

## INFO ON OFF-GRID POWER SYSTEMS

Independent power systems allows people the opportunity to ignore traditional electrical power supply structures and meet their own power needs locally.

In rural regions, where there are no power companies offering electricity, this is often the technology of choice.



**FIVE main components in an OFF-GRID solar electric system:**

### **I. Solar Panels**

Also referred to as PV panels or modules. PV is short for photo-voltaic (“light-powered”). A group of PV panels is called an array. (Windturbines see page 2)

### **II. Mounts**

This is a metal support structure that holds an array of solar panels in a tilted position facing the sun. There are roof mounts, ground mounts and Top of the pole mounts. Some even track the sun.

### **III. Charge Controller**

This is the brain of a solar system, both monitoring and managing the electricity between the PV panels and the batteries.

### **V. Inverter**

An inverter accepts DC solar-battery power on one side and then emits AC power that is necessary to run your appliances like utility power does.

### **IV. Batteries**

Also called a “battery bank,” a group of batteries acts just like a Bank Account. You deposit “Solar energy” is generated during daylight hours and withdrawn throughout day and night.

## **How it Works**

Off-grid solar systems use solar panels, wind or hydro turbines as standalone or in combination to produce DC electricity which is then feed into a battery bank. An inverter then converts the DC power stored in the batteries to AC power - the kind of power found in an on-the-grid home.

Typically, off-grid systems will include a backup engine generator to charge the batteries if they get too low. Such a system can be set up so that the generator starts automatically in a low battery condition to charge them up again.

## **Economics**

Since PV is an income producing asset it can be useful to compare it to other investments you might make. You are adding value to your property. A solar investment is more risk free than most other investments.

## **TWO OF THE MAJOR GENERATING SOURCES.**

### **SUN & WIND**

Solar and wind compliment each other very well, because often it is sunny when it is not windy and vice versa.

Wind generators are modular, so like solar PV panels you can install as many as you need to get the power required. They make a great supplemental power source to PV for charging batteries.

Monitoring the site for his wind potential is a good idea especially if you plan on using wind as your only source of power.

#### **How does Solar work in Winter?**

Solar actually works even better during the coldest parts of winter because there are fewer clouds and higher radiation then. Snow reflection helps also to gain more solar power from your PV panels during winter.

Solar electrical panels or solar collectors mounted on pole or ground mounts instead of roof mounts also have the advantage to tilt them seasonally as the sun sets in winter on the horizon as well as having the possibility to manually clean snow build up in winter if really necessary. Incorporating wind into a solar system, makes systems more independent and is opening a true 24 hour window for power generation.

#### **Comparing solar and wind power sources.**

##### **Wind**

Advantages: 24 hour window. It is often windy when it is not sunny such as during storms and at night. Wind can supplement a solar off - grid power system nicely. Fun to watch.

Disadvantages: Wind turbines are machines with moving parts (mostly only two) and subject to ware, significant stress and damage in high winds. Wind is so variable that there is no certainty of having power when you actually need it.

##### **Solar**

Advantages: More reliable and predictable than wind power. No moving parts. Long 20 – 25 year warranty. (less fun to watch) PV panels are modular which means the system is easy to add onto as your budget allows or power needs increases.

Disadvantages: Seasonal window: Up to a 7 hour's during summer. Approx: 2- 4 hours in winter. Clouds so dense to produce rain or snow will reduce output to near zero (a small percentage of the time).



## The Design Process

### Finding the right size and cost for your power system.

Since solar modules wind generators or hydro turbines can be added any time, sizing is not terribly risky. There is some flexibility because the power you receive varies with the wind speed and sunshine of each year and with the seasonal changes in weather. Your own flexibility in energy usage, will meet your system on the way.

### Your Load

Determine the total electrical load in watt-hours per day.  
List every appliance, how much wattage it draws, how many hours per day it runs, and how many days per week. We can provide a simple worksheet if needed.

This gives a daily average for the week, as some appliances, like a washing machine, may only be used occasionally. You also can start with actual numbers from an current utility bill, and look at what reductions can be made by changing lights, appliances, etc.

It should be noted, that electrical heating applications, namely space and water heating, electric ranges and clothes dryers, due to their high electrical consumption, are not appropriate loads. Alternative energy sources should be used, like gas / wood / grain stoves, supplement solar heating systems etc.

Your load will come out in kWh/month or kWh/day. Whatever you take out during the day - your system must be able to put back in (1KW stands for 1,000watts remember). If some terms used here don't ring a bell please read the **PV Glossary** at the very end.

### Conserve Energy

Conserve! Don't use incandescent light bulbs or older standard refrigerators, freezers and washers.

If you're intimidated by this whole process, don't feel like the Lone Ranger. We can help you to get you started on your way to more independence.

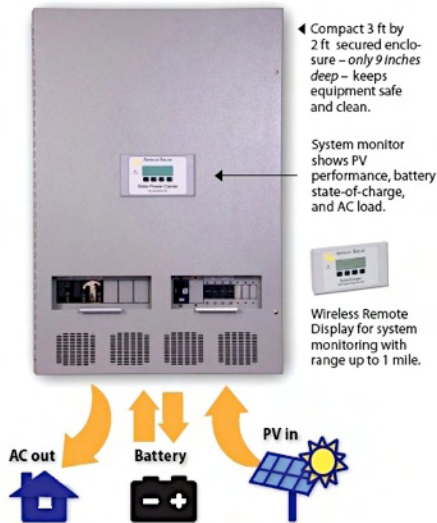
We do need you come up with an estimate of total Household Watt-Hours per Day, which a worksheet will help you do.



As a homeowner you are in the best position to make lifestyle decisions: How late do you stay up at night. Are you running a home business. Is the house empty five days a week. Do you have teenagers who must have 3 showers a day and never turn the PC and other gizmos off while away. Does your pet iguana absolutely require his rock heater 24 hours a day? - etc..

As a business owner you have to ask yourself the same questions - plus how your customers and employes are aware of the fact you are your own power provider. Those are questions we can't answer for you. So figure out your energy usage – and let us know what we're shooting for.

## SIZING THE INVERTER.



A stand alone inverter must be able to power all of the loads that might run at the same time, including any starting surges for pumps and other large motors. When looking at inverter specifications, pay close attention to the time scale for the surge capabilities or ask us. It is often cost effective to oversize the inverter, as incremental costs for similar inverters with larger power capacity are relatively small.

Inverters are sized in watts or kilowatts, with a typical range of 2500 over 4000 to 7200 + watts.

Power board platforms with all matched components including charge control are a good value when compared to separate components - plus you save on installation time (costs). Power boards are a clean and safe way to meet all National electrical codes and pass electrical inspections.

## Sizing generating Tools

Your solar array is sized by dividing the load by the available sunshine. It is realistic for most systems to include a de-rating factor, as the solar panels won't normally be always operating at their peak power point.

Modern small wind generators are designed to work as a stand-alone - or in wind/solar hybrid systems. For most sites a hybrid system using a little of each power source is less expensive and more reliable year-round.

## Sizing the Battery Bank

**This is the heart of your system.** Attention in this area will pay the dividends and cannot be neglected. Without good batteries and a properly sized bank, you may fall prey to the cycle of changing the batteries out every few years, if you already haven't.

In many ways batteries can be best described as "**buckets of electricity**", they may be emptied and refilled and they have a measurable capacity. The capacity of batteries is usually expressed in Amp Hours. In a typical off-grid electrical system the inverter/charger is capable of both emptying and refilling the batteries.

All PV batteries are deep-cycle i.e. designed to be discharged down to 50% or more without damage so that they can supply power over a long period of time (in contrast to a car battery, for example, which is usually only discharged down to 3 to 5 %).

Nearly all batteries used for PV systems are of the lead-acid type. The lifetime of a battery varies depending on factors such as how it is used, how it is maintained and charged, and temperature, but is typically between 5 and 10 years.

Industrial 2 V batteries life expectancy range is at least 15 years. This is being supported by practical experiences in the field since 1969. In fact, real life time tests have shown an average life expectancy of over 22 years.

## Common Questions

### **What kinds of permits are needed for solar or wind systems?**

This varies depending on your locality, whether you are rural or in a city, and what type of system you are proposing. There may be electrical home owner permits, building permits, zoning variances for tower installations, FAA requirements for towers near an airport, neighbourhood or property within city limits.

In a rural setting you might still do what you want without running into any red tape. This too will change over time, but at the moment the freedom of decision is still yours.

### **What kind of maintenance is involved in a PV system?**

Nothing is maintenance-free. PV is as maintenance free as it get's. You do will need to make your chores and check your system regularly to ensure that the wiring and contacts are free from corrosion, modules are clear of debris, and the mounting equipment has tight fasteners.

### **What about cloudy days and night time?**

For off grid homes and buildings, the system requires a battery bank to provide power at night and on days of no sun or wind.

### **\*Back – up Generator.**

Adding a fossil-fuel-powered generator (preferable gas) makes the system complete, and modern inverters with build in transfer switches operate these systems automatically. Adding an engine-generator can also reduce the number of PV modules and batteries in the system. Keep in mind that the storage capability of the battery bank must still be large enough to supply electrical needs during non charging periods.

Real workhorse generators will cost \$10,000 +. Small generators with 3600 RPM engines like common in lawnmowers are widely used for back-up and battery charging, but are not intended to run on a 24/7 basis.

TRUWEST SOLAR can offer you fair prices on workhorse generators like the Kohler Series.

\*If you have on site a power pole you might want to consider using it as a back-up and not disconnect immediately from it. A manual transfer switch would be needed and the monthly service charge from your utility provider would still apply. Your own energy system supplies you, but in case of a shortfall you could always switch over until your system is charging itself up again.

### **How are the warranty and how long does a system last?**

PV panels are generally warranted for 25 years. Wind generator warranties vary between 1 and 5 years depending on the manufacturer. Life expectancy for BOS (balance of system) components, like inverters, are usually 1 to 25 + years. Batteries can last between 1 and 20 years, depending on how well they are cared for and maintained.

This said, a system can last and produce for decades and decades, with some change in batteries and possible maintenance of equipment over the systems life.

### **Can I produce 240 volt power?**

YES! While gas appliances should generally replace big loads like electric hot water heaters and ovens, sometimes 240-volt power is needed for deep wells or special loads. An step up auto transformer can make this voltage or sometimes the pump can be changed to a 110-volt unit. Stacking two 120V inverters makes 240VAC - or you buy an inverter who supplies both voltages.

## **STEP BY STEP.**

If your renewable energy system is to be a success, preparation, planning and proper installation is required.

The first step in any off grid system (and a helpful step in a grid tied system) is - as mentioned before - the load analysis.

This is basically an inventory of all your electrical uses in the home, used to determine what size system you will need. If your budget and the load analysis estimates differ, alterations must be made in one or both.

**All the steps now listed you also can do yourself, or with part or full assistance from us. We encourage homeowners to install under their electrical homeowner permit while this is still possible to save on costs.**

So the next step could be a site visit or survey. For placing a PV array, your best place for your panels will be orientated true south without shadow.

Wind is more difficult to survey, but accurate guesses can be made by observation by the customer, talking to other residents of the area, examining vegetation for “flagging”, looking into available wind data or you can ask for our assistance as we use accurate satellite programs.

After you provided your own information we will produce a system design, based on your energy requirements and the site’s potential. This design includes a list of equipment. There are hundreds of different combinations of equipment to choose from.

We know through experience what works and what doesn’t. We take care of details like inverter/appliance compatibility, and how the battery bank should be configured etc. At this point, you will get a price tag on the system and a quote in your hand.

Purchase of the system comes next. TRUEWEST SOLAR expects payment or a deposit up front for the equipment. Make sure you are comfortable with this set-up. We will then order in the products.

This entire ordering and shipping process can take time, because of actual lead times and availability, or for creating for example a power board for “plug and play” installation – to make it easier for the homeowner to install the system himself - so some patience is needed.

All the proper paperwork product manuals for the components, and other operational guides you may need come with the products.

During installation, TRUEWEST SOLAR explain things that you are curious about. At the electrical inspection there will most likely be no problems if your system is done to electrical specifications.

**TRUEWEST SOLAR** has built its business around these guidelines.

We work closely with customers to ensure that the system will perform as expected.

We provide full before and after service.

## A Profile Of The Successful Own Power Provider

### Responsible.

They are mostly involved in the entire building process from design to finish work.

That doesn't mean that they are out there banging in all the nails but that they know that this is "their own home or business" and that they take the time to try and understand what is going on and put their personal energy into their project.

Knowing how much electricity they will use in their operation is a key design component.



### Patient.

You must be able to take the necessary time to focus on what is important in the design process so your electric system is tailored to your individual needs.

### Adventuresome.

There is a level of enjoyment from satisfaction to excitement in some people in "doing something on your own", achieving independence, satisfaction and in being involved with science and nature on a day to day basis.

### Loves to Learn.

Successful home power producers enjoy learning new things. A curiosity of how things work and a desire to learn how your power system works is very important for them.

### Realistic

The need to know the limitations one has to work with, such as time, budget, support from family members etc.

People with small budgets need to start with small systems and must realize that there will be limits on how much power they can use.



### **Why is energy efficiency so important?**

It is cheaper and more cost effective to improve energy efficiency, than it is to buy enough solar panels or wind generators to power old and inefficient electrical loads.

It is possible, but economically impractical to run electric cook stoves and traditional air conditioning on an off grid solar electric system.

Using gas appliances and new Energy Star appliances will help cut down on the cost of your renewable energy system.

Consider for your hot water needs a **SDHW** (solar domestic hot water system) . A Solar Hot Water can yield 12% to 35% returns on the investment. A solar hot water system typically runs from \$ 4000 to \$7000 installed and provides 60-90% of your annual hot water needs.

**Solar hot water is an extremely cost effective way to reduce your overall energy consumption - see page 10.**

So if you have a plan and looking for a way to gain independence from the grid - or if you just like the idea of doing your part for a cleaner environment, then get a system big enough to meet your needs! We will be glad to help.

### **ENERGY EFFICIENCY.**

The biggest energy users are electric heat, electric hot water, electric stove or oven, car block heaters and electric heated clothes dryer's. Along with air conditioning, these appliances use outrageous amounts of power, thousands of watts every instant they run.

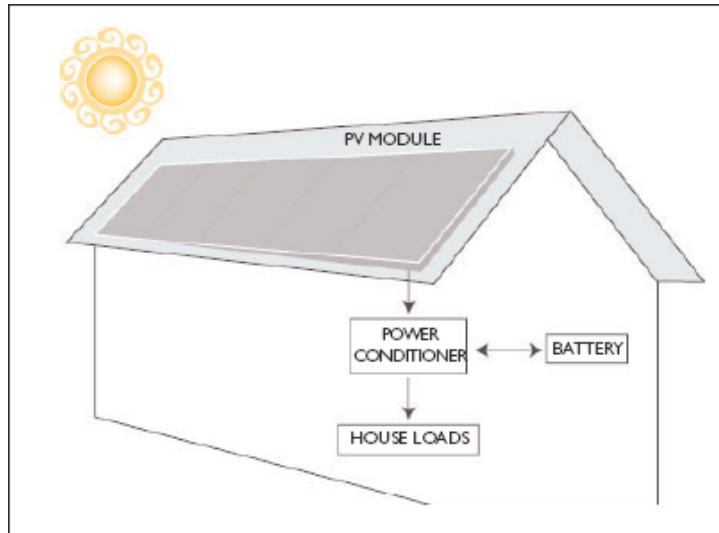
Some appliances consume power 24 hours a day, even when turned off. Televisions, stereos, office equipment, remotes, garage door openers and many other items have been carelessly designed, letting the owner pay the bill.



**Independently powered homes are always designed with those conservation measures in place so that a practical solar electric power system can run your house or operation.**

A Energy saving design is necessary. Rather than sacrificing lifestyle, this means selecting special energy efficient appliances, as well as designing the whole outfit to need less energy.

## OFF-GRID - HOME IN A BOX



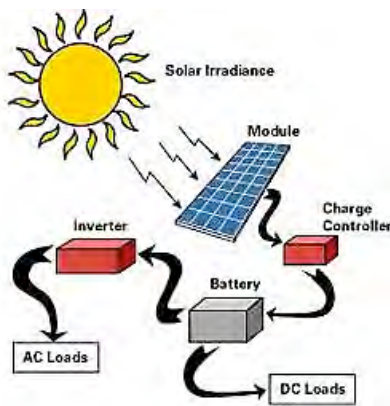
For homes that are off-grid, appliances that use a lot of electricity are usually taken off the PV system or being replaced with gas appliances. House heating usually includes a combination of wood, propane and passive solar housing design, while water heating is often accomplished by using a combination of propane and solar domestic hot water collectors.

While a battery bank can store energy for short periods — typically three to seven days of “autonomous power” — there may be periods of cloudy weather when a back-up source is required. PV-hybrid systems combine a PV system with another power source such as an engine generator (gasoline, diesel or propane) or other renewable energy sources such as a wind or hydro generator.

### Installation.

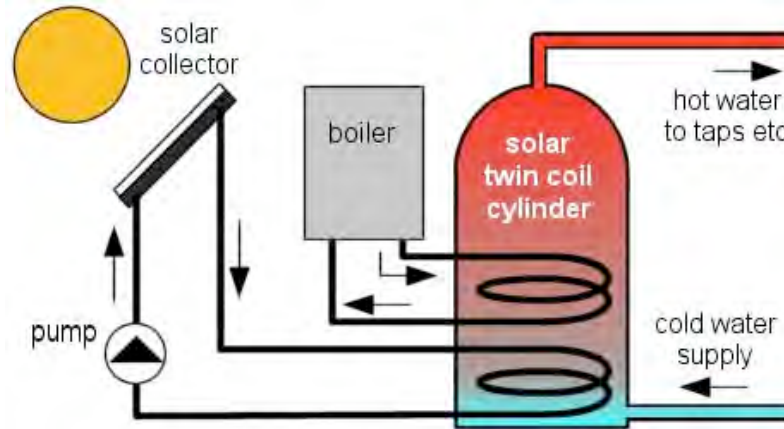
The owner can install the whole system under his electrical home permit. All components come mostly plug and play.

The final connection on the AC side to your house power panel has to be made by a certified electrician.



## Domestic Solar Hot Water Heating

Solar thermal is typically thought to be a more basic form of utilizing the sun's power, as opposed to the electronically more complex systems used in photovoltaic systems. A home or business owner can simply throw some collectors on the roof and before he knows it, he's got a tank of hot water. Run some pipes, and that hot water is in your house and coming out of your faucets and showerhead.



**Economics and Benefits:** Many home builders choose electric water heaters because they are relatively inexpensive to purchase. However, research shows that an average household with an electric or gas water heater spends about 35% - 38% of its home energy costs on heating water.

It makes economic sense to think beyond the initial purchase price and consider lifetime energy costs, or how much you will spend on energy to use the appliance over its lifetime.

The Solar Energy Centre studied the potential savings to homeowners of common water-heating systems compared with electric water heaters. It found that solar water heaters offered the largest potential savings, with solar water-heater owners saving as much as 50% to 85% annually on their utility bills over the cost of electric water heating.

Analysis illustrate that the initial cost of a solar water heater system (\$3,000 to \$7,000) is higher than that of a gas water heater (\$550 to \$1050) or an electric water heater (\$350 to \$950). Depending on the price of fuel sources, the solar water heater will always be more economical over the lifetime of the system than heating water with electricity, fuel oil, propane, or even natural gas because the fuel (sunshine) is free.

Paybacks vary widely, but you can expect a simple payback of 3 to 4 years on a well-designed and properly installed solar water heater. (**Simple payback is the length of time required to recover your investment through reduced or avoided energy costs.**)

After the payback period, you accrue the savings over the life of the system, which ranges from 15 to 40 years, depending on the system and how well the maintenance. If you are building aor refinancing to do a major renovation, the economics are even more attractive.

**Long-Term Benefits:** Solar water heaters offer long-term benefits that go beyond simple economics. In addition to having free hot water after the system has paid for itself in reduced utility bills, you and your family will be cushioned from future fuel shortages and price increases.

**TRUWEST SOLAR** recommends for the do it yourself owner the Skyline system collectors – found at our websites [www.truwest.ca](http://www.truwest.ca) heating section. This system is easy to assemble and works.

## PV Glossary

**Alternating Current (A.C.):** Electric current in which the direction of the flow is reversed at frequent intervals, 100 times per second in Europe (50 cycles per second) and 60 times per second in the USA. Opposite of A.C. is Direct Current (D.C.) - ( like in automobiles).

**Direct Current (D.C.):** Electric current in which electrons are flowing in one direction only. Opposite of Alternating Current (A.C.).

**Balance of systems (BOS):** The parts of the photovoltaic system other than the PV array: switches, controls, meters, power-conditioning equipment, supporting structure for the array and storage components, if any. The cost of land is sometimes included when comparing total system cost with the cost of other energy sources.

**Battery:** For off-grid systems a battery is used to provide energy storage.

**Charge controller:** Charge controllers are typically used in off-grid photovoltaic power systems. The primary function of a charge controller (or regulator) is to maintain the battery at the highest possible State Of Charge (SOC) and provide the user with the required quantity of electricity, while protecting the battery from deep discharge (by the loads) or extended overcharge (by the PV array).

**Demonstration programme:** Projects to demonstrate the operation of photovoltaic and wind power systems and their application to potential users/owners.

**Energy payback time:** The time required for any energy producing system or device to produce as much useful energy as was consumed in its manufacture and construction. For PV the energy payback times is normally 2 to 3 years.

**Inverter:** Device that converts Direct Current (D.C.) into alternating current (A.C.).

**KWh:** Symbol of kilowatt-hour, unit of energy (power expressed in kW multiplied by time expressed in hours). 1 kW/H ( Kilowatt) = 1000 watt

**Watt (Watt):** Unit of power. Symbol is W. 1000 watt = 1 kW/H ( Kilowatt)

**Load:** The amount of electric power being consumed at any given moment. Also, in an electrical circuit, any device or appliance that is using power.

**Open-circuit voltage (Voc):** The voltage across a photovoltaic cell or module in sunlight when no current is flowing; the maximum possible voltage. Unit: V.

**Peak power:** PV modules are rated by their total power output. The peak power is the amount of power output a PV modules produces at Standard Test Conditions (STC) of a module operating temperature of 25 degrees Celsius in full sunshine (irradiance) of 1,000 watts per square meter.

**Note.** This would apply to a clear summer day with sun approximately overhead and the cells faced directly towards the sun. Unit: Watt (W), also written as Wp by professionals in the field.

**Off- grid systems users are:**

Remote properties – no grid access. To bring in power lines can cost \$16 - \$ 30,00.00 a kilometer. An alternative power system gets real popular real quick at those numbers.

People needing reliability. As the grid system ages and blackouts and power outages are increasing, a lot of people losing their sense of humor about being without power - especially in winter.

People who, don't want to depend on the utility companies anymore.

Off grid systems range from \$4,000 to \$100,000 +. The difference is, one household is less demanding in their use of electricity (both in terms of quantity of kilowatt hours and quality of their AC power), than the other and the power system is therefore not as large or elaborate. the majority of our customers spend for complete systems CAD \$ 25, 000 – 60,000.

**At last:**

Do your homework.

If it sounds too good to be true, it probably isn't. There is no such thing as a free lunch.

**TRUEWEST SOLAR** is located at Rosefield near Val Marie in Southwest Saskatchewan and we live on a day to day basis with the products and systems we supply. Information about our operation at Rosefield can be seen on our website [www.truwest.ca](http://www.truwest.ca).

Here we proof - and show to our customers what renewable alternative energy is doing best. Bringing electrical power Anywhere - Anytime.

**Please be prepared to provide the following information at first contact: Your assumed kW/h usage per months, and any unusual power consumers plus your location.**

**Thank You.**

