



**Brooks Solar, Inc.**

*Solar power for People*

solar, wind, micro-hydro renewable energy systems  
design, installation, and service

## Living “Off Grid”

Living “off grid” means you are not connected to a utility company power line, the electrical grid. You must produce your own electrical power to meet your needs. This can be a challenging and rewarding experience!

The average cost of extending power lines is approximately \$30,000 per mile. Check with the nearest utility to determine what your costs might be. Generally speaking, if you are more than 1/2 mile from the utility line, you can install a renewable energy (RE) system to produce your power at less cost than extending the power line.

While you won’t have electric bills with an RE system, there are periodic maintenance costs and costs for alternative fuels such as propane.

### **Conservation:**

First, invest in conservation measures to reduce the amount of energy you need. See our Conservation Checklist ([download link](#)) and implement it’s suggestions aggressively. Reducing your energy needs can greatly reduce the cost of any RE system you install.

### **Space heating and cooling:**

Space heating and cooling account for approximately 50% of annual energy use. Reduce your energy needs for heating and cooling by using **passive solar design** principles. Passive solar design can reduce heating and cooling needs by up to 90%. Further reduce energy needs by “super-insulating” - doubling the insulation levels recommended by building codes. Earth berming, building into a south facing hillside or berming earth up on the north, west, and east sides of structures, further reduces heating and cooling energy needs. We can provide plans review or refer you to certified building designers experienced in passive solar design.

Back up space heating should be accomplished with either wood or propane. It is impractical to heat with an electric furnace, or heat pump, powered by an RE system. They require too much electricity. Back up cooling, if required, should be done with an evaporative cooler (swamp cooler) with an electric fan motor. An air conditioner is too large an electrical load to power with an RE system.

## **Water heating:**

Water heating is the next greatest energy need, approximately 20% of annual energy use. In an off grid home this is usually provided by an on-demand propane water heater, or propane hot water tank. If you are planning to use an on-demand propane water heater, insure it is a model designed to work with solar preheated water. Many on-demand systems will not work correctly with preheated water.

A solar hot water heater can provide the majority of your hot water and significantly reduce propane costs for water heating. For off grid homes, we recommend a closed loop solar hot water collector which circulates a glycol solution (freeze protected) using a separate small solar panel powered circulating pump. The glycol solution is pumped through a heat exchanger attached to a standard hot water tank. This system does not require any power from the household RE system. Solar heating provides most of the hot water, backed up by an on-demand propane water heater or propane hot water tank.

## **Water pumping:**

For an off grid home, pumping water from a well and powering a pressure tank are the next greatest energy loads. Standard well pumps are usually 240 volt AC. Before allowing your well driller to install a standard pump, consider if a DC powered or 120 volt AC pump will do. Inform the well driller that the pump will have to be run with a small generator. This will help him select a pump that will work well with your RE system.

Most RE systems produce DC power, which must be “inverted” to AC power. This conversion results in a 5% to 10% energy loss. A DC powered pump avoids this loss. Most RE systems produce 120 volt AC power and must use a 120/240 transformer or second inverter to power a 240 volt AC well pump. This transformer consumes a small amount of power, but can be switched off when not in use. A second inverter can be costly.

Many water pumps require a very large “surge” of power to start. This can be difficult or impossible to do with some RE systems. Ask you well driller for a “3 wire” pump that has a low starting surge, such as a Grundfos SQ pump.

The ideal situation is to have a DC powered pump that pumps water to a storage tank, which then feeds water to the home by gravity, avoiding the need for an electrically powered pressure tank. Every foot of fall from the tank provides .433 psi of water pressure, so the storage tank should be 50 feet or more above the home to provide reasonable water pressure.

## **Refrigerator/freezer:**

Refrigeration is the next greatest electrical need, 8% of annual energy use. Although many off grid homes use propane powered refrigerator/freezers, common in the RV industry, we recommend highly efficient electric refrigerator/freezers. They use less energy overall, don't rely on a non-renewable fossil fuel, and

are more maintenance free. Super efficient DC models are available, some can be costly. But very efficient brand name AC models are available if you ask for them. They are priced comparably to standard household models.

### **Cooking:**

In an all electric home the cooking range is a large electrical load, 6% of annual energy use. An off grid home should use a propane cooking range/oven. Select a model with a piezo ignitor (which sparks to ignite the flame when you turn the knob), or a pilot light (less desirable because it uses propane constantly - although a small amount), or use matches to start. Do not use models with “glow bars” to ignite the flame. They use large amounts of electricity constantly.

A microwave can be powered easily by an RE system, but choose a small model (900 or 1,000 watt) without a digital clock (which uses energy all the time.) A toaster oven is also useful for small cooking tasks but is a fairly large electrical load.

For the more adventurous, a solar oven can bake or boil foods on sunny days, uses no electricity, and does not add cooking heat to the home in summer. Solar ovens are portable and easily used on any sunny day, summer or winter.

### **Washing and drying clothes:**

Clothes washing and drying accounts for approximately 5% of annual energy use. Shop carefully for an energy efficient and water conserving washing machine (front loaders are usually best.) You’ll not only have to power the washing machine with your RE system, but will likely pump water from a well with the RE system too. How much water the washing machine uses can affect the size of your pump and RE system.

Saving “gray water” (waste water from washing machine, sinks, and shower) to irrigate landscaping will let this water do double duty and reduce the water you’ll need to pump from your well for irrigation. Check with your local Health Department about a gray water system, separate from the “black water” (waste water from toilets) system.

An electric clothes dryer is too large an electrical load for an RE system. Choose a propane heated clothes dryer with an electric tumbler motor. And make best possible use of a “solar clothes dryer” - a good old fashioned clothes line. Retractable clothes lines can be installed under a porch overhang, in a utility room, or in a garage and allow pre-drying clothes in any weather. They retract when not in use to be out of the way. Use your propane clothes dryer to fluff line dried clothes, or to dry clothes in damp weather when necessary.

### **Lighting:**

Home lighting accounts for about 4% of annual energy use. Incorporate natural day lighting in your

passive solar design to avoid the need to use lights during the day. Use skylights (sparingly to avoid excessive energy loss in winter and gain in summer) or “solar tubes” to bring daylight to interior spaces without windows. Use compact fluorescent light bulbs, turn off lights when not needed, and use timers, motion sensors, and photo cells to control indoor and outdoor lights.

### **Other:**

The many other small electrical appliances in a modern home use about 7% of annual energy use. Take a mental stroll through your house and consider all the other energy using devices you have. Eliminate, or reduce the time of use, of as many devices as possible.

Turn off your computer and accessories when they are not being used. A switched surge suppressor outlet strip works well. It is a myth that such equipment can be damaged by turning it off and on frequently.

Turn off appliances when you're not using them.

Eliminate “phantom loads” - such as clocks, cordless phones, “instant on” TVs and stereos, “wall cube” transformers that plug into outlets - all consume power constantly, even when turned “off”! Unplug them or use a switched outlet strip or power cord switch to insure they are disconnected. These loads can needlessly consume your valuable renewable energy if left on when not needed.

Use an appliance power meter, such as a Kill A Watt meter available from Radio Shack, to test your appliances and phantom loads. Know how much energy you are using so you can make informed decisions about your energy use.

### **Producing your own power:**

The first step to designing a renewable energy system is to conduct a Load Evaluation (downloadable form) to determine what appliances you will be using, for how long each day and week, and how much energy they will use. The Load Evaluation is then used to determine the size of the solar array, wind turbine or hydro turbine, battery bank, and inverter to meet your needs.

The most cost effective method of producing renewable energy is with a micro-hydro generator. If you are fortunate enough to have a good stream, a micro-hydro system can produce power for \$.03 to \$.05 per kilowatt hour (kWh.) Even a small system can power a home, because it produces power 24 hour a day, 7 days a week! New intake screens are available to eliminate intake clogging and concerns about impacting aquatic species. Micro-hydro systems are “non-consumptive” - removing water only for a short distance. They do not alter the temperature, oxygen content, pH or other characteristics of the water. We can conduct a site assessment to determine what type and size of micro-hydro system will meet your needs.

Wind power is the next most cost effective renewable energy source (\$.12 to \$.25 per kWh.) You should

have an average annual wind speed of 7 mph or greater, and the wind system tower should be high enough so the bottom of the turbine blades are 30 feet above any obstacle within 500 feet. If “flagging” is present (conifer tree branches permanently bent by the wind) then your site has adequate wind for a wind turbine. If flagging is not present then an inexpensive anemometer is recommended to determine the wind resource at your site before investing in a wind turbine. You can also check [www.windpowermaps.org](http://www.windpowermaps.org) (link) for a mathematical map of the wind potential at your site, but on-site observations are much more important. Tilt up towers make erecting and servicing a wind turbine much easier. Wind turbines are very quiet, and usually cannot be heard above the background sound of the wind in the trees, etc. We can provide a site assessment and install a wind turbine to meet your needs.

Photovoltaic (PV) panels, to produce electricity from the sun, are the most costly form of renewable energy (\$.25 - \$.35 per kWh.) For systems not connected to the electric grid, fixed arrays are recommended for best winter power production at least cost. Tracker mounted arrays, that follow the sun throughout the day, are slightly more expensive but can increase annual array output by 25% to 40%. Building integrated photovoltaic (BIPV) modules are “peel and stick” modules that attach to standard flat pan metal roofing and allow aesthetically pleasing and unobtrusive arrays. We can provide a site assessment and install an appropriate PV system to meet your needs.

Hybrid systems: Often a combination of micro-hydro, wind, and/or PV will provide the most cost effective and reliable power. We design systems to fit your site and your needs.

Backup power: Off grid homes should have a backup generator to provide power during the infrequent times when the RE system cannot meet your needs. The generator can be automatically controlled by the RE system components, providing additional power only when needed.

Power quality: RE systems produce standard alternating current (AC) power, either 120 or 240 volt, just like a utility would provide for a grid connected home. The quality of the power (voltage and frequency range) is often better than many utilities provide, particularly if you’re at the end of a utility power line. Your home can be wired just like a grid connected home, which allows easy connection to the grid later if that becomes economically feasible.

If you have further questions about off grid living, please contact us.