source, such as wood or propane.

One other thing to note is that if you plan to operate sensitive equipment like TVs and computers from an emergency power supply, you will want to have in place excellent surge protection equipment and, in the case of a computer, an uninterruptible power supply (UPS). When a large device like a refrigerator turns on, there is no way that a small generator will be able to keep power stable during the surge. A UPS will prevent your computer from crashing during the blip.

To calculate your power needs, you need to add up the normal and surge wattage figures for all of the devices you want to operate simultaneously. Here are two examples:

1. If you plan to operate a small TV and two 60-watt light bulbs, then you need an emergency power supply that has a capacity of at least 220 watts and a surge capacity of 270 watts. Rounding up, that's 250 watts continuous and 300 watts surge.
2. If you plan to operate your refrigerator, a color TV and a microwave simultaneously, you need 2,250 watts continuous and 3,800 watts surge in the worst case (if all three happen to turn on at exactly the same moment). If you are willing to manage your power a bit and make sure they do not all turn on at once, then your surge power requirement is only 2,400 watts. If you are willing to operate only one of these devices at a time, then, because your refrigerator is the largest power user, you need to size your emergency power system so it is large enough to handle the refrigerator.

The point made in the second example about **staggering your power consumption** is important. Generators tend to get very expensive as you move above 5,000 watts. For example, an inexpensive 5,000-watt generator might cost you $600. A 10,000-watt generator, on the other hand, will normally cost over $2,000. If you are willing to stagger your usage -- for example, running the refrigerator for an hour and then running the well pump, but never operating them together -- you can get by with a much smaller generator.

# Choosing Between an Inverter and a Generator

An engine-powered **generator** is an easy way to supply your house with emergency power. They are relatively inexpensive (typical price for a 5,000-watt generator ranges between $600 and $1,200), produce clean, 120- or 240-volt sine-wave power, and consume only about a gallon of gas every two hours or so (at 1,000-watt output). You can also purchase generators that run off of diesel fuel or propane.


**A 5,000-watt gasoline-powered generator**
This generator has a 10-horsepower engine and a 5,000-watt generator with a surge rating of 6,500 watts. The gas tank (black, mounted across the top of the frame) holds 7 gallons and runs about 12 hours at 1,000-watt usage levels. This generator produces 120-volt or 240-volt output. It is shown with its grounding cable and the 240-volt cable that plugs it into the house's circuit panel.

The disadvantages of engine-powered generators include:

- **Fuel storage**
- **Noise** (especially the less-expensive models)
- **Engine maintenance**

Fuel storage can be a nuisance -- gasoline cannot be stored for more than a month or so unless you use a fuel stabilizing chemical, and even then the shelf-life is relatively short. You need to rotate your inventory on a regular basis to avoid problems.

Here at the Brain household we have a 5,000-watt generator. We are able to run just about everything in the house -- including the well pump, water heater and refrigerator -- with the generator. The only thing we cannot run is the heat pump, so we have gas logs as a backup heat source. We do stagger our usage, but that is not a big problem for us. For example, we will run the refrigerator for an hour and then turn it off to run the well pump.

An **inverter** is an electrical device that converts 12-volt power into 120-volt power. Typically you run an inverter off of your car's battery or off of a deep-cycle battery that you buy specifically to power the inverter. An inverter is a very easy and inexpensive solution if you can keep your power demands in the 200-watt range. If you are willing to build a more elaborate system, inverters can be a good option up to about 2,500 watts, although they tend to get expensive at that point (a 2,500-watt inverter might cost $600 to $1,000, and then you need to buy a number of deep-cycle batteries and a charging system). Inverters have two main advantages:

- They are silent
- They are maintenance-free (when you operate them from your car's battery -- if you build your own deep-cycle battery bank you will have to maintain the batteries).

Here are some things to think about when considering an inverter:


- You can buy a small 150- or 300-watt quasi-sine-wave inverter for about $50 and plug it into your car's lighter socket. It can operate several light bulbs, a radio, a small TV, etc.
- A car's battery has a **reserve capacity** rating. A typical rating is 80 minutes, which means the battery can supply 25 amps at 12 volts for 80 minutes. If you consume 120 watts continuously, that means that you are draining about 10 amps from your car's battery continuously. A typical car battery can supply power at that level for perhaps three hours. A deep-cycle battery can supply power at that level for six or eight hours. Then you will need to recharge the battery (which takes awhile). However, if you are running two compact fluorescent bulbs at 15 watts each, total consumption is only 30 watts, or 2.5 amps at 12 volts. A car battery can supply power for about 12 hours at that level. A deep-cycle battery can supply power for a day or two at that level.
- A typical car's alternator can supply only about 700 watts maximum. To run an inverter with a capacity greater than 300 watts from a car, you need to connect it directly to the car's battery with cables, and you will need to run the car's engine continuously. At that point, it would be much more efficient to buy a gasoline generator.

From this discussion you can see that an inverter only makes sense for very small power loads over relatively short time frames. You can build a large and elaborate battery system to run your inverter if you choose, but that can get expensive.

(Note that a large battery bank connected to an inverter is an important part of most home-scale solar power systems. Solar panels are used to recharge the batteries in that case. See How Solar Cells Work for details.)

Here at the Brain household we have a 140-watt inverter. We run the generator during the day. At night we use the inverter hooked to the car to power one or two compact fluorescent bulbs that provide light in the house.

# Hooking the Power into Your House

There are two ways for you to get power from the generator into your house:

- You can run extension cords from the generator to specific appliances.
- You can have an electrician wire the generator into your home's circuit panel so that you can switch the entire house over to the generator.

The first option is incredibly easy. If all you need to power is a refrigerator, a TV and a microwave, then this is a good way to go. If you need to power your furnace blower, a well pump and other large power consumers, then buying a 240-volt generator and having an electrician wire it into your circuit panel is the way to go.

To switch over to generator power:

1. I ground the generator.
2. I start the generator and let it stabilize for five minutes.
3. I hook the generator up to the circuit panel.
4. I flip the generator's circuit breaker. (The electrician will install an interlock system so that the panel's main breaker automatically cuts off when the generator's breaker turns on. This prevents the generator's power from travelling outside your home. See Installing a Backup Generator for details on the wiring.)

At that point, everything in the house has power. The challenge then is to make sure that multiple appliances do not compete with each other for available power. To stagger the load, all of the big power consumers (refrigerator, water pump, microwave) have their circuit breakers marked on the panel and I can turn them on and off from there.

**Three points from the previous discussion are especially important**:

1. Have an electrician wire the generator in for you. It will cost $200 to $400 for a simple system.
2. Be sure to ground your generator as described in the owner's manual. You can connect the generator's chassis ground to your home's grounding rod, or buy an 8-foot grounding rod at the hardware store for $12 and install it.
3. Be sure to cut your house off from the power grid before starting your generator. If you don't, you risk electrocuting people working on the lines. In addition, your generator will be trying to power the entire neighborhood, and it obviously cannot do that. By having the electrician install a **positive interlock system**, the house's main breaker automatically cuts off when the generator's breaker turns on.

For more information on emergency power systems and related topics, check out the links on the next page.

http://science.howstuffworks.com/power12.htm