Introduction

IS RENEWABLE ENERGY FOR YOU?

- Do you have a remote property without power lines nearby?
- Would it cost more than $15,000 to install powerlines?
- Have you been affected by a power outage?
- Are you fearful of the future cost and reliability of power?
- Are you concerned about pollution from power plants?
- Do you seek independence from the utilities?
- Do you want to do your part for the Kyoto Accord?
- Do you wish for more of the comforts of home at the cottage?
- Would you like to be the first on your block with solar power?
- Does it cost you a fortune to heat your pool?
- Do you use a lot of hot water?

If the answer is **YES** to any of these questions, this guide will help you make an informed decision on the specific technologies that will benefit you the most. An alternative energy system will provide clean, reliable power when you need it most.

HOW YOU CAN BENEFIT

- **Is getting utility power to your site a major expense?** No problem! An alternative energy system can often provide more reliable power at a lower cost than utility power.
- **Building a new home?** Install your renewable energy power system first and use it during construction. .
- **Do you use a generator to provide primary power?** An alternative energy system will reduce your use of the generator, save you money, reduce pollution, and provide peace and quiet.
- **Remote water pumping?** We sell the most efficient water pumping equipment available.
- **Are blackouts a problem for you?** A backup power system will provide emergency power for you during a power outage.

"This is a 1500 Watt/24 Volt performance system that includes a high-quality Xantrex DR 1524 inverter, giving 1500 Watts of continuous / 4000 Watts intermittent power."

If you read the last sentence and understood what it meant, you can ignore this section. If your eyes glazed over halfway through, you may require some re-education in electricity. The more you know about how electricity works, the less money you will waste and the more confidence you will have in your system.

THE WATTS AND VOLTS OF ELECTRICITY

Amperage (Amp or "A" for short)

- Like water flowing through a pipe, electricity flows through a wire.
- An Amp is the amount of electricity flowing through a wire - this flow is called AMPERAGE or amps. Also known as current.

Voltage (Volt or "V" for short)

- Like water flowing through the hose pipe, if you lift one end, gravity pushes the water through.
- A Volt is the pressure with which the electricity is pushed through the wire.

Power or Wattage (Watt or "W" for short)

- A Watt is the actual power generated from the amount of electricity flowing through a wire (AMP) x the pressure with which it flows (VOLT).
- "A watt, is a watt, is a watt" as the saying goes.
- Watts = Amps X Volts.

Energy (Wh or kWh)

- Watt hours (Wh) and Kilowatt hours (kWh) are units of energy. Power = Energy / Time
- When people talk about how much energy an appliance consumes they use the unit kWh.
- This unit represents how much power something consumes in one hour of use - for example, if you used a 100-watt light bulb for 10 hours, you would have used 1000 Watt hours = 1 kWh.
- Amp/hour (Ah) is another way of measuring energy - kWh is a more universal measurement as Ah will vary according to the system voltage.

Alternating Current (AC)

- AC electricity is the most common type of electrical power used today.
- Most common household appliances operate on AC.
- AC electricity is typically at a higher voltage, which is easier to transmit longer distances.
- It is called Alternating Current as the current changes directions constantly.

Direct Current (DC)

- DC power can be stored in batteries - AC power cannot.
- DC power is converted to AC by the use of an inverter.
- Many appliances that have a wall cube plug-in unit are operating on DC power.
- DC offers significant benefits for efficiency - DC motors are more efficient than AC motors.
- Many renewable energy systems will have some DC loads.
- Water pumps and refrigeration are commonly DC.
- Solar panels produce DC power.
- Common voltages include 12, 24, 48 Volts.

Off-Grid Electrical System Components

The illustration on the next page outlines the basic components of an off-grid renewable energy system.

A. Wind Generator **Page 37**

A wind generator converts the power of the wind into electrical energy. Your site requires good wind in order for a wind generator to be effective.

Solar Photovoltaic (PV) Panels **Page 29**

Solar panels convert the sun's energy into electrical energy. Power output is directly related to how much sun reaches the panel. Panels should be located in an area with the best sun exposure possible while keeping the module as cool as possible for best performance.

Common mounting options include:

B. Pole Mount

C. Roof or Ground Mount

D. Generator **Page 85**

Most year-round systems include a backup generator. A generator will provide the extra bit of power that may be needed occasionally and will ensure that you are never out of power. Propane or Diesel generators offer the best levels of service for full time systems. Gasoline generators are generally cheaper to buy but more expensive to operate.

E. Inverter / Power Panel **Page 51**

Inverters, along with batteries, are at the heart of your system. DC power stored in batteries is converted into AC power needed for most household appliances. The size of the inverter will determine how many appliances you can run at the same time. Some inverters can automate operation of a generator and have sophisticated computer controlled systems to allow you ultimate control of your system. A power panel will typically include fusing and safety, charge controllers and system monitoring functions.

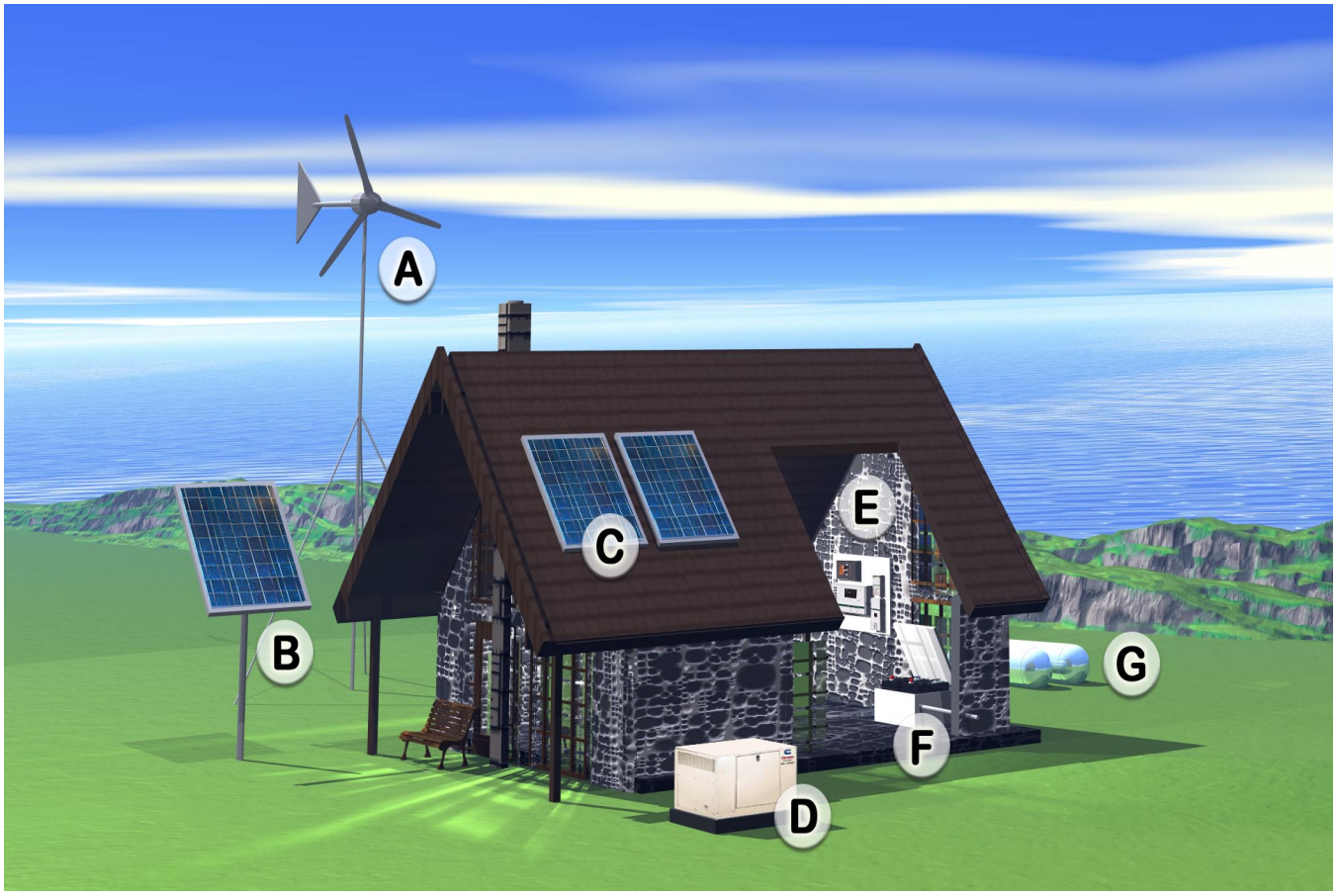
F. Batteries **Page 63**

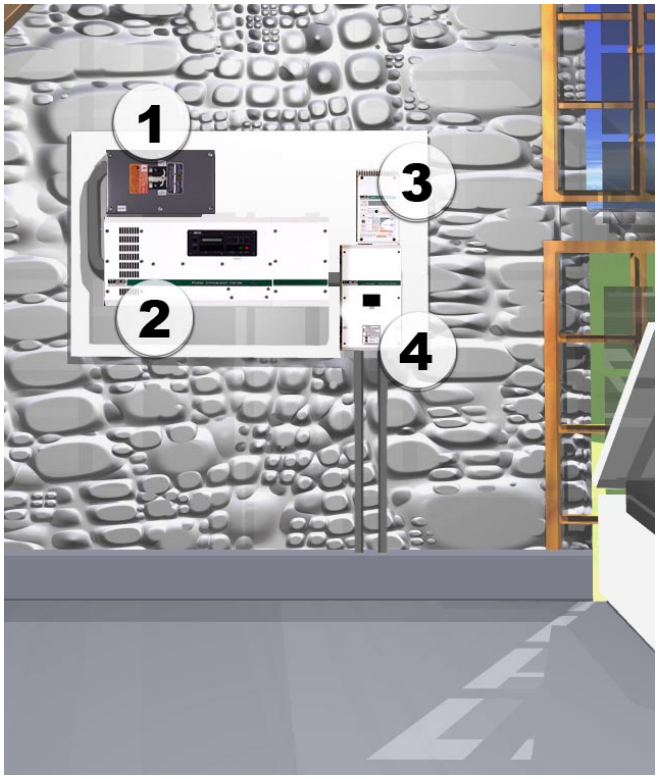
Batteries are used to store electricity. Choosing the right type of battery is crucial when designing a reliable renewable system. A battery bank that is too small will have a short life and provide poor system performance. A battery bank that is too large can make it difficult to maintain a full charge. For safety reasons, batteries must be in a sealed container that is vented to the outside.

G. Fuel

Many off-grid homes make use of propane fuel for heating, cooking and operation of a backup generator. Large tanks are very convenient as the fuel is delivered when needed, freeing you up from carrying fuel back and forth every trip. There is an excellent barge and truck network that serves most locations. Bulk propane is less expensive than when it's purchased in small cylinders.

Off-Grid System Illustration





1. Bypass switch
This allows you to bypass your inverter and run loads from the generator directly.

2. Inverter
Converts DC electricity stored in batteries to AC electricity to run appliances. Many inverters have built-in battery chargers.

3. Controller
Protects your system from overcharge. Some controllers have integrated system monitors.

4. DC Safety Disconnect
Required for code compliance, provides a convenient location for tying together DC wiring.

System Design

TO HELP YOU CHOOSE A SYSTEM, ANSWER THE FOLLOWING QUESTIONS:

1. How much energy do you use in a day (total kWh)?
2. How much energy do you use at once (peak kW)?
3. What resources are available at your site to produce energy?

You can save a lot of money and frustration by sizing your system to suit your energy needs. You could spend too much on a system that is bigger than you need or too little on a system that leaves you short.

POWER CONSUMPTION

The most important factor in designing a power generating system is knowing how much energy will be consumed. It is critical to know where the power is going. A poorly designed system will produce either too little or too much energy. In order to get the best value for your money, it is important to compile accurate information on how the power will be used. This is done with an energy budget.

ENERGY BUDGET

An energy budget is used to assess the electrical loads in a renewable energy system. An energy budget requires that you depart from the traditional concept of unlimited supply of energy. Electricity must be viewed as a finite commodity like flour, firewood, or money. In an energy budget you list of all your electrical appliances and calculate the energy they use.

CONSERVATION FIRST!

Consider this: Conservation is less expensive than generation. For every dollar spent on efficiency you will save five dollars in generation. It is far less expensive to reduce your energy needs first.

The primary method of conserving energy is by using energy efficient appliances. Don't let the sticker price fool you. It is the cost to operate the appliance that really counts. Take the "free fridge" example. An older inefficient fridge consumes many times the amount of electricity of a newer, more efficient unit.

AVOID ELECTRIC HEAT

Appliances such as electric stoves, dryers, heaters and hot water tanks are generally not practical in most renewable energy systems. It is more economical to use other fuel sources (such as propane or firewood) for those needs. If you are lucky enough to have a microhydro resource at your site, electric heat and hot water may be possible.

PHANTOM LOADS

Many people do not realize that many appliances consume electricity even when they are "off" Many electronic products such as stereos, TV's, VCR's, clock radios, computers and items with wall cube transformers draw constant power. Connecting these items to a power bar and turning it off when not needed will help reduce this wasted power. If you are building a new place, have your electrician wire in some switched outlets.

CONSUMPTION - HOW MUCH ENERGY YOU USE

In order to complete an energy budget you will need to know how much power an appliance uses. This is often more difficult than you would think. All appliances are required by law to have a power rating marked on the item, typically near the power cord. In most cases, the number on this nameplate would be the peak power - not the most relevant figure. The most accurate method is to measure it yourself. Please see the meters section on Page 73 for details on products to help you with this.

Most new appliances have an EnerGuide rating on them. This is a relatively good measure of the amount of energy the appliance will typically use. This rating is best used to compare different appliances when purchasing, as they are all tested on a level playing field. The actual energy consumed will depend on your usage of that particular appliance.

CAPACITY- HOW MUCH ENERGY YOU USE AT ONE TIME

Knowing how much power you use at one time will help you determine the inverter capacity that is required. Generally speaking, the more people or appliances, the larger the inverter you will want. With larger capacity inverters, think of them in terms of how many large appliances (such as toaster, vacuum, table saw, water pump) you wish to run at the same time. Do you require extra capacity so the water pump can kick in as required?

AC Appliances

Appliances	Qty	Watts	Hours Day	Days Week	Watt hrs week
RADIO	**1**	**15**	**8**	**5**	**600**
Battery Recharger		20			
Belt Sander 3"		1000			
Blender		325			
Circular Saw 8 1/4"		1600			
Compact Flourescent Light		14			
Computer		60			
Computer Monitor		84			
Colour TV (Tube)		286			
Drill 1/2"		750			
DVD		12			
Hair Dryer		1100			
Jigsaw		300			
Laptop		35			
Microwave Oven		1125			
Power Tool		1350			
Refrigerator/Freezer (16 cu ft)		380			
Satellite TV		40			
Sewing Machine		78			
Toaster Oven		1550			
Vacuum Cleaner		1025			
VCR		35			
Video Game System		45			
Well Pump 1/3 hp		850			

Total AC Watt Hours per Week _____

DC Appliances

Appliances	Qty	Watts	Hours Day	Days Week	Watt hrs week
INVERTER STANDBY	**1**	**5**	**24**	**3**	**360**
Battery Charger		6			
Cell Phone		3			
Halogen		20			
Inverter Standby		5			
Motor		70			
Refrigerator/Freezer (SunFrost)		12			
Radio RX		4			
Radio TX		50			
Stereo		15			
TV 14" Colour		70			
VCR		16			
Water Pump		50			

Total DC Watt Hours per Week _____

Watts = Volts x Amps
Watt hours/Week = Qty x Watts x Hours/Day x Days/Week

Note: Power Consumption is based on average appliance power consumption, actual values may vary.

System Design - Selecting System Voltage

This is one of those “fork in the road” decisions when building your energy system. Changing system voltage later is a costly and disruptive process. Forethought into your system design and future expansion possibilities will save you money in the long run.

Here are some general guidelines for selecting system voltage (there are countless exceptions):

12 Volt systems

- Suited to small systems with limited needs for future expansion.
- Charging sources (solar, wind or microhydro) are within 50’ wire run of the batteries.
- The upper limit on inverter capacity is 3 kW.
- Our entry level systems are mostly 12 Volt.
- The lower the voltage, the higher the amperage. The higher the amperage, the greater the resistance and the more expensive the wire will be to carry that higher amperage.

24 Volt systems

- A 24 Volt inverter will use half the amperage of a 12 Volt inverter of the same size and operates more efficiently.
- One of the most common voltages with lots of room for expansion.
- Single inverters up to around 4 kW are possible in these systems.
- Wire costs are reduced.
- Longer transmission distances are possible.
- More 24 Volt appliances are available than 48 Volt (pumps and fridges are common)

48 Volt systems

- For larger, higher performance systems.
- Single inverters up to 6.0 kW.
- Much longer transmission distances are possible.

Higher Voltages

- For specific projects such as water pumping and grid intertie.
- High voltage systems can economically move power many miles.
- Please contact Energy Alternatives or your local dealer to discuss your application.