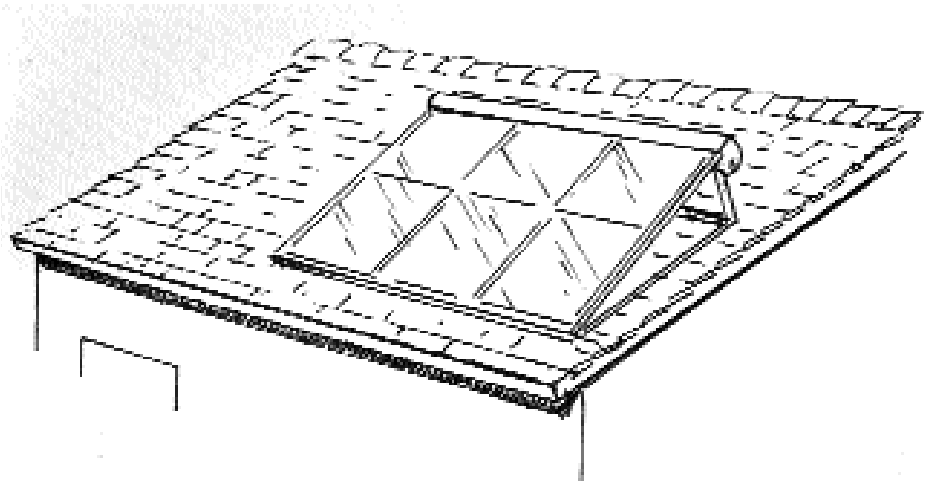
Solar Power—Is It the Answer for Your Electric Needs?

By Steve Willey



"Solar electric power has quietly grown to become an everyday practicality in thousands of homes…"

Home electricity generated by sunlight was a novelty of interest to a few young back-to-land families in 1979, when we put our first three solar electric (photo-volt-aic) modules on our mountain-top home.

The power company wanted $24,000 to bring lines to us, and wind had not worked well for power at this location. The choice was clear for us, This was the start of a hobby and part time home-based business that has grown into a life work promoting solar electric power as a clean and reliable source of home electric power.

Now, 10 years later, independent sources of energy are less in the news, but solar electric power has quietly grown to become an everyday practicality in thousands of homes beyond the reach of power lines. Older folks upgrading a summer cottage without power into a full time comfortable retirement residence, as well as young families building a first home on remote land are finding independent photovoltaic power systems able to meet their electrical needs.

The price is often lower than the cost of extending power lines to a remote building site, and then paying lower bills forever.

Most people have little understanding of where their electricity comes from or where it goes. In power line connected homes, this can result in higher usage and higher bills. Likewise, with your own independent power system, lack of understanding of where the power goes can lead to higher costs, and even prevent it from working properly. This article will give an overview of how we design a typical solar electric power system for the individual home, and help you decide whether to seek your power from the SUN or from your local utility company.

If your interest is to reduce the bill from the power company for your present house, where you have power lines installed already, I do not recommend photovoltaics at today's prices. The careful selection of efficient appliances we will discuss allows our home to function comfortably on less than 20% of the power a typical home uses.

You can do the same without using photovoltaics at all and your electric bill will drop dramatically.

Reducing the Electric Bill

First, switch from electric to wood, gas or thermal solar for **all** major heating, water heating, cooking and clothes drying appliances. The gas and wood substituted will cost less than the electricity you use to heat, and you will see overall savings after the cost of changing over is paid.

Then switch your regular light bulbs to the super-efficient 120 volt AC "PL" type OSRAM brand lighting with electronic ballast in the bulb, and switch to the Sunfrost super-efficient refrigerators and freezers that we use. This would all be a prerequisite to installing a solar electric system to take over a power line connected home.

Once efficient and appropriate electrical usage is attained, your power company bill will drop to about 115 of the present amount, and you will have reached your goal without the expense and responsibility of a solar power installation.

If your interest is security from short term power outages then a battery backup system that is recharged by the power company will cost far less than complete solar power.

The Photovoltaic Answer

If your interest is philosophical or ethical in wanting to remove your support from and dependence on power companies and their nuclear problems, **or**

If your interest is to become totally self-reliant in supplying your own electrical needs for whatever reason, or

If utility power is not available or prohibitively expensive to bring in to your site, solar electric power can provide the answer as it did for us.

For me, photovoltaics is not just a technology, or a way to be independent. It's not just a job and it's not just the answer that powers my home. It also empowers an ethical, non-polluting, non-nuclear way of life, in harmony with the natural resources of the earth and of the individual homesite.

Its available right now, doing it's job every day.

How Solar Power Works

PHOTOVOLTAIC MODULES convert sunlight to DC electricity when sunlight shines on their surface. Modules are constructed of glass and

silicon crystal or sometimes non-crystal cells. There are no moving parts and the cells do not wear out with use. Photovoltaic modules are usually guaranteed for 10 to 12 years by the factory to produce as much power, within a few percent, as the day you bought them. They are expected to last 20 to 30 years, perhaps infinitely, and I take that to mean the rest of my life.

The electricity generated is DC like that in an automobile. Modules can be added at any time to increase the amount of power generated, as needs of the household increase. Less power is generated on days when the sun is not as bright and in winter's shorter days.

MOUNTS for photovoltaic modules are usually aluminum rails that hold the modules facing the noon sun atop a roof or pole, or sometimes on a ground platform. The location must be exposed to direct sun year-round, with no shadows falling on the modules. Tracker mounts are available that aim at the sun's position all day to produce more power. Their benefit is mostly in summer and in southern latitudes.

AN ENGINE DRIVEN GENERATOR, about 4000 watt size, with a fast battery charger is also included in most home power systems, but it is used as little as possible! It is the most costly way to produce power considering the fuel and limited engine lifetime. Nevertheless, a generator will produce extra power on demand in case the sun will not. This is a less costly way to provide for the least sunny month of the year than doubling the number of your solar modules.

Power Storage

BATTERIES store electricity generated by the solar modules and provide power at all times to the home, whether the sun is shining or not. Like a bank account, you cannot take more power from batteries than you deposit into them. Batteries are the only perishable part of the system, with a usual lifetime of 5 to 10 years. This life is greatly shortened by misuse or neglect, such as over charging, depleting the charge too deeply, or failing to recharge promptly. They last longest when kept charged, and rarely discharged over 50%. Batteries today are usually a lead acid type, specially constructed for "deep cycling" which means more frequent use of the stored power than a * car battery would provide. In many cases they look like very large car batteries, with 2 to 14 of them required.

A CHARGE CONTROLLER automatically limits the ' charge to the battery when it becomes fully charged, to prevent damage from overcharging. Some charge controllers stop at that, while others provide an ammeter so you can see how much power is being produced by the solar modules, and a volt meter to read how much charge is in the battery.

This device often also provides easy connectors for wires from your solar modules and wires to the battery. It may also have switches to manually start and stop the battery charging, in addition to its automatic control. When the batteries become fully charged, some charge controllers can automatically divert any additional free solar-generated power to run a fan or pump. Safety fuses for the battery charging circuit are often provided with the controller.

LOW VOLTAGE DISCONNECT is a function built into many charge controllers, or distribution fuse boxes or inverters. This either warns you or cuts off your power if the battery storage becomes depleted enough to cause battery damage.

Power Conditioning and Distribution

Some homes use only DC (for lower cost and simpler lifestyle) and some use only AC power for easier installation and less need for non-standard equipment. We use both together, to minimize costs and have a better operating power system for all, our needs.

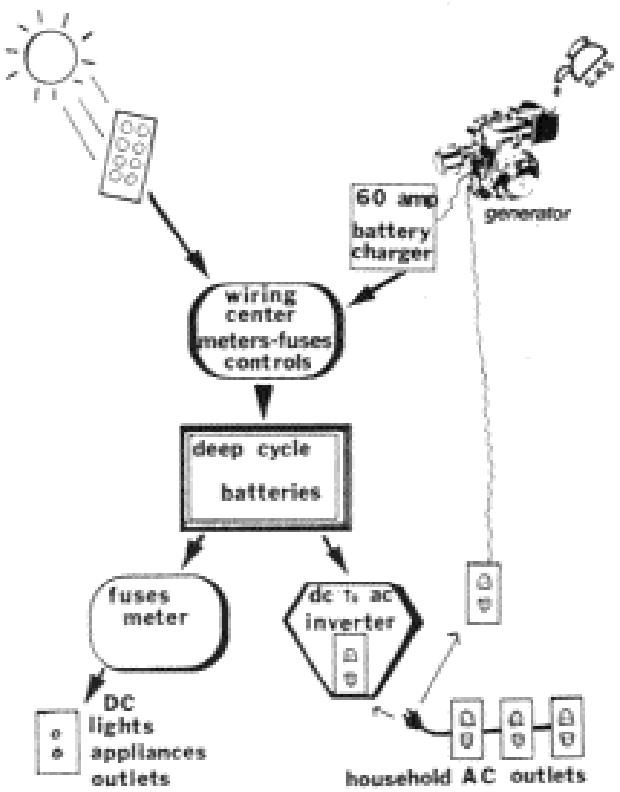


Figure 1. Ingredients of a Home Solar Electric System.

DC POWER can be used directly for some applications like super efficient refrigeration and lighting. Electronics like phone answer machines and automotive accessories like stereo and fans are common uses with DC. Many items designed for DC use less power then their standard counterparts because DC is usually of limited supply in a vehicle or boat with the smaller battery. Such equipment, if adequate to the job, can save you a lot of power and money in your home power system.

Wiring runs for low voltage DC cannot be as long as for higher voltage. Generally 12 gauge Romex standard house wiring is sufficient for efficient lighting and radio or TV up to about 50 feet, if few items operate off each wiring run. Wall switches rated 15 amp AC are fine for lower current (3 or 4 amp) DC lighting applications.

AC POWER can be produced with an **inverter**, many of which are designed just for solar electric homes. Inverters convert battery (DC) power to 120 volt AC power, like the power company's familiar product, which will operate most ordinary home appliances.

Lights, water pump, power tools, stereo, VCR and TV, and most other household appliances are easily operated with the appropriate size inverter in the power system. Inverters are rated by size, and cannot operate appliances or combinations of appliances beyond the rating. This means you might have to operate only one or two large appliances at a time with a 2000 watt inverter, or only small appliances if you select a smaller size. Some "standby option" inverters also act as an automatic battery charger whenever the engine driven generator is started.

With the 22-module solar electric system on our home and business, we have all the light we need, deep well pump, office machines, computer, power tools, and more. A toaster, microwave oven, hair drier, and washing. machine are some of our largest power loads that the inverter operates.

Some appliances that **cannot** be used at all are electric heaters, electric water heat, electric cook stove, or air conditioning, because these use enormous amounts of electric power to make heat. This is no real problem because that heat can easily be produced at less cost with wood, propane, and heat from the sun. Electricity is more appropriate for things like television, vacuum cleaner, or computer, all of which use very little power and cannot use substitute fuels.

Fuse and Breaker Boxes:

It is essential, even in the smallest home power system, that each wire connected to the battery be fused for safety. Separate AC and DC fuse boxes and wiring are essential where both types of power are used.

Quantities of Power—System Size Planning

Complete photovoltaic home power systems generally are priced from $1,500 to $15,000. The costs range so widely because of the wide variety in lifestyle and power needs of the users, and because of variations in amount of local sunshine.

A power system that starts small is easy to expand later to a larger one as the power needs grow. Since the cost of a photovoltaic power system is proportional to the amount of power it can generate, money is saved by installing some special appliances that conserve power rather than paying to generate extra power for wasteful appliances.

How you use the power is just as important as where you get it, and can actually save you more money. Refrigerators and freezers designed for solar electricity need 80% less power, and new types of light bulbs are now available that use 80% less power than standard models. Though these appliances cost a little more, the power system cost is reduced drastically.

Assuming typical usage patterns with appliances picked for efficiency, I offer two examples that will work (See figures 2 and 3). In the desert they will produce more power than described, and in places known for lack of sun they will produce less than described.

TYPICAL CONSERVING SMALL HOME
$2880-6000

Good Start For Later On

This provides efficient lighting, DC TV and stereo, shallow well pumping, small inverter for blender, sewing machine, drill, computer, VCR, etc. The AC generator runs larger appliances like a washer, deep well pumping, vacuum, circular saw, and supplements battery charge at the same time for winter needs.

4 solar modules: 10 amperes, and mounts	**1260**
Batteries: 4 or 6 L-16: 700/2000 amp furs	**580/870**
Charge Control & Meters: Mark III/BCC	**160/280**
Home Power DC Fusebox	**160**
Inverter: 550 Tripplite or Trace 612	**170/494**
Generator: 3-4 KW AC, low or hi quality	**350/2800**

Figure 2. A Small Home Solar System

MORE ACTIVE FAMILY SOLAR HOME
$8520-9320

Most popular design for full time home

Provides power for ample DC refrigerat61and lighting, and AC power for vacuum, washer, microwave, well pumping, color TV, VCR, stereo,! computer, and the smaller appliances usually all on solar power. The generator is used mainly in overcast winters just for washer or well pumping. Can be easily enlarged later.

10 solar modules & mounts: 30 amperes	**3160**
Charge control box	**280**
DC fuse or breaker box	**150**
Batteries: 1750 amp hours, 5 pr L-16	**1400**
Inverter: 2000 watt Trace with charger & fan	**1330**
Generator: slow speed, elect. start, propane	**2200-3000**

Figure 3. A Medium Home Solar System.

Living with Solar Electricity

If you decide to produce your own power, you become your **own** power company. You are the only meter reader and janitor your company has. Fortunately, those are the only job openings at your own power company.

Most of the trial and error experimenting has already been done by the many thousands of people already using solar electricity. Today's fully automatic home power products control the charging of your batteries, and convert the solar power to standard AC household electricity as needed. The engineering is all done for you.

You need only keep the equipment clean and connections tight, and read the meters regularly. The solar modules need to be adjusted about twice a year to face the noon sun. The sun is lower in the sky in winter, and overhead in summer. You simply tilt your solar module mounts upward each spring and downward each fall. Equipment replacement is mostly limited to replacing aging batteries every 6 to 10 years.

Your major responsibility is to make the batteries last as long as possible. This requires monthly inspection, wiping the tops clean, checking water level, and making a note of how charged or discharged they are. They must be kept as fully charged as possible for the longest life, and be completely charged full at least once each month. If you find one dark winter month that you are using more power than you are receiving from the sun, i.e. your battery is lower each time you test it or the low battery alarm is activated, you have three choices: 1) run the generator engine to make up the shortfall, 2) conserve on your power usage until sunnier weather, or 3) add more solar modules.

(Steve Willey owns and operates Backwoods Solar Electric Systems, 8530 Rapid Lightning Creek Road, Sandpoint, ID, 83864.)