

## The Off-Grid Home

<http://www.backwoodssolar.com/learning-center/off-grid-solar-articles/the-off-grid-home>

Your own independent power system can provide most electric conveniences at a remote home site, where bringing in utility lines would be impossible or prohibitively expensive. Just extending utility power 1/4 mile or more to reach a home site can cost \$15,000 and up, and that's before you get any power. Equipment to produce your own solar electric power may cost less. If power lines are not near your land you can choose clean renewable resources, boats and recreational vehicles can use the same equipment on a smaller scale.

Natural and free energy already on your site in sunlight, wind, or falling water can be converted to electricity. We specialize in power entirely from solar, wind, or micro-hydro, plus generator backup in climates short on sunshine.

We use it! For over 30 years, Backwoods has specialized in off-grid power for the remote home. For years Backwoods Solar was entirely powered by equipment from this website, and currently most Backwoods Solar employees power a home or a portion of their home with our products. At Backwoods Solar you are talking to people who use the equipment every day.

Our catalog introduces beginners to the joy of making your own power. The first 30 pages explain how to do it, what you need, how to prepare a house to use solar electricity, and the approximate cost for several examples. The second section of the catalog contains all of our equipment and prices, with more explanation on each class of product. Towards the back of the catalog, you'll find order blanks and shipping information, followed by instructional books, DVDs & videos.

An Independent natural power system typically produces just 10 to 25% of the electricity consumed by a utility powered American home. That is about 1 to 5 or at most 10 kilowatt hours of electricity on each sunny day.

Rather than major life-style changes, we keep most advantages electricity offers while consuming only a small percentage of the power others use. Here is how: The amount of power your system generates depends on the natural energy resources at your location and on how much equipment you install to gather that energy. How much benefit you receive from that energy depends on careful selection of lights and appliances for maximum energy efficiency and on your conservation habits. That means using special lights, refrigerators, and freezers that use about 1/4 as much power. It means using natural gas or propane for major heat production in cooking, water heating, clothes drying, and home heating. (Try to include passive solar home design and perhaps some wood heat). We install extra switches to cut power off phantom electric loads, that is, things like stereo, TV, garage door openers, and office equipment, all of which consume power even when not turned on. We often wire doorbells, wireless phones, and motion sensor lights to DC power direct from the house battery bank, to use no power when idling. We use motion sensor and timer switches for outdoor lights. We use heating systems that distribute heat without pumps or blowers. Cooling is evaporative instead of air conditioning. We learn how to get the most benefit from the fewest kilowatt-hours. In short:

1. Design the whole house (water, heat, power) for low energy use.
2. Carefully select very special low energy lights and appliances.
3. Eliminate energy waste in appliances, and from human carelessness.

After meeting those three measures, a practical, affordable solar electric system (or wind, or micro-hydro) can provide electricity for a comfortable home.

Prior to moving, just five kilowatt hours per day ran Backwoods Solar's business, shop, and Steve and Elizabeth Willey's home. The business used four computers all day, lights for 4-5 workers, photocopy machine, postage machine, phone, fax, and paging system, business communication radio, and electrical workbench. The home included lights, microwave oven, range hood, juicer, refrigerators,

freezer, TV, satellite, VCR/DVD, stereos, clothes washer, deep well pump, compost toilet fan, built-in whole house vacuum system, fans, electric lawn mower, electric rototiller & electric weed eater, plus a mechanical shop building full of power tools.

#### EFFICIENCY IN YOUR OFF-GRID HOME

Most household appliances and lights use only a little electricity easily supplied by the sun, wind, or micro-hydro. Solar electric homes convert most of their power to 120 volt AC, to use as needed for household appliances and lights. Most common uses are lights, water pump, TV-VCR/DVD-satellite, computer, stereo, vacuum cleaner, kitchen appliances, sewing machine, power tools, and office equipment. Even high wattage appliances like microwave oven, hair drier, toaster, and clothes washer consume little power because their actual running time is short. Water pumps including deep well pumps up to 1/2 horsepower are used. Electric refrigerators and freezers are selected carefully to save energy in a solar home; also gas and small DC powered refrigerators are used.

#### WHAT YOU SHOULD AVOID IN YOUR OFF-GRID HOME

No major electric heating or cooling appliances. Electric heat, electric hot water, electric cook stove, electric heated clothes dryer, and air conditioner account for 80 percent of typical monthly utility bills. It is absolutely NOT practical to operate these major appliances with electricity. These use from twenty to one hundred times the power your TV uses. Other fuels produce heat at much lower cost. Use wood or propane fueled furnaces, propane cook stoves and water heaters; use gas fired clothes dryers (or just a rope in the sun). Build homes with passive solar heat design to save heating fuel for the rest of your life. Later in this section, we give advice on wise selection of major appliances.

Avoid most large refrigerators and freezers. Many refrigerators have poor insulation and run long hours every day. Most still use well over 1.5 kilowatt hours per day, over 450 kilowatt hours a year. Careful shopping can turn up a few models using less power. Special electric refrigerators and freezers designed for solar powered homes use much less, and are shown in this website. These highly insulated units can save at least 50% of the energy consumed by ordinary refrigerators. The added cost of more efficient appliances is less than the added cost of a larger power system to cover the use of inefficient appliances. Propane refrigerators, also in this website, can lower start-up costs.

Air conditioning is too energy intensive to be practical other than a window unit in a very large solar power system. Evaporative cooling - swamp coolers - work well in non-humid areas.

#### STATE OF THE ART ELECTRIC HOMES TODAY

Thirty years ago, independent home power meant designing and building your own equipment. Today, it doesn't have to be a full time hobby, though it still can be fun. Home power system designs and components are standardized. Common problems have been solved by the experience of thousands of solar, wind, or water powered home owners. All the equipment is readily available, from a basic starter setup for lights and TV in a small cabin, to a full AC powered home and business. A good power system may consist of just 3 or 4 integrated components that building inspectors easily approve.

STILL - Independent electrical power is not quite a 'turnkey' appliance like a central heating system with sales and service people knocking at your door. Many independent homes are in remote places, where the owner is the prime decision maker, meter reader, and service person. A practical solar electric system requires some owner participation in planning, management, and maintenance. The owner-builder who understands batteries and equipment will have a better working system, save money, and become more self-reliant.

The main responsibility is managing your batteries, that is, making sure the batteries get fully recharged each week, and rarely discharged below 50 or 60%. This is done by watching the meters and if needed, running the generator to supplement shortfalls due to extended no-sun weather. About once every month or two, one battery cell should be checked with a hydrometer, a glass tube and rubber bulb device with a float, that reads the condition of battery fluid. At the same time, the battery tops should be wiped clean

and dry with a paper towel. Several times a year you check every cell, and add distilled water to the battery cells to maintain the correct fluid level. An extra charge process called equalizing is sometimes required to restore weak battery cells to normal. Batteries have limited life, and need to be replaced every 5 to 15 years (depending on type) no matter how well you care for them.

Solar modules last well over 25 years with little maintenance. Warranty is 20 or 25 years on most modules sold at Backwoods Solar.

Electronic components are also long lived, but like TV sets, can fail unexpectedly, or be damaged by lightning or by incorrect installation. Most carry a 1 or 2 year warranty.

#### HOW MUCH WILL POWER COST?

Because life-styles and power usage vary so widely between individuals, a rural solar electric home can be set up anywhere from \$2,500 to \$53,000. Most often our customers spend between \$6,500 and \$18,000. Cost varies with amount of power needed, and also with the average daily sunshine hours for your location and climate. Northern areas with overcast snowy winters need a lot more solar modules and batteries than homes in New Mexico or Arizona, though both may use the same amount of power. The quantity of power you need relates to the number of people in the house more than to the square footage of the home.

Windmill generators can be used together with solar, to generate power in more varieties of weather. On a site with wind speeds measured and confirmed, wind generation used together with solar can reduce the total cost of the power system.

Micro-Hydro power is the best choice and lowest cost power source for those few sites with the required water resource. If there is a small stream dropping 20 feet or more in elevation across your land, or a larger stream dropping 5 feet, water power may be possible. You might generate all the power you need from a micro-hydro turbine for as little as \$5000 complete, or as much as \$16,000, plus the cost of the pipe line.

Backwoods Solar can help you choose and estimate the cost of the right equipment if you let us know how many people are in the house, something of the life-styles, the appliances, whether there is a home-business activity, and anything else affecting power usage. The above estimates do not include a backup generator which can range from \$3500 to \$10,000 depending on size and quality.

#### WHERE DO I PUT IT?

Batteries, inverter, and electronic controls should be installed in a utility room inside or near the residence. Electronic equipment mounts on 4 to 5 feet of wall within 8 to 10 foot cable length from the batteries. Equipment could be installed on the outside wall of a separate battery closet. Batteries take 2 to 15 square feet of floor space within the cable length from wall mounted equipment, and should be beside, rather than directly in front of wall mounted equipment. Allow ample working room to check batteries, and avoid cramping everything in a tiny closet. Electronic components need the same environment as a computer, TV, or stereo: a place that is clean, and away from moisture condensation.

Batteries should not be accessible to children or others unfamiliar with their hazards. Flooded lead acid batteries emit minimal amounts of flammable, (nonpoisonous) hydrogen and oxygen gas when charging, so should be enclosed in a box vented to outside by plastic pipe. They should stay above freezing but avoid temperatures over 100 degrees F. An outside battery and equipment shed may be used in moderate climates, but avoid putting batteries on a wood floor vibrated by the generator engine. Distance from the power room to generator and to the house AC circuit breaker panel is not critical. A generator should be in its own shed some distance away, to avoid the noise.

Distance from power room to solar module location is limited, as explained in the chapter on mounting

solar modules. Modules are best pole mounted, or can be roof mounted if trees and buildings prevent good sunlight at ground level.