

# Standby for Power

A generator can provide days of emergency power. Here's how to choose the right one.

BY SEAN GROOM

While I was writing this article, a tree branch fell on a power line about a half-mile from my house. The lights, refrigerator, and air conditioner shut off, and my laptop battery quickly gave up. On the plus side, my neighborhood was quiet.

With a permanently installed backup generator, my lights would only have flickered, and the neighborhood would have been a bit louder. Moreover, my family would have had dinner at home, the kids' clothes might have been washed, and my editor would have gotten this article a day earlier.

Of course, things could have been far worse. It could have taken days instead of hours to restore power, and it could have been winter. Thoughts like that cause many homeowners to buy a backup generator, but what kind do they really need?

Generators come in lots of flavors: sleek and quiet Hondas that would fit in a suitcase, brutish-looking wheeled Generacs complete with a hoisting ring for craning around a job site, and permanently installed tractor-size Kohlers that automatically switch on the moment grid-supplied power fails.

These examples represent the three broad categories of generator sizes: small, portable types for running a limited number of items

(up to 3000w); larger, wheeled models capable of running a job site or a house's essential appliances (4000w to 17,500w); and large, permanently installed standby generators that can power a house's essentials or provide whole-house backup (7000w to 100,000w).

### Three emergency-power strategies

Plugging appliances and lights directly into a portable generator is the most basic power-

## POWER IN A PINCH

Small portable generators up to 3000w are emergency generators in the most limited sense of the word. Because they have just two or three outlets, you're limited in what you can power by both connections and output size. You might be able to power your refrigerator, a small space heater, a light, and a laptop. However, in some cases multiple portable generators can be wired in series for greater power. You are limited to 120v outlets, so ranges, dryers, sump pumps, and furnaces can't be connected.

The more expensive generators in this category use an inverter for a nice, clean sine wave and quiet operation, which suits their intended use for tailgating, RV camping, and outdoor events.



**Small and quiet.** Honda's \$2600 EU3000i Handi, just 19 in. tall, 25 in. long, and 78 lb., uses an inverter for clean power output and quiet operation. Even at the rated load of 2600w (maximum 3000w), it's only 65 db.—a bit louder than a conversation. The variable-speed engine stretches the capacity of the 1.56-gal. gas tank by reducing rpm as the load decreases.

backup strategy. The advantage of a portable generator is that you can use it for construction projects and camping. When it's used as a home backup generator, however, drawbacks outnumber benefits. It must be outside and away from windows (i.e., not in the garage). Also, running extension cords through the house (often in bad weather) is inconvenient and potentially dangerous, as is refueling a hot generator every few hours. Also, you're

## HOME POWER FROM A JOB-SITE WORKHORSE



**Low-cost protection.** Briggs & Stratton's Elite Series top-of-the-line portable residential generator (model 030471-0) is a no-frills workhorse at a reasonable price of just \$1200. The 8000w-rated output (10,000w maximum) is enough to power the absolute bare essentials and keep food from spoiling, pipes from freezing, and the sump pump running. The savings, however, come at the expense of features such as a fuel gauge, low-oil shutdown, and automatic idle control, which are found on generators in the company's Pro Series line, aimed at job-site use.

Large portable generators can meet all the electrical needs of small homes, but they are typically used for powering essential circuits. Although the backup protection is not automatic, generators starting in the 5000w to 6000w range are typically equipped with a twist-lock 120v/240v, 30-amp outlet that will connect the generator to a manual transfer switch. This eliminates the need to run extension cords through the house.



**User-friendly controls.** An illuminated control panel on Generac's \$2000 XG 10000E (10,000w rated; 12,500w maximum) helps when setting up or fiddling with the generator at night. A display shows unused capacity, and a fuel gauge on the 9-gal. tank means you won't be caught on empty. There are plenty of connection options: A 120v/240v 50-amp circuit-breaker-protected twist-lock outlet can feed a transfer switch while four covered 120v outlets with GFCI protection and two covered 120v/240v 30-amp outlets offer direct plug-in options.

## YOU'LL NEVER KNOW THE POWER WENT OUT



**Backyard power plant.** Powered by an eight-cylinder GM Vortec engine, Briggs & Stratton's 45kw liquid-cooled generator (\$15,000), with a surge capacity of 56kw, is large enough to replace grid-supplied power in all but the largest houses. Despite its size, it runs at only 65 db. (slightly louder than normal conversation), thanks to its relatively low operating speed of 1800 rpm, full enclosure lined with foam sound-attenuation panels, and an automotive-style muffler.

Paired with an automatic transfer switch, standby generators kick in during a blackout or brownout even if a house is unoccupied. All you'll notice is a flicker in the lights before you're back up and running. The controller also automatically exercises the generator to test the engine and to prevent the oil seals from drying out. These generators range from small 7kw units designed for running only the most essential items to enormous power plants in the 50kw to 100kw range that easily power the largest residence. Engine size and type determine the cost of these generators. Units up to and including 20kw typically rely on air-cooled engines, which are cheaper than liquid-cooled engines. Unlike their portable cousins, standby generators are fueled by natural gas or propane.



**A balance of cost and size.** Kohler's 20kw model 20ES (about \$5000) includes a mounting pad, fuel line, and 200-amp transfer switch, which accepts up to 24 circuits to ensure that all essentials are backed up. Kohler's five-year warranty is one of the longest available, and the company boasts that its systems restore power in less than 10 seconds for minimal disruption.

**Small generator that pulls its weight.** Air-cooled versions of Generac's Guardian Series, from 8kw to 20kw, retail from \$2300 to \$4600, including a transfer switch. Generac's \$3000 10kw model with a Nexus transfer switch can digitally manage two central air conditioners and have the ability to include four additional load-management modules, increasing the effective size of the generator. The controls have an adjustable 10- to 30-second startup delay to avoid nuisance power-ups, and you can program the time of the weekly 12-minute exercise period.



## FIVE WAYS TO MANAGE THE LOAD

To size a generator, you need to know the load of the things you want to power. You can find the power requirements for an appliance on the body of the device, on the nameplate, or on the data tag on the electric motor. If the draw is listed in amps, you can convert to watts with this formula: watts = amps x volts. Most items run on 120v, but dryers, furnaces, and some other appliances run on 240v. Once you know the loads, add them up.

There's a catch, though: You have to account for start-up loads. Electric motors need more energy to start than they do once they are running. For example, a refrigerator might consume 540w when running, but it'll draw 1200w for a few seconds after the compressor has started. You don't typically run all those loads at the same time, so you don't need to meet the total starting load. Instead, you either build in extra capacity for these starting loads, or you manage them by turning off other circuits when large electric motors start. This can be done manu-

ally by switching circuit breakers or with the help of a transfer switch programmed to direct power to some circuits and shunt other circuits based on the total load.

Why not install a larger generator instead of using load-managing transfer switches to keep demand under the generator's output? The answer is cost. For standby generators between 10kw and 20kw, the cost at the margin for each increase of 1000w is relatively small. Once you exceed 20kw, however, generators require a liquid-cooled engine rather than an air-cooled engine. This upgrade—like jumping from a lawn-mower engine to a car engine—doubles or triples the price.

The price listed with each category below is only a starting point. Expect the actual cost to vary greatly depending on the size of the house, the size of the load, and the specific transfer switch used. Also, installation costs are not included and can easily rival the cost of the generator and the transfer switch.

### THE POWER AND PRICE CONTINUUM

5000w

Portable generators

10kw

Standby generators

#### 1 **Lowest cost, least convenience**

Based on the typical load of a 2500-sq.-ft. house, a 5500w or larger portable generator offering 240v electricity and paired with a manual transfer switch can power critical loads. A good rule of thumb is to have one circuit for each kilowatt of generator power (excluding electric heat and AC loads). A 6000w generator with a six-circuit transfer switch could back up a sump pump, a freezer, and a refrigerator, with two or three circuits left for lights and a TV, and possibly another kitchen circuit for a microwave. It's unlikely that all these devices would be on at once, so with care, you could connect additional circuits and power them intermittently by manually turning circuits on and off.

**\$1000**

#### 2 **Automatic essential power**

For the same home in option 1, a permanently installed 10kw generator and 12-circuit subpanel-type automatic transfer switch mean you don't have to connect and start the generator manually, or refuel it during use. The 12 circuits are the only circuits powered, but you'll be able to add a well pump, an electric water heater, and possibly a small (3-ton) air conditioner to the load.

**\$3000**

#### 3 **Doing more with less capacity**

The largest air-cooled generator (20kw) might back up the whole house in the 2500-sq.-ft. scenario as long as the central air-conditioning compressor isn't more than 5 tons and the house doesn't have electric heat. However, even a slightly larger house could have two AC compressors. They might use 7800w running together, but their combined start-up draw would be 22,800w—enough to overload a larger generator. Generac's load-managing Nexus Smart Switch (about \$700) has two dedicated circuits for air conditioners that stagger their starts. This reduces the required size of the generator and saves you from spending two to three times more for a liquid-cooled model to handle the unmanaged start-up load of two AC units. You also can add up to four modules—\$60 devices installed along the circuit's wiring—that will monitor the load and, if necessary, delay and stagger the demands of additional energy hogs like well pumps, sump pumps, and electric ranges.

**\$5000**



## Two switch options

**Manual:** Typically found with larger portable generators, these transfer switches are used to disconnect the service panel manually from the grid and connect it to the generator, often via an exterior inlet. Managing loads becomes easier, and there are no extension cords. However, fueling and capacity for the generator are still a consideration.



**Automatic:** Limited to permanently installed standby generators with dedicated fuel hookups, an automatic transfer switch and controller monitors the house's incoming electricity. If voltage from the grid drops, the generator turns on, and the electrical panel automatically switches over to generator power. This system also monitors the electrical grid and automatically switches back to normal utility power when power is restored.

20kw

50kw



### 4 Prioritizing circuits

Large homes with big but still undersize generators that need to manage the load of more than six appliances can use a load-shedding transfer switch. One example of these expensive switches—Generac's \$1500 Nexus LTS—has 16 circuits for powering priority items. The transfer switch will also power the remaining circuits in the main panel and monitor the frequency (Hz.) of the current, which in North America is supplied at 60 Hz. If current falls below 57 Hz. (typically caused by high start-up loads), the switch will shut off all nonessential circuits to keep the priority items running. After a delay, the non-essential circuits are brought back online.

GE's Symphony II (\$1200) is intended to back up the whole service panel by having you prioritize appliances. When the generator approaches maximum load, it sheds the lowest priority circuits one at a time until there's capacity available to power the highest priority circuit. Once demand falls, lower priority circuits are brought back online.

**\$6000**

### 5 Worry free

Switches for whole-house protection are relatively basic, but they require a generator large enough to handle all the loads in the house, including their respective start-up loads. These service-rated transfer switches (\$600 to \$1000) shift the entire service panel over to generator power. It may still make sense to use a switch with dedicated AC-load management to reduce stress on the generator.

**\$12,000**

limited in the number of items you can run both by the output rating of the generator and by the number of outlets. Finally, small fuel capacity means that you need to have a large quantity of gasoline on hand for anything but the briefest power interruption.

The next step in backup power relies on a larger portable generator—typically a unit on wheels—that energizes the house's circuits through the service panel. This scenario requires a manual transfer switch to disconnect the service panel from the grid and to connect it to the generator, often via a permanently installed exterior inlet. While the generator's output rating still limits the number of circuits you can power, these wheelbarrow-style portable units come in sizes large enough to power an HVAC system, critical appliances, and lights. With the transfer switch, you can manage the load by switching circuits on and off. Of course, you still have fueling issues, and maintenance routines include testing the engine monthly.

For automatic power, you need a pad-mounted, permanently installed outdoor generator. Depending on the output size, a standby system can be configured to power either essential circuits or the entire house.

The key to the system is the automatic transfer switch. A controller monitors the electricity coming into the service panel. If the supply is interrupted or the voltage drops below 60% (known as a "brownout"), the generator's engine starts. After a brief engine warm-up (about 10 seconds), the transfer switch disconnects the service panel from the grid and shifts to generator power. The controller continuously monitors the utility feed, and when grid power is restored to more than 80% voltage, the transfer switch reconnects the panel to the exterior line and shuts down the generator.

Automatic switchover is an obvious advantage, but the other primary advantage is that these generators are plumbed to the natural-gas line, so there are no refueling issues. If your area doesn't have a gas utility, you can convert the engine to run on liquid propane.

To decide what size generator and type of backup system will serve your needs best, walk around your house and envision it during a blackout. What damage would occur if the sump pump didn't work? Would pipes freeze without heat? How much food would

# DIY or don't?

Should you tie your generator into the electrical system yourself, or should you call a professional to do the installation? It depends.

Pad-installed generators and automatic transfer switches are often packaged together and sold by big-box retailers at reasonable prices, with the implication that the owner can install them. But plenty of people who set out to install a transfer switch probably shouldn't. To help you decide if you're ready to tackle this task, the first consideration is the condition of your service panel and the type of transfer switch you want to install.

- Installing a manual interlock is a DIY project if you've got the empty spaces for a generator circuit.



- If you buy a service-rated transfer switch, which installs between the meter and the main panel, it's a job for a pro.
- A prewired subpanel-type switch is fairly simple, and one electrician told me that if you can wire a three-way switch, you can install one of these. But—and this is a big but—there are a lot of ways to get in serious trouble, especially if you can't recognize a multiwire circuit and keep the shared neutral properly balanced. Also, a transfer switch is more difficult to install than a subpanel, where all the circuits are new. With

a subpanel-type transfer switch, you have to pull the existing circuits that you want to back up and then splice the leads from the transfer switch into that slot. If there's not much space in your service panel and/or the wiring inside is a rat's nest and/or the length of the prewired leads isn't quite long enough, you're in for a long, frustrating day. Remember that even though the main breaker is off, there are still two hot feed wires with 240v in the panel.



Manual interlock



Subpanel-type transfer



Service-rated transfer

spoil? Does anyone rely on powered medical equipment? Would your work in a home office be disrupted significantly? Is the house unoccupied for days or weeks at a time?

After that, calculate the load of the electrical devices you plan to power (sidebar pp. 48-49) to determine the generator size. The number of branch circuits you plan to power, the types of appliances you will back up, and your inconvenience threshold determine how you'll connect the generator to the house's electrical system.

## Connecting the generator

Whether they are wheeled generators or permanently installed units or have two-pole or

four-pole alternators, all these models generate electricity the same basic way (see "How It Works," pp. 20-21). Output ratings vary with engine size, but automatic backup and load management are handled by the transfer switch and controller, which is the brains of a home backup-power system.

You need a transfer switch to connect a generator to a home's wiring. The switch, installed between the generator-powered circuits and the meter, is both a convenience and a safety device. Most important, it prevents back-feed—sending electricity from the generator out into the grid. This scenario can injure or kill utility workers trying to restore power to the neighborhood, can

cause a fire, or simply can fry your generator. Transfer switches simplify load management. Instead of plugging and unplugging appliances, you can turn circuits on and off as needed to ensure that the circuits you're using don't exceed the generator's output. Some switches prevent the generator from overloading by automatically opening and closing circuit breakers.

Regardless of whether you manage the load manually or automatically, make sure the transfer switch is rated for the generator's output (sidebar p. 49). □

Sean Groom is a contributing editor. Photos courtesy of the manufacturers.