Living Off the Grid

Solar, Wind and Renewable Energy Guide

By Les and Jane Oke

Introduction

Our purpose is to take you, the normal grid connected family and transform your life. We will take you from an ordinary urban existence to living off the grid in just a few easy steps. That is our goal.

This text is designed to be read from cover to cover, step by step in order to achieve that goal. You may bookmark later for your own reference, but for now read the whole thing.

Another thing you will notice are a number of text links that appear in blue, just like the preceding one, throughout the book. For those of you not familiar with text links, just by clicking on them, they will take you directly to a web page for you to read. ***You have to be connected to the internet when you are viewing the document for it to work***. The above text link will take you to our own homepage at Off Grid Living.com. Go ahead and try it. Just click on the text link in blue.

Ok, you are back now. These text links will take you to a web page that we personally recommend or that we have dealt with. Only those books, products or services that we own or have used will be recommended. Many other companies have asked us to recommend their inferior products, but we will not. Only books and products that pass our 'Off Grid Living Seal of Approval' will go in this book.

If you are looking for the fastest way to start living off the grid then carefully follow these text links and read all that they say.

Anything is possible living off the grid.

Enjoy,
Les and Jane

OUR JOURNEY TO

Chapter One:
As an introduction to our own journey towards living off the grid we are reprinting here an article that Jane and I wrote for a well known magazine called Mother Earth News (circulation 300,000) in February 2003. This adventure really began at that time. Enjoy

Our Handmade Home
By Les and Jane Oke
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We cut our own lumber and built our off the grid home in 1994.

During the days of skyrocketing interest rates in the late 1980's, my wife, Jane, and I realized that our dream of owning a home was slipping away. For the first eight years of our marriage, we lived in a rented house in Southwestern Ontario, and we just could not save fast enough to buy our own place. We were determined to live Debt Free, so we learned how.

At that time a friend of ours Steve gave us a box filled with old issues of Mother Earth News and Harrowsmith magazines. That box opened up a whole new world for us.

Reading those magazines, we realized other people looked at the world the same way we did.
In 1992, we purchased 20 acres of forested land in Eastern Ontario, about 150 miles away from our original home. The property was plowed in the winter and had school bus service, but it did not have electrical power. We were determined to live without the 'monthly mortgage', as Jane calls it, to the electric company, and stay debt free.

The same friend introduced us to Living the Good Life the classic homesteading book by Helen and Scott Nearing, and we discovered self-sufficiency. We began corresponding with Helen (Scott had died five years earlier) about our move and our worries. In her motherly way, she patiently guided us through our fears. I still have those letters.

Letter from Helen Nearing
Harborside, Maine
August 18, 1993

Dear Friend,

You write and ask how one finds people of similar aims and congeniality. Sometimes one never does. After decades of expressing our opinions on our likes and dislikes there are very few people who agree with us entirely.

With the vegetarians, and hygienists and theosophists we are too radical politically. With our political friends we are too queer with our vegetarian and 'spiritual' ideas. With conservative people we meet socially we are too far to the left in everything. So we go our way alone and maintain our own standards, let the chips fall where they may. You may have to learn to stand alone.

Very best wishes,

Helen Nearing

So we stood alone and on May 5, 1994, we moved to our property, determined to build our home before the first snow. We had saved $5000 for this purpose- we soon learned that much more money would be needed or a new plan.

We lived in a tent trailer that I had bartered for working with a local carpenter. By June, we had the land cleared and the concrete footings and block walls done. We poured footing with the same wheelbarrow my father used to build his own house some 40 years before.

A local contractor put in the septic and well, as well as clearing some more land.

Early June saw us agonizing over the high price of lumber. The next week I was at our chain saw dealer to pick up oil and a new chain when I casually mentioned the price of lumber. Sometimes a casual word dropped to our chain saw dealer friend Dean can result in 2 hours of conversation so I am very careful. But this time he dropped a golden nugget of advice that literally saved our dream of building our home.

He asked, "Have you seen these mill attachments that fit on your chainsaw? You can make your own lumber if you have the trees." Excited, I told him, "I've got 20 acres of trees. Keep talking!" At this point I was certain that last statement would cost me the whole day, but it proved well worth it.

He explained how it worked and I ordered one that day. When it arrived the next week, I set it up and went to work. The mill attachment cost about $250(Canadian dollars), but it literally paid for itself the first day!

Throughout June and July we cut lumber. I'm proud to say that not one piece of store-bought lumber makes up our house frame. We cut studs, 6 x 6 floor joists, 10 x 10 beams – some of them up to 20 feet long, 19 foot roof trusses and 12 inch wide roof boards , all with the chain saw mill. Granted it was smelly, hot and dirty work. But the chainsaw mill proved indispensable to this 'cheap Scotsman' as my wife (and father) called me.

We only cut mature trees, and we used dead and damaged trees whenever possible. Because we cut the lumber right where the trees fell, all the

waste was left to break down and fertilize the forest. In a healthy forest, there is no need to replant; simply let natural regeneration take place.

Building the house turned out to be a slow process. Soon October was closing in on us and we only had the second floor done. A roof was two months' work away. What should we do?

After working for nearly five months without a day off, we took a trip to visit our parents' home in Southern Ontario. While we were there, my dad mentioned a large greenhouse tomato grower who had suffered hail damage to half of his plastic greenhouses. His insurance was replacing all his greenhouses and he lots of 20 x 200 foot rolls of used plastic to give away.

After we visited the site, the owner loaded two rather unwieldy rolls of plastic into our full-sized van. The kids sat on the plastic for the five-hour trip home. The next day we installed two layers of plastic over the second floor as a makeshift roof, said a prayer thanking God for all He had given us, and we moved in. It was September 25, 1994.

Finally, we were warm and happy and we lived in the house like that for three years. During those years we started a market garden business and began selling organic produce just like we had before we moved. That provided most of our income, along with part-time jobs. We built a 60 foot greenhouse with dead cedar we had cut from the property (with the chainsaw mill) in order to enhance our produce business. We covered it with the left over plastic.

From the beginning we experimented with Renewable Energy and we bought our first solar panel just after we moved in to the house.

We spent the off-season cutting roof trusses and roof boards in order to finish the house as soon as we could. March 1997 was unseasonably warm and sunny, so we decided to put the roof on. This was a huge act of faith, as we would have to remove the covering of plastic on the second floor, in order to put up trusses.

The rain could literally pour in any time it wanted. March in Ontario sees its fair share of snow as well. But we didn't worry, we just worked. We all

worked 22 days straight to put the roof on, with the help of our wonderful neighbor's the O'Donnell's who came over nearly every day. At 10:30 on Sunday morning, on the 23rd day we worked, my son Andrew and I pounded down the last shingle nail.

Then it started to rain. Jane and I stood on the hill overlooking the house, holding hands, and holding back the tears. We rejoiced as water dripped off the eaves. We were done.

And we are happy. Anything is possible off grid.

During slow times we work on other projects. In 1998, we built a root cellar from field stone, a wonderful building material. It is free for the taking and looks tremendous when the project is done. It's also a great challenge to master a new art. Believe me, it is an art putting irregular stones together and imagining what they will look like when you are finished. After the root cellar, we tackled building our fireplace.

The fireplace turned out beautiful and is the focal point of our first floor living area. Everyone remarks on how well the fireplace fits in with our timber frame design.

When we are asked why we live the way we do, one event always springs to mind: the ice storm of 1998. Two full days of freezing rain in February put most of Eastern Ontario, southern Quebec and the northeast United States in the dark from downed power lines. It virtually paralyzed the area for over two weeks. In contrast, our children were ready at the school bus stop after the storm ended, but the school was closed for 12 days. We were relatively unaffected.

The hubbub that followed the storm included a gigantic cleanup effort in the affected areas. Our 90 year old neighbor flatly refused to be removed from her home by rescue teams, and moved into an emergency shelter.

She unequivocally told her would-be rescuers, "I've lived more years than I care to remember with just my woodstove, my hand pump and bucket, and my outhouse. It's you people who have the problem." She then promptly went back into her house, closed the door and proceeded to fire the woodstove to make her supper.

Our neighbor really makes us smile – our lifestyle is similar to how she grew up more than 80 years ago. She also smiles when she talks to us because we can relate to each other. Most people just don't get it. (She died last year at the ripe age of 93, still living at home. We are going to miss her)

I know that anyone with a modest amount of energy and perseverance could do what we've done. I owe a great deal of credit to the people who have gone before us and shed light on our journey to self-sufficiency. Special thanks to Helen and Scott Nearing. I hope you are both smiling at our accomplishments, wherever you may be. We hope we can now help others just as you have.

This article was reprinted from my original manuscript and text. 2007
Our journey towards renewable energy usage began in 1993 as well

OUR JOURNEY TO LIVING OFF THE GRID CONTINUED

RENEWABLE ENERGY AND OUR LIFE

Jane I purchased our first piece of renewable energy equipment in 1994- a very small 1.4 watt solar panel. It was purchased at a local department store for about 20$, the panel being sold as a vehicle battery charging system. It was intended that the solar panel be mounted on your dashboard to charge your battery.

We used it in our newly built timber frame home to power a DC car radio. Jane and I hooked it up directly from the tiny solar panel with a battery because we simply could not afford a battery after building the house.

That first winter of 1994 in our new home that little radio would crackle to life at about 9:30 in the morning. That is if the Sun was shining. In light cloud cover it would still work, but heavy clouds would interrupt our radio reception because not enough solar energy was reaching the tiny solar

panel. In the afternoon, as the Sun started to set, the radio would crackle and fade to silence once again.

We lived with this primitive renewable energy system for over two years. Jane and I would take turns hand pumping water from our well into five gallon pails everyday for our household water supply every afternoon. Firewood was brought in for the evening as well at this time. We used kerosene in the beginning for lights (we soon adopted candles because of the toxic kerosene fumes in the house).

In 1996 we purchased a slightly larger 15 watt solar panel and a single deep cycle marine battery. We figured at the time, although wrongly, that this would at least provide us with lights.

We installed a single fluorescent bulb and it would last exactly one hour on a daily charge from our solar panel. The marine deep cycle battery was soon ruined as well. We discovered our cheap department store charge controller we had installed came with defective wiring instructions, ruining our battery by allowing it to charge to fully, and drain down too much.

Back to square one. As a side note, this same company, one of Canada's largest retailers, continues to sell this same charge controller with the same faulty wiring diagram, even though we informed them of the problem (and they acknowledged receiving the advice)

At this point, after lengthy discussions we decided we just didn't know enough about renewable energy. More research was necessary. We read everything we could on solar panels, wind turbines, and possible hydro power for our stream. We started with our goal of energy self-sufficiency and worked backwards to identify the best possible means for achieving that goal.

We didn't want any more false starts or mistakes. It was just too important to us.

What follows in the following chapters is the method we have researched and used (many others too) to go from a totally energy dependent lifestyle to living off the grid completely. Now, realistically we don't expect

everyone to live as we do. You can take this to any level that you wish, from simple backup power when the grid is down; to a grid-tie system selling your excess back to the utility, to living completely off the grid. The choice is up to you. That is the real purpose of this book, to help you make those choices.

You can use this method to discover exactly the right Renewable Energy choices you need to make. Whole subdivisions are being designed to be run off of wind farm energy, or even huge solar installations capable of running small towns are being built. This manual will help you see what the right choice is for you.

Chapter 2:

SITE SELECTION

Buying property vs. staying put- your options, backup power, why off grid? , solar, wind water, Grid-tie – why not? , fund your early retirement, it's your choice.

If you presently live in a home that is connected to the power grid, as most of us do (or did in our case), it is not a simple matter to just snip the wires and start producing your own independent power. No doubt that is why you are reading this book- to find out how you can do just that. With soaring utility cost, what options are available to the homeowner?

Many people wrongly assume that adding a few solar panels and hooking them up will lower their electric bills. Well, not quite.

With present solar panel pricing, producing your very first Kilowatt of power will cost about $3000. Before you fall off your chair, just go take a look at your present utility bill. You will see that you are paying about 10 cents per Kilowatt of power from your electric company.
So why would I want to install solar panels if it is going to cost so much, you are probably thinking?

The answer is complicated, but very simple. Once your solar panels are installed (or wind generator, or other renewable energy choices) you will never have to pay another utility bill! Clearly, renewable energy is a long term approach to solving the problem of high utility costs. It would take a very long time to recoup your investment. Your utility company uses their advantages of huge capital investment, government subsidies, and economies of scale to keep us tied into that utility bill.

In order to break free from their grasp and get our lives back clearly another approach is needed.

The real problem is high energy usage in the home. Take a look around right now at that refrigerator, dryer, and electric range- all very high end users of electricity.

If you decide to stay in your present home and install renewable energy to run it then radical conservation methods and investing in super-efficient appliances would be necessary to run your home. Even a modest scaled independent power system would cost several thousand dollars and your lifestyle would have to undergo drastic changes to make it work.

If lowering your electric bill is your prime concern then implementing conservation measures is a better investment dollar for dollar compared to independent power.

This is a great place to start. Think of it as training for your end goal of running your home with independent power and you will succeed.

We used to make games of conservation in our home when our kids were small. Children are especially good at coming up with creative conservation practices in the home. Get them involved in this process from the start.

CHOOSING BACKUP POWER

Whatever you decide to do at the end of reading this book, one thing is certain a backup power system will inevitably be a great place to start after implementing some simple conservation measures. Since our overworked grid electric system is nearing its maximum power output in most areas, you can expect more frequent blackouts. Start with a backup system you will be glad you did.

DON'T GET LEFT IN THE DARK. HERE'S WHAT YOU NEED TO KNOW ABOUT CHOOSING A BACKUP POWER SYSTEM.

Power failures can be a real pain; at the very least, blackouts disable heating, water supplies and lighting. If the power outage lasts long enough pipes freeze in the winter and you shiver in the dark wearing every piece of clothing you own. If the power goes out in the summer months food in the freezer thaws and spoils very quickly.

As mentioned earlier, one event always reminds our family of the dangers of a power outage - the ice storm of 1998. The damage was so severe that some local residents didn't have power restored for four weeks. The storm left millions of Eastern North American residents in the dark. Our family, in contrast, felt the impact of the storm only slightly. How is that possible? We live off-grid and generate our own power.

Fortunately we heat our home entirely with wood, our batteries were charged from our solar panels and we had 20 gallons of gasoline on hand for our backup generator, just in case. In short, we were ready for a power outage. My old Cub Scout leader was right when he said, 'Be Prepared'. Thanks Dad.

Follow these simple steps and you will be too.

Stand Alone Power systems rely exclusively on solar energy to meet a need for electricity. As mentioned in the preceding, they may incorporate batteries which store energy from the PV modules during the day – for use at night or in periods of low solar radiation.

Alternatively, they may power the application entirely, with no need for batteries such as water pumping. In general, stand alone PV systems are the most cost-effective source of electrical power. You may, however, decide to choose a hybrid PV system because of the environment where it will operate or because you need a system that operates independently and reliably.

Hybrid systems, consist of PV modules and a wind or fuel-fired generator. A hybrid system is a good option for larger systems that need a steady power supply, when there is not enough sun at certain times of the year, or if you want to lower your capital investment in PV modules or want a wind generator too, and storage batteries.

PORTABLE OR PERMANENT STANDBY POWER

First off there are two main types of backup power - portable and permanent standby. Portable generators, gas, propane or diesel, have become quite popular options. Permanent Standby power options include large generators tied into your hydro panel, or renewable energy alternatives such as solar panels, wind and micro hydro power generators.

PORTABLE GENERATORS

If you live in a town or city and are tied to the grid your power supply probably doesn't go off that often, and when it does it's not off that long. If this is the case for you then a small portable generator is probably all you will need to weather the storms. You will need to power a few lights,

refrigerator and furnace and this option would provide enough power for these needs.

Small generators (under 5000 watts) are designed for only occasional usage- less than 50 hours per year, which should be lots for normal operation. They cost less than $1000, some as low as $400. Even a less expensive model will last 10 years, not a bad investment for $40/ year. Or you could choose the option we did in the beginning, and that was to buy the very best backup power generator that we could find. It cost a bit more, but it will run for days on end and it is so quiet.

When buying a small generator the main criteria that divides the lower and a higher priced model is strangely enough, the muffler and the inverter. Higher priced models run much quieter.

When we bought our Honda EU 3000 the salesman actually started it up in the showroom and let it run while we carried on a conversation right beside it! Try that with your Box store specials.

Quiet is important to us so we bought it. A terrific inverter and the Honda reputation sold us as well.

Another viable option exists as well, while not a portable generator; it does provide nearly all of the options that a generator will. The so- called Power
Box will provide enough power to run most appliances during a short power outage.

If your normal power outage lasts only a couple of hours, this is a good option. We wouldn't want to depend entirely on this option but it should see you through most situations.

All a Power Box consists of is a battery, inverter and charge controller all rolled into a neat portable package. They come in sizes of 300 to 1200 watts depending on your expected usage and cost from 150$ to $400. They are quiet, easy to use and charge from either DC or regular AC current making them very versatile.

STANDBY POWER GENERATION

You should realize also, that your need for backup power increases substantially if you live in a rural setting. Rural residents know that the power goes off more often and for longer periods of time. There is also the added need to pump water from your well. All of this boils down to the need for a larger more durable system.

This can mean simply a large diesel generator hooked into your electrical system with a transfer switch that automatically turns on the generator when the power goes off, or a renewable energy system with small generator backup. Our family has chosen the latter option for various reasons. In fact, this article was produced on a computer run entirely from renewable energy- solar panels.

Our friend Mike Sheppard, who recently bought a hunting lodge that is 18 miles from the nearest power line, runs his lodge entirely from a large (25 Kw) diesel generator. He is quite a handy guy and feels comfortable with his choice. For the future he is seriously considering the solar option though.

WHY RENEWABLE ENERGY?

As I mentioned our family has chosen to live with Renewable Energy for many reasons. Energy produced from solar, wind and micro hydro is clean, nearly noise-free and produces no noxious fumes.

I cringe when I hear phrases like ‘Green Power’ or ‘Environmentally Friendly’, because they are so overused. The truth is renewable energy goes a long ways past ‘reduce, reuse, recycle’.

It is in fact a socially responsible lifestyle choice. If we are going to keep our beautiful forests, lakes and rivers clean and alive we have to take personal responsibility for our fuel choices. The choices we make today will ultimately determine if our World will remain the beautiful place that God intended it to be.

Our family has taken personal responsibility for our fuel choices, and you can start today. Just keep reading.

A SIMPLE EMERGENCY BACKUP POWER SYSTEM

When Jane and I first began using renewable energy in our home the small equipment we could afford was mostly designed for vehicle battery charging, not household daily usage. A small solar panel was usually wired into a vehicle electrical system to provide a trickle charge to the battery when the vehicle was not in use. Years ago, small inverters that would run regular household electrical equipment such as a TV or Computer were becoming popular for in-vehicle usage.

We wondered; why not apply this technology to our home? It was fairly inexpensive. Just think, you might have nearly everything you need right on hand when the power goes out next time. That newer vehicle sitting in your laneway is equipped with the latest pollution control devices and will quietly idle away for hours in your driveway.

It is a very simple matter to hook up one of those small DC inverters mentioned earlier to your vehicle and run an extension cord to your home.

In an emergency situation you could power lights or run your freezer for an hour to keep your food frozen.

Now, we don't recommend extended usage of your vehicle in this way, but it should see you through a tight spot.

Here in Ontario vehicles must meet strict emission tests every two years so we are quite certain that less pollution is produced this way when compared to a gasoline generator without emission controls, which would be most people's choice of solution in this situation.

GRID- TIE SOLAR OR WIND

Selling electricity back to the power company has become very popular. But with the cost of your initial equipment to set up your renewable energy system is it really worth it?

We don't recommend this option unless some very serious safety considerations are met and you use a licensed renewable energy installer. You will find out why in the following pages.

Grid Tie Solar or Grid Interconnected as some people know it as, has become very popular lately. The reason is simple- homeowners are quickly sold on the idea of seeing their electric meter run backwards and receiving regular checks in the mail from the utility company.

There is a major benefit to the homeowner that is tied to the grid, in that you can both purchase power from the utility company when your power demand is high and sell power back to them when a surplus of power is produced with your system. This has the effect of reducing or eliminating the need for costly batteries in your renewable energy system.

Many systems use only a simple inverter setup with no batteries used at all. The power utility itself serves as the battery in this case. Effectively the power utility acts as your battery backup.

Since batteries make up a large part of the cost of any alternative energy system, costs are kept down by using the power grid in this way.

There are concerns that should be addressed before this option is chosen though. First of all, such a system carries a large and potentially dangerous current into the home. A grid-tie setup can only be installed by a qualified electrical contractor for this reason. So, the do it yourself option is out.

We visited a professionally installed grid-tie system when it was just being finished up this past summer, here is what we saw.

GRID TIE IN TORONTO

When Professional Renewable Energy Installer Vern Sherwood first told us that he was installing more grid tie solar systems than any other type of renewable energy system we had to wonder why?

So when he called and told us that he was just finishing up a solar grid tie inverter installation right in the shadow of the CN Tower in downtown Toronto, Ontario we jumped at the chance to have a look.

It was a beautiful early summer day in the city when we arrived just as Vern and his competent staff was finishing up testing the system. We met with the owner of the house, Nick Thierry, who happened to be in the publishing business as well, to discuss why he chose a grid tie solar system for his beautiful home.
In Nick's own words, "Solar Grid tie is the way I wanted to go. I've never minded being the first one on my block to try something new." explained Mr. Thierry.

For the present he decided to install a grid tie solar system in his home. He plans on purchasing many high efficiency appliances and looks forward to having his hydro meter run backwards when the sun is shining full.

He hired Vern Sherwood (a local dealer) to install the system, and had originally called him a couple months before. The actual installation, a 3KW solar grid tie system with inverter took about 8 days to install, but it took many weeks waiting for the local electrical inspector to finalize his inspection.

At the time of writing this article Nick had just got his grid tie solar installation up and running.

Vern's staff includes many very talented people including a licensed Electrician that he regularly works with on larger projects such as this grid tie system.

He also has a varied and colorful staff of regulars who don't mind being 6 levels up on the scaffold. I have worked many years in the construction field and I can tell you for certain that you really start watching where you put your feet when you are 3 levels high (about 15 feet off the ground).

These guys looked as if they were born up there, could dance a jig, and still lift the sometimes unwieldy solar panels into the array without even breaking a sweat. In a word, these guys were professionals. Nick's grid tie solar installation looked great.

LET'S TAKE A CLOSER LOOK

At Nick Thierry's the solar panels that were installed had a power generating capacity of just over three kilowatts. The electrical contractor estimated on average about 15 kilowatt hours of power produced every day (rather optimistic by our calculations).

If we assume a regular 30 day month that would equal 450 kilowatt hours of power produced by the system in one month.

In the province of Ontario that would add up to a whopping $42 of savings on Mr. Thierry's usual $280 electrical bill.

Mr. Thierry was quite clear at this point that he had other reasons besides economics for installing the system. He liked being first in the neighborhood, and he wanted to make a contribution to green living- even if it didn't quite cover all of his costs. It was definitely a step in the right direction.

It soon becomes clear that power production by your renewable energy system is best used in the household, and not sold back to the low paying market of the power utility. Now, many people disagree with us on this point, but as you will soon discover another option holds much more promise for the average family today.

The homeowner in the above example spent over $30,000 to install a renewable energy system that would return him exactly $42 a month. Surely we can find a better way to invest our money?

ANYTHING IS POSSIBLE LIVING OFF- THE- GRID

When we first made our decision to move we checked every possible angle. Finally we asked ourselves, wouldn't it make more sense to purchase a scenic rural property for considerably less money than we would pay in town?

One step further and we asked, couldn't a remote homesite be purchased for a fraction of the cost of property where there are power lines out front?

As an example, our family paid a mere $12,000 for 20 acres of land in 1993. It was estimated by the power utility that it would cost over $17,000 just to run power lines to our new home site. As you know, we already had found out that the road was plowed and maintained in winter, and there was school bus service.

What if we used that $17,000 instead to install a renewable energy system- solar, wind, hydro turbine, or a combination of all three?

We would never have to pay another utility bill, or see those unsightly wires and poles dotting the landscape. Best of all, there are never any power outages when you are living off the grid.

Since we are not paying out that $200 per month in utility bills, we can use that money to make our life better. In our own situation we chose to install satellite internet and satellite TV. Little things, but living off the grid is sure enhanced when you have high speed, and all of the Hockey Playoffs (Canadian eh) to watch.

In Nick Thierry's case, if he had been so inclined, he could have sold his downtown home, moved to the country and installed the grandest renewable energy system in the province. It's all about what you ultimately decide is important.

WHAT WOULD YOU BE MISSING ?

Is there anything that is missing from our lives because we chose to live in a rural setting off the grid? The answer today, is an unequivocal No. Not a thing. When we first moved, however we did without a lot, in order to have more today and for the future.

Technology has definitely caught up with the average family wanting to work from home as well. Toss the commute, and work out of your own home. Jane and I chose to start doing writing from home and eventually developed a very interesting and challenging business writing for different magazines and websites, including our own.

Jane chose to take photos for the internet and magazines. She has had her photos published in many varied and prestigious places, receiving a steady income from her work.

You would be using clean renewable energy to fuel your dreams, just as Jane and I are and riding this technological wave that has allowed you to work at home.

FINDING YOUR NEW HOME

The hard part (you knew there was a catch didn't you) is finding that remote homesite or country acreage. Your first objective should be to decide exactly what you want in a piece of property and stick to it.

We had some rather strict criterion to meet that we will share with you to help you come up with your own property search questions.

We wanted to look for a good price, water availability, and wind potential, solar potential, over 10 acres, school access reasonable and within an hour of a major shopping center.

Our own search for that perfect property began in 1992. At that time our oldest son was just beginning school. So, with this in mind, our own search for a property had to include a good school for our kids to attend that wasn't very far from our future homesite.

Now, within walking distance just wasn't practical so we would settle for a short drive to the school. With busy extra-curricular activities and later teenage social lives revolving around the local rural school we were glad we included this criterion in our decision.

Jane and I decided that we would want to be within a 5 mile drive of the school- it turned out that we were able to find a suitable property within 2 miles of the school. That turned out to be a mere five minute bus rides coming and going to school most days for our kids.

One of the other main considerations was the size and price of property we wanted. This was our first property purchase so we didn't have a lot of money to spend. If you already own a home and are contemplating an off grid move then many more options open up.

In recent years there has been a real and substantial exodus of people out of the cities toward rural areas. Baby boomers in particular are cashing out

their high dollar city homes and investing in rural property where there money goes quite a bit further.

In a rural setting you can have more land, more trees and basically the same house in the city with a substantial pile of money left over. In some cases a lot more money than you would have ever believed. There would be money to start that home business, speed up the retirement process or any other worthwhile cause.

As an added twist with a whole assortment of other benefits you could, as many are doing, set up this dream home in a remote place and install your own renewable energy system.

You would never again have another utility bill and you would be doing your part for the environment. It is a commitment that you will never regret having made- renewable energy is the choice of the future, and it's available today.

YOUR LITTLE PIECE OF HEAVEN

As mentioned earlier, this was our first property purchase. We had always wanted a woodlot and a bit of acreage, but how big? With a bit of research we discovered that a 10 acre woodlot would provide all of the firewood to heat our home for our lifetime and beyond. It would also provide some logs for building that we would need. Perhaps this size acreage would not provide all of our building material, but most of it. So we set 10 acres as our minimum size.

We also wanted to be close to the school and within an hour's drive of the nearest shopping center.

It took us more time than we expected, about two months. But we did find our little piece of heaven. Within months of our search beginning we started clearing land, planning our home, getting permits together and most importantly becoming completely debt free.

Chapter 3:

DEBT FREE LIVING

Living in a rural setting where income earning potential is severely limited it is imperative that you are out of debt before beginning this transition. If no debt payments have to be met then the small scale or home based business you have always dreamed of can be a reality. It may seem strange that we would want to include a section in this book on debt free living, but it is absolutely essential. Take the time to become debt free and the joy will instantly return to your life.

HELP ME GET OUT OF DEBT, LES!

I just received an email this week with this heading. It was from a friend of mine, whom I have known for years. He is a very smart guy, successful, married, 2 grown kids, one in college- but he was almost begging me for some help with his own mountain of debt. I dug up the information I had on how Jane and I got out of debt and sent it to him.

Then it occurred to me that there are probably a whole lot more people out there in the same sinking ship. I did a bit of research. As a writer I was trained to research different subjects and report on them. The numbers I found were staggering- consumer debt in the billions, the average household has $7000 of debt, not including their home. I couldn't believe it.

So I set out some time this week to try and help.

It may seem strange that a guy with a website called Off Grid Living would want to put ‘Help Me Get Out of Debt' in this book. But I assure you that it is important.

Living Off the Grid means many things to Jane and I, but first off it means we are not slaving to pay for utilities or anything else at a job we hate.

I know there are certain things you just can't avoid paying for in cash-taxes, and taxes and well you know. But, not surprisingly enough it is consumer debt that keeps us tied to utility bills and the good life full of products we don't really need or even really want. Get rid of the debt and we can soon eliminate other bothersome expenses that rob us of the joy in our lives.

Our own Off Grid adventure started with us getting out of debt. We wanted our adventure in this life to be free from any strings. We wanted to be free. And freedom starts by being debt free.

There are no words to describe the feeling of knowing you don't owe one cent to anyone in this World. You are finally free. Real freedom starts with a choice, the choice to get out of debt and stay out of debt. Here is how you do it!

Debt creeps up slowly on us until finally it controls our lives. Jane and I know, we have been there! You don't notice it at first, but soon you find yourself living in a paycheck to paycheck world. What you make one month is gone before you have any time to add it to your savings account… The burden is immense.

Trying to create a debt free lifestyle can be a real challenge. It has taken Jane and I nearly 20 years to come up with our own formula. We have finally achieved a debt free lifestyle, and we are sure that you can too.

Creating a debt free lifestyle is the goal of many North Americans today. Debt has become a part of everyday life; some would say an inescapable part of our daily lives. But it doesn’t have to be that way.

Needs and Wants for your debt free lifestyle

You have to be honest at this point and ask yourself some hard questions about living a debt free lifestyle. Do you honestly want to be out of debt? Or are you addicted to new cars, a better home every 5 years and every imaginable convenience in that home?

When Jane and I were first married we had the good fortune to read a book by Helen and Scott Nearing that shaped the way we viewed debt. They had a plan for getting out of and staying out of debt. The first issue they dealt with was that everything they needed would be paid for with cash- no credit. Good lesson, and for the most part we listened.

Next, they purchased only those items that they really needed, and only after careful shopping revealed the best price. A debt free lifestyle is not easy to achieve.

The Wage Slave economy and your debt free lifestyle

Scott Nearing, a former economist, also was dead set against what he called the 'wage slave' economy, that kept people tied to the city and for the most part debt. Jane and I found this out the hard way over many years.

It all boiled down to needs and wants though. Did we really need that brand new car? Or did we just want it? The answer revealed a lot to us. We didn't need it, but we bought it anyways. It was a dumb move. Five years of $321 a month payments and we vowed that never again would we borrow money.

It tied us to a job (wage slave!) for years. And it hurt our life. Our debt free lifestyle became our biggest priority at that time.

A simpler life spent living a debt free lifestyle

A debt free lifestyle in the year 2007 and beyond calls for attention to details, but mostly it calls for reducing your wants and living a simpler life. What price would you put on fresh vegetables grown in your own organic garden picked on a Tuesday afternoon in August, when the rest of the world is at the office? Freedom is a great thing to have. Being free to come and go as you please knowing that you don't owe one cent to anyone on the planet is a great feeling. But it comes at a price. Your debt free lifestyle will come at a price.

The price you pay for a debt free lifestyle
You are probably thinking of some massive price tag, or years spent saving money to achieve a debt free lifestyle. Nothing could be further from the truth. The real question is what can you live without?

That place in the country will be cheaper, but you can't just walk to the corner store to rent a movie, or buy a bag of milk. You can have 20 acres for the price of a city lot if you want it though.

And all of that space leads to many possibilities. Grow a garden to feed yourself, keep some chickens for meat or eggs or both. There is also time for hunting and fishing to provide for your family.

The simpler life is not for everyone. In many ways it could be though. If we all slowed down and made time for the things that we really feel are important, instead of just doing them on the weekend, the world would be a much better place.

Noise and strife would be replaced with contentment and a purpose for your life. Cherish that debt free lifestyle as it is the key to ongoing happiness.

IS LIVING DEBT FREE POSSIBLE?

The answer thankfully is a resounding YES. Of course it starts with some rather drastic lifestyle changes. Of course you are used to drastic change by now- you are planning your Off Grid Move aren't you?

The solution, it sounds simple, is this: if you can not pay for it, do not buy it. That's how our parents lived, as did their parents. Speaking from experience, it is very easy to get in over your head very quickly. It is also very difficult to get out. If you are overwhelmed with debt, there is little else you can think of.

Living debt free is a feeling that's hard to explain. It's a feeling that's alien to most consumers today. But once you've had a taste of living without

debt, and without the stress that often comes with it, you will wonder if you were, in fact really alive before. The possibilities opened up are truly wondrous.

YOU CAN REDUCE YOUR DEBT BEFORE ITS TOO LATE

Reducing debt usually isn't a high priority for people until they have already gotten into trouble with overspending. Using a few basic guidelines, and debt calculations, we can help you see when your debt load is getting into the danger zone. Learn how to avoid the pitfalls of debt.

Pay Yourself First
Essential to long-term financial success, and protecting your future, is paying yourself first. While this may seem easy to do, it happens to be the last thing most people do, instead of first.

Debts and other financial obligations, money for entertainment, and other spending always seem to take a higher priority. You have to STOP! Think about it, if you aren't worth being paid first, then who is? Put something away in your savings now, and leave it alone. It doesn't matter if it's only $5 a week, just do it!

Make extra payments
Last, but not least, is making extra payments, not just the minimum payments, on your debts. You have probably already seen this method to reducing debt many times, but it just can't be stressed enough. Do that extra payment, however small, every month, and take advantage of the compounding effect and reduce your debt.

Jane and I paid off an amazing $43,000 in debt in just 3 years and 4 months,

IT WON'T BE E-A-S-Y

Every week I am asked, "Can it really be this hard to get out of debt?"

That was the question I was asked more often this week than any other. According to current research, it looks like it is.

Getting out of debt is the financial equivalent of trying to quit smoking.

My wife Jane, who has suffered through some earlier struggles to get out of debt says, "It's like gaining weight. You put on a few pounds during the holidays and you have to work like crazy to take them off." She is right. It is a whole lot easier to get in debt than get out.

Beating Debt Is Simple, But Not Easy

Getting out of debt and staying out of debt is actually pretty simple, at least compared to most things. It really boils down to spending less money than you make, on a consistent, long-term basis. That's it. Nothing else will get the job done. Nothing at all.

And it's easy too. Right? Wrong! While conquering debt is rather simple, it's a long road away from easy. One moment of weakness -- or worse, one cruel act of fate, - and you're scratching your way back out of the hole. Laid off, you get hurt, or somebody doesn't pay you and wham!

How did something so simple get to be so hard? Well, beating debt demands a lot of will power over a long period of time. Since you have been on this planet for a reasonable length of time, you know that this is one tough combination to nail down. With effort it can be done though, consistent long term effort. That is how Jane and I paid off $43,000 in debt in just 3 years and 4 months.

You can become debt free just like we did by following the advice in the guidebook we used.

This system was unique in that it integrated our own belief that we could get out of debt quickly if we only knew how.

Do you know that everything we have learned about debt and money from the time we were little kids is wrong. Take the time to follow this

program. The freedom it brings will change your life. It works hand in hand with our own program for living off the grid.

Chapter 4:

YOUR OFF GRID REMOTE HOME

Now that you have chosen your off grid homesite, or decided to stay in the home you now enjoy, it's time to take stock. You have gotten your family out of debt, or you are well on your way to getting there. Now what do we need to do?

It's time to go over the decision making factors in choosing which form of renewable energy devices you will use in your home.

The Sun, the wind and the water

Depending on your site you might choose solar, wind or hydro power. As a secondary choice for the mechanically inclined you might even consider a steam powered generator run from waste wood. Or even hydrogen power in the future. All of these choices will be dealt with in detail to ensure you make the right decisions for your family.

The renewable energy system you install depends on a number of factors. The first specification we need to remember is that your renewable energy system will likely produce less than 25% of the electricity that is typically consumed in the average North American home.

That would come in at a rather meager 10 kilowatt hours of production a day. Take another last look at your electricity bill to see how much you presently ***use*** everyday and you will see the situation that needs to be addressed.

How do we live comfortably on such low power consumption? This is a very reasonable question. You might be thinking major lifestyle changes, right? The answer is that there are ways to take advantage of all that electricity has to offer AND use a whole lot less of it in achieving a comfortable life.

You will learn all about what we mean in the next section, we promise.

Next, you will want to do a preliminary site inspection of your property. Hopefully you will have done this prior to buying it, but in some cases we are forced to work with what we have.

In general, a careful examination of your home site will reveal if you have wind energy potential. Does the wind blow enough to irritate you often? Then wind power might be an option.

Does the sun shine at your home more than its cloudy? You might consider solar panels as your renewable energy solution.

We were lucky enough to have a stream running through our property that could potentially produce electricity. You might too.

The main point being made in this early stage is, the more renewable energy equipment you purchase the more power you will have to use.

LET'S GO SHOPPING

My wife just loves shopping, and when she was informed that we would have to buy new appliances and new lights for our new home her eyes lit up. If there is someone in your household that enjoys shopping as much as Jane does, then this section is made for you. Listen up.

You are going to need special lights, new fixtures and all new appliances designed to use about one quarter of the power of regular department store goods. There are even special clothes dryers, refrigerators and freezers especially made for off grid applications using renewable energy.

SOLAR HEATING

If you chose the off grid option, you are no doubt up to your eyeballs in designing your own home. Since you are designing your own home why not take advantage of the heat produced by the sun that falls everyday on your home. This can provide supplemental heat in the North or provide nearly all of your heating needs in southern climates.

If at all possible you should try and use renewable fuel to heat your home as well, in addition to solar heat.

SOLAR THERMAL

Hot Water from the Sun

Another major benefit of using the sun's heat is for water heating in your home. Solar water heaters, or solar thermal units have been improved dramatically in the past few years. They are both more reliable and better quality than ever before. Here is how they work and you can decide if they are right for you.

There are many solar water heaters on the market today. It's hard to know where to begin. Probably the best place to start is with the basics of how to heat water with the sun- first off you need a solar collector.

A solar collector is a device for extracting the energy of the sun and transforming it into a more usable or storable form. Energy from sunlight is in the form of electromagnetic radiation. The amount of solar energy

striking the earth's surface at any one time depends on conditions and location on the surface, but it averages about 200 watts per square meter.

A typical solar collector uses water as the storage medium, because water has a very high thermal capacity, is abundant here on Earth and is convenient to handle.

The direct radiation is captured using a black-painted surface which absorbs the energy and conducts it to the storage medium. Metal, especially copper or aluminum, makes a very efficient heat sink. To increase the amount of heat absorbed the metal is painted black.

As it heats up, the collector will itself start to radiate heat back into space, which reduces its efficiency. To counter this loss of efficiency two things should be done. First, a glass plate is placed above the collector plate which will trap the radiated heat within the airspace below it.

This exploits the so-called greenhouse effect, which is in this case a property of the glass - it readily transmits solar radiation in the visible and ultraviolet spectrum, but does not transmit the lower frequency infra-red re-radiation very well.

The plate is also insulated below to prevent losses by radiation to whatever is below the collector.

The second way efficiency is improved is by cooling the collector plate - this is readily done by ensuring that the water is circulated sufficiently quickly through it - the water carries away the absorbed heat allowing more heat transfer and thus upping efficiency. The warmer water is either directly stored, or it passes through some form of heat exchanger which warms another tank of water. It could also be used to heat a building directly.

The temperature differential across an efficient solar collector is usually only 10 or 20 degrees C - a large differential may seem impressive, but is in fact an indication of a less efficient design.

The two main types of solar collector system are Thermosyphon and pumped. In the thermosyphon system, the storage tank is placed above the

collector. As the water in the collector is heated, it will rise and naturally start to circulate to the tank. This draws in colder water from the bottom of the tank.

This system is self regulating and requires no moving parts or external energy. This system uses very little outside energy. Its main drawback is the need for the tank to be above the collector, which may prove to be physically difficult.

A pumped system uses a pump to circulate the water, so the tank can be below the collector. This system requires external energy to run the pump though.

Many people use small solar panels with DC circulating pumps and a small independent battery to maintain the system. This option uses very little energy input. This system does need some form of control electronics to measure the temperature differential across the collector and regulate the pump accordingly.

Solar collectors can be mounted on a roof but need to face the sun, so a north facing roof in the southern hemisphere and a south-facing roof in the northern hemisphere are required.

Make sure they face the sun as directly as possible. Where adequate sunshine is readily available, a 6-10 square meter array will provide all the hot water heating required for a typical family house. Sustainable living just got a whole lot simpler.

Chapter 5:

YOUR COMFORTABLE OFF GRID HOME…….
Designing for comfort

We have now looked at the various options available in general for the running of your home with renewable energy. In summary, you will have to design your home for low energy usage including heat, water and power consumption.

Next, you will select lights and appliances that are very specialized in their low energy usage.

Lastly, you will eliminate waste energy consumption in your home, shutting off those devices not in use and using conservation practices which you have been learning.

Now we are ready to….

Design your Off Grid Power system

Now that you have heard the good news- that you won't be giving up very much in the way of technological devices that make our life easier, it's time to design the actual power system to run your home.

When designing your power system that you will depend on for years to come it's a good idea to start with your expected energy usage in your home. Typically this is called an energy budget. After you complete an energy budget you will have a better idea of the amount of power production that will be necessary to run your off grid home.

YOUR ENERGY BUDGET

First off, in order to complete an energy budget you will need to know how much power typical appliances use. What follows is a chart to help you.

AC *Appliances Typical Energy Usage*

We obtained these numbers from our own appliances and those of many neighbors. Much thanks to them as we snooped through the backs of all of their appliances.

Appliance	Watts
Toaster Oven	1500
VCR	35
Well Pump	800
Sewing Machine	87
Satellite TV	50
Refrigerator/freezer	460
Vacuum	1125
Circular Saw	1500
Hair Dryer	1500
Jigsaw	300
Computer	100
Laptop	60
Monitor	60
27” TV	200
DVD	14
Drill	800
Microwave oven	1245
Compact fluorescent	13
Battery Charger	25
Blender/mixer	350
Belt Sander	800

DC *Appliance Energy Usage*

Appliance	Watts
Cell Phone	4
Motor (small)	65
Sunfrost refrigerator	13
Radio	15
Stereo	30
Water Pump	50
VCR	15
14” Color TV	75
Battery Charger	7
Inverter Standby	5
Halogen Light	20

A bit of Math…. but it won’t hurt…

Now that you know how much energy your appliances use you can figure out your total energy usage per week, and per month.

In order to do this simply figure out how many hours each device is used each day. Multiply this number by the number of watts that device uses and you will come up with the watt-hours of usage. Add all of the totals together to come up with your total watt-hours of usage for the week, and for the month.

Keep these numbers with your notes for now. We will use them soon to design your charging capacity, battery bank and inverter sizing.

Some Examples to help you… and your own worksheet

In the following examples, two hypothetical case studies show how the worksheets can be used. The first example, the family is interested in PV power for a remote vacation cabin.

The second example, meanwhile, want a system that will provide reliable power year-round for their home and business. Both families are interested in renewable energy and want to know if a PV system would be appropriate for them.

Example 1

Summer Cabin Power System

This family owns a small vacation cabin where they spend most summer weekends and holidays, as well as the occasional weekend in the winter.

The cabin has no electricity or running water and is far from the grid. After several years of filling oil lamps and hauling water, they would like to enjoy the benefits of electricity. However, the cabin is their escape from the noise and pollution of the city, and they would prefer a quiet, non-polluting power source. They are particularly interested in a PV system because it is durable and requires low maintenance.

The main priority is to keep costs at a minimum, and they are willing to sacrifice power availability to do this. After all, they do not have power now, and the thought of the odd blackout does not bother them.

They have a propane-powered refrigerator, and they are willing to switch to fluorescent lighting and make do with a minimum of appliances to keep their power needs low. For their needs, a system that is small, solar-only and is stand-alone appears to be a good solution.

Working through the worksheet, they find that roughly a 120-Watt system and about 211 Ah (ampere-hours) of batteries could meet their needs at a price they can afford.

Example 1 Worksheet

Step 1
Estimate Your Power and Energy Needs (watt-hours per day)

Appliance Load	AC or DC (check one)		(A) Rated Wattage (actual or typical values)	(B) Hours Used Per Day	(C) Watt-Hours Per Day (A) x (B)	
	AC	DC			AC	DC
Kitchen lights (2)		✓(12 V)	20	1 h (x 2) = 2		40
Bedroom lights (2)		✓(12 V)	20	1 h (x 2) = 2		40
Living-room lights (2)		✓(12 V)	20	4 h (x 2) = 8		160
Water pump		✓(12 V)	120	1 h		120
Stereo		✓(12 V)	8	4 h		32
TV (black and white)		✓(12 V)	27	3 h		81
Subtotal:		AC: N/A Wh/d		DC: 471 Wh/d		

DC to AC inverter efficiency ranges from 80 to 95 percent. To help you with your first calculation, 0.90 has been inserted in italics. Adjust the efficiency figure, if necessary, once you have chosen the inverter for your system and have read the manufacturer's ratings.

This family does not need an inverter because all their loads are 12 V DC . They can add one at any time.

Adjust AC loads for inverter losses:	AC load =	0	Wh/d:
	Effdc ac	0.90	0

Total daily load: DC loads + adjusted AC loads = 471 Wh/d

Make a Rough Evaluation of PV-System Size

This summer cottage will be equipped with a stand alone PV system.

Estimate the Required Battery Capacity (ampere-hours)

Nominal voltage of battery: (typically 12, 24 or 48 volts) (V_{bat}): 12 VDC

Number of days of battery storage needed (a good rule of thumb is three days for an autonomous system): 3 d

Battery capacity (Ah):

$$\frac{\text{Total daily load (Wh/d) x days of storage}}{\text{Battery voltage } (V_{bat}) \text{ x } 0.42^{***}}$$

$$= \frac{471 \text{ Wh/d x } 3 \text{ d}}{12 \text{ V x } 0.4}$$

= 211 Ah at 12 V

Nominal voltage of battery: (typically 12, 24 or 48 volts) (V_{bat}): _____ VDC

Number of days of battery storage needed (a good rule of thumb is three days for an autonomous system): _____ days

Battery capacity (Ah):

$$\frac{\text{Total daily load (Wh/d) x days of storage}}{}$$

Battery voltage (V_{bat}) x 0.42***

= _____ Wh/d x ____ days
_____ V x 0.4

= _____ Ah

Year-Round Remote Residential Power System

In this example we are dealing with a young couple who have been living beside a small lake for several years, away from the electric grid. They run a small handicrafts business, manufacturing woven goods.

They use a propane generator to provide power for their home and studio now. But they have grown tired of constant noise and pollution, increasingly high fuel bills and frequent maintenance requirements.

Their electrical consumption is low despite many loads because the fridge and stove run on propane. (Running large loads on propane greatly reduces the up-front cost of a PV system.)

After filling out the worksheet, they find that meeting their needs with an autonomous system would be too expensive. They figure that they can currently afford only a small fraction of the PV panels required, but they may be able to add more panels in a few years.

In the meantime, they decide to combine their existing propane generator with PV panels to make a hybrid PV system that offers the potential to reduce the aggravation and costs linked with using a generator. Based on their current resources, this appears to be their best option.

Knowing this, they are now in a better position to talk to a PV dealer about the type of system they want.

Example 2 Worksheet

Step 1. Estimate Your Power and Energy Needs (watt-hours per day)
You do this one! Fill in the blanks from the previous example

Step 2
Make a Rough Evaluation of PV-System Size

- Evaluate Which Stand-Alone System Is More Suitable: Autonomous or Hybrid This summer cottage will be equipped with a hybrid PV system.

Estimate the Available Sunlight
Sunlight: 4 h/d

<u>Now It's Time to design your own system</u>
<u>Worksheet to Evaluate System Size</u>

This worksheet will help you get a rough estimate of the size of your PV system. For this level of design, you need only choose a nominal battery voltage and collect the information on the available hours of peak sunlight in your area.
The results that you will obtain below are only estimates and do not replace the technical design and expertise required for a proper system.

Worksheet

Estimate Your Power and Energy Needs
In watt-hours per day
Appliance Load
AC or DC
(which?)
A- Rated Wattage
(actual or typical values)
B-Hours Used
Per Day

Watt-Hours
Per Day
(A) x (B)

AC
DC

AC
DC

WHAT'S WATTS ??

All this talk of watts and power usage could have you scratching your heads already so let's take a few minutes to let our brains catch up and go back to school.

We call this section….

Electricity 101

For some of you it may be instructional to start at a basic level in understanding how electricity works in everyday life. Unless you work everyday in the electronics field or are a licensed Electrician you may want to get back to the basics first. Right now we will explain the terms used in this discussion of electricity as it pertains to your off grid home.

Watts
We started our discussion earlier asking you how many watts your appliances use everyday and your weekly wattage (power) consumption. Most people are fairly familiar with the term watt, but most don't know what it describes. A watt is the power produced by current (amps) flowing through a wire multiplied by the pressure (voltage) at which it flows.

Volts
Like water pressure in a pipe, voltage is the pressure of electricity flowing through the wire.

Amps
This is the amount of electricity flowing through the wire.

Power Rates
We are most familiar with the term KWH (or Kilowatt Hour) as it appears on our monthly power bills. This is the rate of power flowing through a wire. As an example, if a 100 watt light bulb is turned on for ten hours the power rate would be 100 x 10 = 1,000 watt-hours or 1 Kilowatt hour (kilo means 1000)

Direct Current (DC)
We will be discussing both Direct Current (DC) power and Alternating Current (AC) in the planning of your renewable energy system. AC current is what you presently use in your home.

The most important difference between AC and DC power is that DC current can be stored in a battery while AC power cannot.

In the Renewable Energy system that you are designing to run your home DC power produced by your solar panels or wind generator (for example) will be converted to AC power by using an inverter. Inverters will be discussed later in
depth.

In this way you can still use many of the same appliances that you currently depend on. Because of the blessings of capitalism, AC appliances are cheaper since there are so many units produced. All you shoppers, I know that I promised you would be able to buy new appliances, but for now you should know that you will be able to continue using some of the appliances you now own.

Common DC voltages are 12, 24 and 48. The advantages of DC appliances are many, but most important is that DC motors are more efficient than AC motors. There are many applications for DC power and the benefit is that we can use this form of energy in our off grid home, while in your present tied to the grid home you cannot.

AC Current
Alternating current is called this because the current changes direction constantly. AC is the most common form of electricity usage today mostly because it is easier to work with than common DC current.

OFF GRID POWER SYSTEM COMPONENTS

You are nearly ready to start making decisions about which renewable energy system components to install. Your first step will be to take a look at the different basic components that will make up the system.

Solar Panels
When most people think of renewable energy today they think of solar panels. Solar panels or Photovoltaic panels convert energy from the sun into DC electrical current as we talked about earlier. The fine details of how this happens will be explained later.

Solar Panels produce electricity in direct relation to the amount of sunlight falling on them. They should therefore be placed in a very sunny location with not even any partial shade if possible.

This is a good choice for most people, but not always the best choice. If you live in the sunny south you should probably lean in this direction. But if water power is available or the wind blows enough to irritate you at your property don't be too hasty to buy those panels just yet.

Wind Generators
We are not talking about Wind Farms in this book. You know the ones that stand several hundred feet tall and have blades that look like a giant helicopter.

They cover entire fields in some areas and run entire small towns. We think this is incredible and sure does beat living next door to a Nuclear Power Plant.

This book however is a discussion about home-scale independent power generation – not big business scaled to the renewable energy sector.

Today, small wind generators are being manufactured that will run your entire home at a small fraction of the cost of a similar solar panel array.

The key is blowing in the wind. Steady, year-round wind is necessary for this system to work as a primary renewable energy system. We will show you how to determine this in our discussion of wind generators and wind towers.

Hydro Power

You don't need Niagara Falls in your backyard to produce all of your electricity needs year round with a hydro power generator.

Small hydro turbines are now being made so that even a small flow of water can produce more power than you can ever use.

The advantage of a hydro power system is that it will run 24/7, not just when the wind blows or the sun is shining. That's right, water flows round the clock. As you sleep that stream will just keep running and charging your batteries for tomorrow. This is a great choice for renewable energy if you choose your homesite very carefully.

Steam Power

We will put you in touch with people who can help you convert wood heat into steam, turning a turbine and generating power for your household.

If you are not mechanical and able to fix stuff, this is not a good choice. Do you regularly fix your own car or truck? Do you have rural property? If you answered yes to both questions then give steam a look see.

Hydrogen and Future Fuels

Much talk exists today about hydrogen and many other future fuel sources. There is no commercially available, small scale, backyard hydrogen generators yet so we will refrain from talking about them until there are.

We are not talking about big business options for converting our dependencies from oil and gas to hydrogen fuel either. This could be a world wide option to end energy dependence or it could spell our end- we do not know yet.

Generators (fossil fuel)

If you plan on using only renewable energy to power your home, it's a good idea to have a fossil fuel generator as well. No doubt your relatives will show up unexpectedly to check out your new lifestyle. And of course they will bring their non- conserving ways with them, leaving the lights on half the night or have to run the TV and computer all day.

Your system is designed to accommodate your peak usage not two families, so an overflow source of energy is a wise decision. You probably won't use it very often, but a few times a year you will be glad it's there. We know we are.

Most Off Gridders use their generators for battery charging only when their system is not running at peak efficiency. The Sun doesn't shine for eight days and the wind hasn't blown for nearly two weeks, what do we do?

In steps your gas powered generator to charge the batteries.

Another Great Solution…

We stumbled on another great idea for using your backup generator to produce power. It is quite exciting and reasonably priced.

The simple system amounts to a diesel generator that runs on Biodiesel can be produced for pennies on the dollar compared with regular diesel

fuel and it burns cleaner. The original diesel engine was designed to be run on peanut oil, this new (old?) technology just steps up the process taking into account modern machinery requirements.

Batteries

Your battery bank is truly the heart of your renewable energy system. Batteries are used to store DC electricity during your daily charging cycle for use at a future time.

Since the times at which your peak charging occurs rarely coincides with peak production times (our experience) then batteries are used for energy storage.

Choosing your batteries is a very critical decision in designing your renewable energy system. If your battery bank is too small then your system will not perform well and your batteries will have a very short life. If your battery bank is too large it will be difficult to maintain a full charge, again resulting in poor system performance.

Inverters

Over the past 20 years inverter technology has leaped ahead resulting in many options opening up for the off grid homeowner.

Inverters convert DC power stored in your batteries into AC power commonly used in your household today. As mentioned earlier this allows you to use many AC appliances you now own, and use many of the low energy larger appliances as well.

We worried mostly about running our sensitive computer equipment on inverter power.

Additional Equipment

We also recommend a charge controller for your battery bank which keeps your system from overcharging and damaging your batteries.

You should consider a bypass switch which allows you to turn off your inverter loads and run appliances directly from the generator. We do this with the washing machine sometimes during big laundry days with low energy production (November).

You should also get a DC Safety Disconnect for Electrical Code compliance.

SOLAR THERMAL

Not all renewable energy is used to produce electricity, as we talked about with our woodlot, which obviously renews itself. The same can be said for new Solar Thermal technology.

In the course of a day a tremendous amount of energy falls on your home in the form of sunlight. This energy produces heat, much the same way that a pail of water heats up outside in the summer while in the direct sunshine.

If we set out to capture and store this heat energy we can use it to heat our domestic water supply or our entire home in some cases. Just think, hot water for showers, or your pool, all free from the sun.

Free hot water for your pool is available for under $100.

SELECTING YOUR SYSTEM VOLTAGE

Now that you know the different basic components that will make up your renewable energy system it's time to make your first decision. It is very

important to decide what voltage your system will run at, in order to design an efficient setup for long term use.

It can be very costly to change system voltage later if you decide to expand the size of your power generating setup.

Your choice will basically depend on the size of your renewable energy system and your peak demand for power. Remember those earlier calculations we did with power usage, now is the time to dig them up.

Your Choices…

12 Volts
We would recommend a 12 volt system for only the smallest systems. Weekend cottages in remote areas, or small backup power systems could be run on 12 volts. With this sized system there is very little room for future expansion.

It can be set up rather inexpensively though.

Your charging sources must be within about 40 feet of your battery bank in order to charge efficiently. The maximum upper limit for inverter power (AC) is about 3000 watts with a 12 volt system as well.

There is also the fact that heavier more expensive wire must be used to carry 12 volt current. Here's how it works. Remember Electricity 101?

With a low voltage system (12 volts) your amperage (current) increases. With higher amps comes higher resistance to flow. Think of water flowing through a pipe. As more water flows, bigger pipe is needed to carry that flow.

Basically Low Voltage = Larger Wire = Higher Cost

If your won't need any future expansion (be sure !) and you meet the above criterion a great little system can be set up rather inexpensively.

24 Volts

This is our recommendation for home scale renewable energy production. 24 Volts is very common and most companies sell components in this voltage. There is also lots of room for expansion of your system later on.

You would be able to run a 4000 watt inverter with a 24 volt system which allows more usage of AC equipment in the household.

As mentioned earlier, when voltage increases, amperage or current decreases. With a 24 volt system smaller wire can be used resulting in lower costs of installation of the system.

You also have the option of setting up your power generating system farther from the house. This is a good choice for wind towers, or micro hydro setups which are very site specific.

You can't change where the highest elevation is on your property for wind tower placement. You also can't change where that stream flows to suit where you have placed your home.

Maximizing power output usually means running a higher voltage system to accommodate greater distances to your power source and 24 volts fits very well.

48 Volts

If your power output source is a great distance from your home you might want to consider a 48 volt system. It is more efficient and would also allow you to run a 6000 watt inverter setup for your home.

Although not as common as 24 volts, most larger manufacturers now carry higher voltage systems for special large scale or high performance systems.

Special projects such as grid intertie or deep well water pumping can be set up very efficiently with higher voltages. We know of several setups (micro-hydro) where the power generating system (water flow) is over two

miles from the households that it powers. But it is still more economical to install this system than to run power lines to the site.

The size and application of the system you are designing will usually determine your system voltage. Take a few minutes right now to digest this information and make the voltage decision. Please take into account your maximum daily power needs and the size of inverter you think you will need based on these numbers.

Lastly the distance to your power source will prompt the right decision in most cases. If you are not sure, just come by our website and drop us an email at OFF GRID LIVING

Chapter 6:

Choosing your power source

SOLAR PANELS, WIND GENERATORS OR…

Let's take stock for a minute. You now know your peak usage, what voltage to choose for your system and the names and uses of all of the different components used in your renewable energy system.

Now we will examine which power source to choose. We will start our discussion with solar panels or photovoltaics because they are so common.

Solar Panel choices

Solar panels are probably the simplest form of renewable energy. There are no moving parts and we have seen installations in place with only minor maintenance for over 20 years.

How does the Sun make Electricity? 

Simply put, the cells inside of a solar panel convert the sun's energy into electricity. PV cells are normally fabricated using special semiconductor materials that allow electrons, which are energized when the material is exposed to sunlight, to be freed from their atoms.

Once freed, they can move through the material and carry an electric current. The current flows in one direction (like a battery), and thus the electricity generated is termed direct current (DC).

Just under the surface of a solar panel are small thin pieces of semiconductor material called cells. These cells, usually a series of cells aligned in rows, make up the panel. The cells that make up the panel are made of silicon in most cases, and are treated with phosphorous or boron.

As light strikes the cells it is captured by the semiconductor material. This is known as the photovoltaic effect.

What Is PV?

The term "photovoltaic," commonly referred to as PV, is derived from a combination of the Greek word for light "photo", and "Volta," the name of the Italian physicist, Alessandro Volta, who invented the battery in 1800.

The PV effect is the direct conversion of solar energy into electricity. This process does not generate much heat like solar domestic hot water or solar pool heating systems do. It also differs from the process used in solar

thermal, where concentrated solar energy is used to produce steam that activates a turbine connected to a generator.

PV power systems do not have any moving parts. They are reliable, require little maintenance and generate no noise or pollutants. PV systems are great in that they are modular - the building blocks or cells come in a wide range of power capabilities, from a fraction of a watt to more that 300 W. Modules can be connected to achieve the power that your application requires.

Some large PV power plants have several megawatts of power, although most installed PV systems are much smaller.

Unfortunately, there is a lot of the sun's energy lost in this transfer of energy from light to electricity. Everyday larger and more efficient panels are manufactured it seems.

Even though they are not that efficient at converting light to electricity solar panels remain a very good choice in the renewable energy system because of their low maintenance and long life.

Properly installed your solar panel array should last around 50 years. Not a bad long term investment for most people.

The Advantages of PV Power Systems

Users of PV power systems appreciate their quiet, low-maintenance, pollution-free, safe and reliable operation, as well as the degree of independence they provide.

Why else should you consider buying a PV system?

If you are some distance from an electrical grid, it may be cheaper to generate your own power rather than pay to extend transmission lines from the grid.

Fossil fuel- Diesel, gasoline or propane generators are the main alternatives, but many people find them noisy, polluting and costly to run and maintain.

It also makes little sense to turn on a 5-kW generator to power a few 100-W light bulbs or the TV. PV systems reduce the negative aspects of generators by using them only as a backup.

When capital cost is an issue, or when photovoltaics alone are not enough to replace an existing generator, you can use a wind generator as part of a hybrid PV system. It works great and reduces the use of the generator.

This kind of charging system is more efficient than a generator running continuously at low load.

In addition to saving fuel and lowering maintenance costs, you will increase the generator's life span.

Also, since the PV panels and battery banks are modular, you can expand the PV system gradually as your budget or needs increase. That, we think is the best part.

The Limitations of PV Power Systems

It is important to realize that PV power systems are expensive when compared with the low price of utility power in North America for the most part.

You should reserve the electric power produced by PV modules, an inverter and a storage system for your most energy-efficient appliances, tools, lights, etc.

Although it is technically possible, heating with photovoltaics is generally not recommended. You can easily and more efficiently collect heat with a solar thermal system.

A solar water heater or pool heater mentioned earlier generates more hot water with less initial cost than any PV-powered heater.

Also, for cooking, it is generally more cost-effective and convenient to use a stove that operates on propane or natural gas rather than solar electricity. Jane and I use propane, it is our one concession to the fuel of oil

Stand alone PV-powered homes and cottages often rely on wood cook stoves for cooking and space heating. Refrigerators are becoming more energy efficient, so the cost of operating them with PV power is now feasible. They make some great ones now.

From an economic point of view, first consider investing in energy-efficient electric AC appliances, and then size your PV system based on actual consumption.

For example, using compact fluorescent lights will reduce your electrical consumption for lighting by 80 percent or more.

Your Remote Cottage Example

A cottage, located away from the power grid, uses photovoltaics to power several fluorescent direct current (DC) lights, some halogen lights and a DC water pump, which supplies water to the residents.

A stove and a refrigerator run on propane fuel. No inverter is needed, but one can be included any time if alternating current (AC) loads are added.

The cottage is equipped with a PV system that consists of the following:

two 75-W solar modules (150 W of photovoltaics);
a 20-A (ampere) regulator;
a load/fuse panel;
a bank of batteries; and
a second PV system that powers a small, exterior DC light with an 8-W panel and an independent battery.

The cottage is used primarily on weekends and during vacations, which explains the large battery capacity compared with the total area of PV modules. This allows more energy to be available during two days of occupancy, and the PV modules recharge the batteries over the remaining five days of the week. This system has been functioning maintenance-free since 1997.

Power for Remote Lodges

Owners of remote fishing lodges may find that a properly designed PV hybrid system is economically attractive, be it PV-diesel, PV-wind or a combination of the two.

The high cost of diesel generation at remote sites often prompts the owners to look for alternatives, namely, renewable energy technologies. In many instances, a PV-diesel hybrid system proves attractive because it is cost- effective, simple and reliable.

During periods of little sunshine, the use of the diesel generator can be reduced by drawing power from a bank of batteries and by running the generator only when the batteries are low.

Most Resorts operates from April to October and can accommodate up to a dozen people. Our friend Mike owns such a place

The cottages are equipped with propane- powered appliances and lighting. Electricity is used year-round in the main lodge to power a full range of appliances, including a clothes washer, a large freezer, a water pump, televisions, lights and power tools.

The owners instead decided to improve the resort's energy efficiency. They switched to more efficient 12-V fluorescent lights, put a smaller motor in the water pump, installed timers on the exterior lights and moved their freezer outdoors in the winter.

Using more efficient lights, in particular, has had a significant impact on daily energy consumption.

Some resorts like our friend Mike owns, the resort's diesel consumption has been considerably reduced since the PV-diesel hybrid system was installed. The generator is used once every three or four days for about 10 hours to recharge the batteries.

Previously, it had consumed fuel continuously, while supplying only about one quarter of its nominal capacity.

The PV panels contribute about 15 percent of the lodge's energy requirements. They also permit a gentle trickle charge of the batteries at the end of the charging cycle, thereby extending battery life and increasing the system's efficiency.

Because the diesel generator is used more efficiently in the hybrid system than it would be on its own, it needs fewer oil changes and less frequent major overhauls and repairs.

Also, the life span of the generator is extended. During its first year alone, savings in fuel and maintenance charges totaled about $7,000.

Despite the high up-front cost, the hybrid system paid for itself within six years. The owners are pleased with their PV system and particularly enjoy the quiet, clean operation – a major improvement over the constant noise of a diesel generator.

They have since added four PV modules, increasing the capacity to 752 W. This further reduced the need for diesel- generated electricity. The original lead-acid batteries were still being used in 2000, after 14 years of service.

Mike was so satisfied with photovoltaics that they also equipped each of the seven cottages with a stand alone PV lighting kit with one module and one deep-cycle battery.

Mobile and Recreational Applications

Chances are that you are already relying on PV technology to help you keep track of time, balance your budget or enliven your leisure hours. Many products such as watches, calculators and toys have been PV-powered in an inexpensive, reliable and convenient way for many years.

Equipped with tiny PV cells that produce power even in dim lighting, these consumer products eliminate the need for costly batteries that need to be frequently replaced.

Nowadays, versatile PV power packs are also used to power larger consumer products.

They are available in a range of sizes, from fractions of a watt to over 100 W. Small solar panels can also be hooked up in series or parallel connections to serve various power needs.

They can be used as either a direct power source or as a battery recharger. These convenient PV systems power everything from radios, cassette recorders and cameras to lawn ornaments, walkway lights and batteries for sailboats and gliders.

The clean and noiseless operation of PV systems for many recreational applications is a significant benefit.

RECREATIONAL VEHICLE APPLICATIONS

In recreational vehicles and electric-powered boats, PV panels can help recharge batteries.

The main advantage of a PV system is that it will, at the least, maintain the state of charge of batteries on board – even during extended periods of time when you are not using the equipment.

Photovoltaics in Agriculture

PV systems are particularly well suited where a small amount of energy in remote locations is needed for agricultural applications, such as electric fencing, water pumping for irrigation or stock watering, pond aeration, etc.

Electric Fencing

In this area many farmers use remote fencing for their cattle, or goats. PV-powered electric fencing is popular in Canada's western provinces, chiefly in northern pastures where land is open for cattle.

Several cattle ranchers in northern Alberta and British Columbia and here in Ontario have installed PV modules to charge the batteries of standard electric fencing.

These batteries will never run down. PV-powered electric fencing not only eliminates the cost and inconvenience of regular visits to check batteries, but also costs less than barbed wire fencing, which is the other alternative to conventionally powered electric fencing.

Water Pumping for Cattle and Irrigation of crops

Water pumping is one of the most attractive uses for PV systems. In agriculture, the demand for water is greatest when the weather is hot and

dry, precisely when the most solar energy is available. What could be better?

Simple solar direct types of PV systems are ideal for many irrigation applications where crops can do without water when the sun is not shining.

In situations where irrigation is needed independent of weather, power stored in the form of pumped water, rather than in costly storage batteries, makes PV-powered irrigation systems economically attractive.

What type of Solar Panels should I choose ?
A PV System to Suit Your Particular Power Requirements

Right now you can choose from three main types of panels- Monocrystalline, Polycrystalline and ThinFilm (or Amorphous)

Tried and True Monocrystalline Solar Panels…

For many years monocrystalline solar modules have been the workhorses of the solar market. Those iridescent blue faced panels you have been seeing on rooftops are probably of this type of panels.

They have distinct rounded individual solar cells visible from all angles stacked in very uniform rows.

This type of solar panel is produced from a single silicon ingot or crystal. Manufacturing costs are very high because of this process making them the most expensive solar modules on the market.

They are, however the most efficient type of solar panel making them the correct choice when space is at a premium.

Monocrystalline cells have a life expectancy far exceeding 25 years, probably over 50 years. The only real problem with this type of cell is it's fragile nature making it a requirement that it be mounted in a very rigid frame.

Polycrystalline Solar Panels…

Polycrystalline modules are manufactured from a block of multi-crystalline silicon. They are usually square and have a varied, almost mosaic-like appearance.

Only slightly less efficient than monocrystalline modules they are cheaper to manufacture and thus cost less money.

You can expect the same great lifespan as monocrystalline cells too.

Thin Film Solar Panels…

Recently a new product was introduced into the market that could provide some much needed answers for solar power users. Amorphous silicon PV or thin film technology could make rigid solar panels obsolete if some better research is done.

Thin film solar panels are produced by applying silicon material on glass or stainless steel, or more commonly between two pieces of flexible laminate material.

Solid or rigid thin film panels are in use by flexible laminated thin film panels are more popular. The flexible panels can be applied to any surface and sometimes used as roofing material.

Most customers like the almost seamless blending of solar panels right into their roof top. Saving you the cost of regular shingles or steel roofing, thin film solar panels are a good choice.

These panels are not nearly as efficient at converting light to electricity when compared to mono or polycrystalline solar panels- not nearly by half. You would need twice the space to accommodate their installation.

From a manufacturing standpoint they do absorb light more efficiently though, allowing for a thinner design and less material being used in their manufacture.

The real benefit, because less material is needed, is in the simplified manufacturing process resulting in lowered costs to build. The lower price ahs pushed thin film panels to the lead in price per watt of output.

The panels may have to be slightly larger, but it costs less for the homeowner for every watt of power production. They are flexible, light and rarely break during shipping. Add in the great price and this makes thin film panels a great choice where space is not a consideration.

They jury is still out on the lifespan of these panels though. Some say they will last just as long as monocrystalline panels, others point to their decreased efficiencies only a couple of years after purchase.

As mentioned earlier, with increased research this could be the answer. We have a couple smaller panels and they seem to work fine, but we like

our monocrystalline solar panels and are going to stick with them. Your choice.

New Technologies…
There are many new forms of solar panels out there, from spheral solar to liquid paint on solar panels. All very revolutionary, but all need some time to be properly tested before we would recommend them.

For that reason we leave you with these three choices and will let you make up your own mind.

WHICH COMPANY SHOULD I DEAL WITH WHEN I AM READY TO BUY ?

First Off- Be Prepared
Before approaching a dealer, you should consider your power requirements and the type of photovoltaic (PV) system that will suit your needs and your budget as we have just discussed.

The following are typical questions that you should ask yourself. Be prepared to supply the following information as precisely and clearly as possible:

What is the application?
What needs to be powered?
Are my loads as efficient as possible?
How much power (wattage) and/or energy (watt-hours per day) is required?
What is the energy-usage pattern (e.g. hour per day, days per week, seasonal use)?
Do I need battery storage?
Do I want an autonomous, hybrid or grid-connected system?
Do I want to start small and add modules in the future?

A first step in any design or cost evaluation is to assess your load: What do you expect the PV system to power?
The more detailed and accurate the list, the easier the sizing of your PV system will be for you or your dealer.

Where to Find PV Systems
Apart from some specific consumer products or special sales, PV power systems are just beginning to be widely available.

Dealers of recreational vehicles, boats and electric fences may sometimes offer PV solutions adapted to their products.

However, for most custom applications, you will need to find a PV dealer. Generally, this gives you the advantage of better service, since such dealers should have a good understanding of the technology and can help you select, size and design the system that best suits your needs.

There are many distributors and dealers of PV systems in North America, and the industry network is growing. Some of these companies specialize in different types of systems, e.g. communications, home energy systems, consumer products, agricultural and unique design.

Choosing a Dealer

A PV system should be designed for the best efficiency and cost-effectiveness. It is wise to consult a professional at the design stage.

Most dealers offer design and consultation services as well as PV modules and "balance of system" components such as batteries and inverters.

Some companies concentrate on industrial applications; others specialize in residential and commercial systems. Make certain that the dealer you select has proven experience in designing and installing the type of system you want.

Ask to see some systems that have already been installed, or talk to someone who has bought a system that is similar to what you want.

A responsible dealer will ask you questions about your power consumption, lifestyle and needs before designing your PV system. If you cannot afford as many PV modules as you would like but intend to add to the system later, make sure that the system designer knows this.

The PV dealer should offer a warranty on parts and labor. The warranty for PV modules can now be as much as 25 years, depending on the type of modules and manufacturers' policies.

Most modules will perform reliably for a longer period. Check which warranties the dealer offers on the other components (electrical and mechanical) and on the labor.

Moreover, check on follow-up service available from the dealer. In general, take the same sort of precautions when buying a PV system that you would when buying a new appliance.

Following is a list of items to consider in evaluating a dealer's product and service. Use it when choosing a dealer.

- follow-up service
- design/sales experience
- knowledge of energy efficiency
- area of expertise
- product quality
- product warranty
- installation service
- price
- and most important- do they live with the products everyday

Making a Decision

Of course, cost is always important in any purchase decision.

The economics of PV systems are often quite dependent on your site. In general, your present energy sources tend to have low initial capital costs but have high operating and maintenance costs.

In comparison, PV systems have higher initial capital costs but have lower maintenance and operating costs.

Thus, to evaluate the economics of a PV system, you must consider the total costs of competing alternatives – including capital costs, fuel costs and maintenance and operating costs over the life span of the system. That could be as high as 50 years, but use 25 years in your calculations.

For off-grid operations that have labor and maintenance costs, PV systems can often be economical.

For individual homeowners, who usually do not count their own labor for operation and maintenance as a cost of running a generator, the initial cost of a PV system may appear to be high you can expect.

For many home and cottage owners, the other non- economic benefits of PV systems – in particular, their reliability and quiet, non-polluting operation far outweigh the extra costs.

Especially in summer, owners of PV systems appreciate that they can enjoy the sounds and smells of nature without interference from their power system. That is truly wondrous.

The cost of a PV system depends on a lot of factors. A simple stand alone system for a cottage or cabin, suitable for powering a few lights, a water pump and radios can cost from $700 to $2,000.

Larger, hybrid systems suitable for year-round residences or lodges can cost from $5,000 to $30,000.

In considering the economics of PV systems, it is important to realize that the costs of these systems are steadily declining. The PV industry, like the computer industry, is continually evolving and pricing are decreasing.

Improvements in PV cells, batteries and other system components and in system design are resulting in lower prices for PV systems.

One of the most attractive features of PV systems is that they are modular, as we mentioned earlier. The PV component of a hybrid system can be sized to suit your budget: as prices decline and/or your savings increase, you can add more PV panels and decrease your reliance on the backup generator.

If you do not already have a generator and are considering a solar system for a cottage or sailboat, you can start with a small system to power a few essential appliances and upgrade it as your finances allow.

Because PV systems last 25 years or more, they represent a solid investment. By the way, the price for used panels is not much less than that for new panels because they remain in perfect condition for years.

Installing and Maintaining Your Photovoltaic System

One major advantage of photovoltaic (PV) systems is that they are relatively simple to install and maintain. For large or complex systems, PV companies usually help with installation and maintenance.

Installation

Your supplier should give you any relevant system documents. Carefully read all of the manufacturer's recommendations.

As with any electrical system, safety is important. You must obtain any necessary building and electrical permits and ensure that the system is installed according to the building and electrical code.

Qualified people should install the system. If you have a grid-connected Wiring must be properly installed to avoid shocks, fires and other hazards.

The main consideration is the type and size of wire. For example, the array wiring must be suited for outdoor use and be sized properly in order to carry the peak current.

Consult a professional designer or installer to select the proper wires.

You will also need the services of a professional installer to:
Properly fuse the system for protection against short circuits in the wiring or appliances.

Ensure that the system is properly grounded and protected against lightning; and
Include switches between all components of the system that need to be isolated for any reason.

Mounting the PV Array

PV modules are designed to be installed outdoors without additional protection. A mounting structure must be constructed to support the modules in all weather conditions.

Many manufacturers sell support frames designed to hold their modules; you may decide to build your own.

Factors to be considered in mounting the array include orientation, safety, structural integrity and local codes.

The PV array should be mounted so as to take full advantage of the sunlight. In the northern hemisphere, it should face south; true south is best, but a deviation of 15 degrees east or west will not affect performance very much.

Very large installations can be mounted to track the sun either automatically or manually. In most cases, the mounting is fixed at one angle (a right angle to the sun at noon), but can be adjusted according to the season.

Select a site where the array will not be shaded at any point during the day. A shadow on the array can substantially cut power output.

If possible, ask your neighbors if they plan to add trees or buildings adjacent to your property. Easements and restrictions are two types of legal instruments.

When used for solar applications, they provide certain guarantees to property owners about their access to sunlight. If access to sunlight concerns you, such a written agreement may be worthwhile.

Depending on the array size and the particulars of the site, the PV array can be mounted on a roof, a pole or the ground.

In general, the large surface areas of the modules create high wind loads on the mounting structure, so the structure must be designed accordingly.

Due to these high wind loads, ground-mounted installations require proper foundations. For small, ground-mounted installations, foundations can be posts sunk into the ground to anchor the array support frame.

The support frame itself may be made of metal or wood. Modules are mounted so that the bottom of the array is above the highest depth of snow likely to fall. Make sure that there is no bottom lip on the array so that snow can slide off freely.

You can use pole mounting for small systems to ensure proper orientation or to lift them above potential sources of shade, such as buildings or trees.

The main advantages are no snow buildup to shade the array and the potential to track the sun.

For many residences and cottages, roof mounting is an attractive option, particularly if the building is under construction.

Living Off The Grid

The modules should be mounted a short distance above the pitched roof and tilted to the optimum angle. Since PV modules work better when the ambient air temperature is lower, the free circulation of air around them will improve their performance.

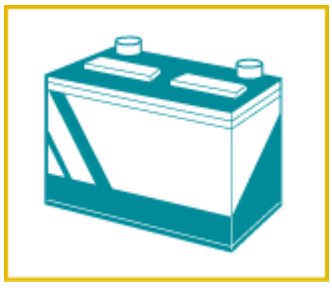
Elevating the array will also prevent the buildup of moisture and gunk behind the modules. This buildup will rot the roof and deteriorate the electrical connections.

For residences and cottages with a chimney, the array should be mounted in such a way that shading from the smoke is avoided.
Proper chimney installation should insure of this.

Wherever you choose to mount the array, unless shading is a concern, try to locate it as close as possible to the battery bank or to the load.

This will lower wiring distances and resultant power losses.

Housing your Batteries…



Your choice of battery location should comply with the Electrical Code, whether you install the batteries inside or outside.

The location should also be designed to keep the batteries warm (25°C is best), because their capacity decreases at temperatures below 25°C. This means that if you choose to locate your batteries in an unheated space, you will need to insulate the area properly.

You will also need greater battery capacity to compensate for the losses at lower temperatures. Make sure that your supplier knows about the planned location of your batteries.

The batteries and other equipment should be accessible for maintenance and inspection, but safety must also be considered.

Batteries may give off hydrogen gas during charging and can be a source of electric shock, so the room or area where they are housed should be properly vented to the outside and kept locked. In addition, other electrical components, which can also be a source of spark, should be kept separately from the battery housing.

Do not locate batteries near sources of heat or possible sources of open flame or spark. Finally, read all of the manufacturer's recommendations and warnings about the safe and proper use and handling of batteries.

Inside Locations for Living Off The Grid applications

Batteries located inside the living space should be properly vented to the outside. For small cottage systems with as an example, two 12-VDC (volt direct current) batteries, you need a vent that is at least 1 inches in diameter.

Keep batteries separate from the living space by housing them in special battery cases and should be properly ventilated to the outside.
For summer cottages, keep batteries full of charge to prevent freezing in the off-season.

Outside Locations

Batteries located outside of the living space should be housed in a box or shed. In a very cold location, you can house the batteries in a buried container for better temperature control.

In all cases, batteries should be well protected from the elements and be well vented to the outside. Battery maintenance varies with the type used.

Basic maintenance includes visually checking the electrolyte levels and regularly verifying the specific gravity of your batteries with a hydrometer. Add distilled water as necessary, and clean and tighten battery.

Also, check for any leaks or physical damage to batteries. Follow battery and charge regulator instructions.

PV Maintenance

An important advantage of PV systems is that they require little maintenance. The arrays themselves are durable and reliable and need little attention.

The following summarizes the principal maintenance that your system will need, but you may wish to ask your dealer for a maintenance schedule that is adapted to your particular system and location.

Unless you live in an extremely dusty area or have severe problems with ice storms, you need to inspect the wiring and general panel appearance only occasionally.

If your system has an adjustable mounting, you can carry out this routine maintenance check at the same time as you adjust the tilt angle of the array seasonally.

When you adjust the angle of the array for winter operation, snow loading is not a problem because the array is tilted steeply. If the array becomes

dusty, clean it with a mild soap or plain water and a soft cloth. Be careful not to use strong solvents on your panels.

WIND GENERATORS

The Answer is blowing in the wind……

About Wind Energy

Wind energy converts kinetic energy that is present in the wind into more useful forms of energy such as mechanical energy or electricity.

Wind energy is a pollution-free, infinitely sustainable form of energy. It doesn't use oil fuel; it doesn't produce greenhouse gas, and it doesn't produce toxic or radioactive waste.

And it does not smell.

Do you remember those old Jacobs wind generators that were used to pump water for families on the prairies?

Current wind energy machines are called wind generators", or more generally, "wind turbines".

As recently as the 1920s, over a million wind turbines pumped water and provided electricity to farms many years ago in North America.
The current interest in wind energy was started by the need to develop clean, sustainable energy systems that can be relied on for the long-term future now.

Modern aerodynamics and engineering have improved wind turbines and wind generators substantially.

They now provide reliable, cost-effective, pollution-free energy for household applications.

How is wind energy produced ?

Wind energy is the kinetic energy that is present in the wind or moving air.
The amount of potential energy depends mainly on wind speed, but is also affected by other factors.

For any wind turbine, you can calculate that the power and energy output increases dramatically as the wind speed increases.

Therefore, the most cost-effective wind turbines are located where the wind blows the strongest.

Wind speed is affected by the local terrain and usually increases with height above the ground, so wind turbines are usually mounted on tall towers high above the ground. Way up there usually.

The cost of wind energy

The cost of wind energy is determined by:

-the installation cost of the wind turbine installation
-the interest rate on the money invested
-the amount of electricity produced

Any wind generator that is installed in a very windy area generates more electricity than the same unit installed in a less windy area.

So it's important to assess the wind at the potential site. Thus the power generated would be cheaper.

Modern wind turbine generators cost about $1500 and $2000 per kilowatt for wind farms that use large machines.

Smaller individual wind generators that would be suitable for your home cost up to $3000 per kilowatt. In good wind areas, the costs of generating electricity range around five and ten cents per kilowatt hour.

That cost is somewhat higher, but wind energy costs are decreasing every year, whereas most conventional generation costs continue to increase at an alarming rate.

By comparison in remote areas, generating electricity with diesel generators can range from $0.25 to $1.00 per kilowatt hour.

Wind makes sense. In good windy areas, electricity that is generated by the wind is clearly cost effective.

When compared to the money that is charged by electrical companies, wind energy costs are nearly competitive. But many people buy wind generators for more reasons than just the cost.

Using wind energy around the world

The use of wind generators is growing around the world.

In terms of installation worldwide, the wind power industry now turns over more than 10 billion USD.

At the end of 2005, over 48,000 megawatts of wind-generated electricity produced some 95 TWh of electricity. That is sufficient energy for the electricity needs of some European nations.

From our own perspective 2005 was a record year for new installed capacity in Canada. As of April 2006 Canada's installed wind energy capacity was 944 MW, enough to power more than 280,000 homes, wow!

The many benefits of wind energy

Wind energy is an ideal renewable energy because:

-it is a pollution-free, infinitely sustainable form of energy
-it doesn't require fuel
-it doesn't create greenhouse gasses
-it doesn't produce toxic or more importantly radioactive waste.

Wind generator energy is quiet and does not present any significant hazard to birds or other wildlife. Although some bird fatalities are noted each year.

The ownership of wind generators by individuals and the community allows people to participate directly in the preservation of our environment as well.

Each megawatt-hour of electricity that is generated by wind energy helps to reduce the 0.8 to 0.9 tons of greenhouse gas emissions that are produced by coal or diesel fuel generation each year.

And that is a lot of emissions.

Producing Electricity from Wind

Sources of Wind

Wind is produced by regions of different temperatures and/or pressures in our atmosphere.

On Earth, almost all wind is created by incoming radiation from the sun.

This happens when the sun heats a land mass and the heat from the land is absorbed by the surrounding air. When the air reaches a certain temperature, around midmorning usually it begins to rise quickly upwards.

This quickly results in a low-pressure area at ground level and a higher-pressure area above the land. Wind is then created.

Air naturally moves from high-pressure zones to low-pressure zones, trying to equalize the air pressure.

This air movement creates, you guessed it, wind.

Areas of the Earth closer to the sun, such as the equator, become warm quicker than areas further away, such as here in Canada. As air moves over warm areas and rises, cooler air from surrounding areas rushes in to fill the space left by the rising air and again wind is created.

Due to elevation, topography, surface roughness, and location, some areas experience more wind than others. Closer to large bodies of water, lakes or the oceans especially have good winds, and thus possible wind generator potential.

Creating Electricity from the Wind Energy

The air surrounding Earth is made up of many gases, and the wind is essentially moving air molecules.

If you slow down those molecules, as in the case of the wind striking the blades of a wind generator, they need to 'release' their kinetic energy.

In this way, Wind turbines capture the kinetic energy in surface winds and convert it into electricity.

Wind generators do this with three basic parts: blades, a shaft and a generator.

As wind moves over the turbine blades, it creates high-pressure air below the turbine blades and low-pressure air above them, causing 'lift', just like an airplane.

Lift makes the blades rotate since each blade is slightly angled.

The blades then turn a shaft that moves magnets in the generator. This movement of the magnets creates electricity. This electricity can be used on-site by a home, business, farm, and stored in batteries.

Amount of Electricity from Wind Energy

Wind speeds are often measured in meters per second or miles per hour.

The amount of energy available in the wind is proportional to the wind speed multiplied by itself 3 times. (E.g. if the wind speed doubles, the amount of energy in the wind goes up by 2 x 2 x 2 = 8 times!).

Typically, wind speeds greater than 7 mph are needed before a wind energy system can begin to generate electricity.

The speed at which your wind generator begins to generate power is called the “cut-in” speed.

The “cut-out” speed, usually around 60 mph, is where the turbine turns or stops to protect itself from damage.

The precise amount of energy that can be taken from the wind is complicated and depends on such factors as the variability and distribution of wind speed, height of the rotor, diameter of the area swept by the rotor, and density of the air.

One strange factor in all of this wind calculation is if you took all of the energy out of the wind, the wind’s local speed decreases.

Keeping this in mind, if you took all the energy out of the wind, the wind would stop completely!

In reality, however, you cannot remove all the energy from the wind. The most energy that an ideal wind energy system can extract is approximately 59%.
That’s still pretty good, it even has a name, it is called the Betz limit.

To determine how much electricity can be produced by a turbine from the wind, you need to know the wind speed over time and the amount of electricity a turbine generates at different wind speeds.

Wind speed is often expressed as the number of hours per year the wind blows at different speeds. Local wind charts are available online.

Each wind turbine model is tested by the manufacturer or a third party facility to measure the electricity output at different wind speeds.

This is known as a turbine ‘power curve’. The combination of a site’s wind distribution curve and a particular turbine’s power curve yields the estimated electricity that the turbine could generate on that site. And that is what we have to figure out.

Hills, ridges and valleys can block the wind or create undesirable turbulence for a wind generator system.

In this case mounting a wind energy system on a hill and on a tower will increase the amount of wind energy available.

This is what you should be looking for. Remember that you want a location that is 15 feet above every obstruction for a radius of 300 yards.

Due to the ground's friction, wind speed increases as you move higher. This is a good thing to know if you are installing a wind generator.

For most open spaces, wind speed increases 12% each time the height is doubled.

A small increase in wind speed leads to a large increase in energy output as the energy available in the wind is equal to the wind speed multiplied by itself times 3 remember.

Types of Small Wind Turbines

Small wind turbines are generally categorized as:

Horizontal Axis Wind Turbines

In these wind turbines the shaft is parallel to the ground.

Although they must self-align with the wind, Horizontal Axis Turbines are mechanically simple and require a relatively small foundation and guy wires on the ground to mount and secure the tower.

The majority of small and large turbines installed today are of this type.

Vertical Axis Wind Turbines
In these models the shaft is perpendicular to the ground.

These turbines typically require a relatively large foundation and many supports.

There are few commercial systems of this type in production today.

Small Wind System Components

Small wind turbines usually consist of the following components:

Rotor – The rotor consists of the blades and a shaft.

The blades are usually fiberglass, metal, or reinforced plastic or wood. The wind flows over the blades and converts the wind energy from moving wind into rotational motion of the rotor.

The diameter of the circle formed by the rotor blades determine how much energy can be extracted from the wind and thus the power generated by the system. Most manufacturers rate their wind machines based on this number.

Generator
This produces electricity from the rotation of the turbine rotor.

A generator produces Direct Current (DC) power or an alternator produces Alternating Current (AC) power, depending on what type of turbine you have.

Gearbox (on some) – Most turbines above 10 kW use a gearbox to match the rotor speed to that of the generator.

Nacelle – This is the removable casing to protect the generator/alternator and gearbox. This is a very important part of the machine in high winds.

Tail vane
A tail vane or yaw system aligns a Horizontal Axis Wind Turbine with the wind.

Most home scaled micro and mini systems use a simple tail vane that directs the rotor into the wind. In some systems, the rotor is downwind of the generator, so it naturally aligns with the wind.

Some tail vane systems can be offset from the vertical axis to regulate rotor power and speed by tilting the turbine slightly upward. This is a very technically efficient way to protect the wind generator from high winds.

The following components are also usually supplied as part of a small wind turbine package:

Control and Protection System

Control systems vary from simple switches, fuses and battery charge regulators to computerized systems for control of tail vane yaw systems.

Tower –
Your wind tower is very important. It holds the wind turbine in the path of the wind.

It must be designed to support severe conditions, such as extreme winds, hail and icing, snow and all sorts of other conditions you might receive in your area.

Many types of towers are available including tilt up towers (very popular), guyed towers, and self-supporting towers.

Tilt-up towers are normally used for small systems under 1,000 W as they allow assembly of the turbine on the ground and allow safe and convenient maintenance of the turbine.

Guyed towers are economical, very strong when properly installed, and are also tilt-up in design at times. The guy wires require space around the base of the tower so they can be properly anchored

Non-Tilt-up, self-supporting towers are usually lattice like an old TV tower or a cylindrical shape and are used for larger turbines above 50 kW. They are very strong, more expensive, and often require a crane to erect.

Issues to be Aware of…

Safety. Modern wind turbines are very safe and can operate for many years without any problems. One issue to consider here in Canada is ice accumulation on the blades. It can come flying off when least expected.

Extreme weather. Yes this is a land of extreme weather. In some parts of the country, the environment is very hard on equipment and can cause problems for the wind turbine. We have found that variable, gusty winds to be especially trying on equipment.

Neighbors. The proximity of a wind turbine to your neighbor's property should be discussed before you put it up.

Aesthetics. The visibility of your wind turbine could be an issue. A wind turbine can affect your view, or it might change an historic landscape.

Noise. The noise level of a turbine depends on several factors, including local winds. Most are very quiet

Zoning and Other Legal Issues. Local municipal offices should have information.

Local wildlife. Small wind turbines can pose a danger to birds in certain conditions.

Turbines with Power Ratings of 300 Watts to 1 kW

Wind turbines in this size present the greatest variety in terms of technologies and designs. And they are inexpensive, mostly due to the large number of competing manufacturers.

These machines operate at variable speeds and thus produce variable voltage AC power, which is then converted to DC by a rectifier circuit.

The actual output of these turbines is usually DC electricity, which is most commonly used to charge batteries.

An important characteristic of these systems is that they can often be simply mounted on a pipe of 2" diameter, or smaller.

If you use guy wire, this pipe can serve as the tower.

This makes for a relatively simple and inexpensive tower installation for the "do-it-yourselfer"

Maintenance tends to be almost negligible, they are that well made.

Turbines with Power Ratings above 1 kW to 30 kW

Turbines in this size category represent a more significant investment of both time and money for the homeowner.

They are more complex and more expensive and in most cases these wind turbines are installed by professionals, and require regular inspections and maintenance. Mostly they are used to provide power for single-family dwellings or larger off the grid structures.

Properly sited, small wind turbines are one of the most cost-effective choices for generating some or all of your own electricity.
Wind energy becomes more cost effective per kilowatt as the size of the turbine's rotor increases.

Although small turbines cost less initially, small turbines are currently more

Estimate Your Peak Power

Back when we were discussing solar panels you estimated your total electricity load. Then you figured out the maximum (peak) electricity you will need to draw at any given time.

Decide What Size of Turbine You Need
With the calculations from the exercise on solar you can now figure out what size wind generator you will need.

There is no right turbine size for a given application, as it depends on how you plan to use the system and how much you're willing to spend.

Take your home's average annual wind speed and look at the manufacturer's specifications for each turbine to get an idea of approximately how much electricity that each wind turbine would produce. Compare the generating performance of each model with your peak power and this should give you a good idea.

Location on Your Property
The distance from the wind turbine to your home will affect the size and expense of the wire used. So, if you need a long wire run, it is preferable to to invert DC to AC.

A wind turbine mounted on a tower will generally perform much better than a rooftop installation.

Tower Height

Your wind generator should be installed at least 15 feet above anything within 300 feet

Choose the right wind generator? Which one?

Here are some questions to ask yourself.
How long has the manufacturer been producing wind turbines?
How long has that make and model been on the market, more than 5 years?
What's the performance and longevity in different applications?
How easy are they to install?
How much service is offered with the wind turbine?
Do you need to buy the tower?
Is the wiring and smaller parts also supplied?
Is it suitable for do-it-yourself?

or will you need a professional to install it?
How easy will it be to get replacement parts now and in 10-15 years?
What type of equipment is the inverter capable of operating?
What quality of AC power does the inverter produce?
Does the warranty cover a reasonable period including parts and labor?

Could You Do It Yourself?

Ask yourself the following questions:

Can I pour a proper cement foundation?
Do I have access to a crane for erecting the tower safely?
Do I know the difference between AC and DC wiring?
Do I know enough about electricity to safely wire my wind turbine?
Do I know how to safely handle and install batteries?

Answer No to any of these? Go talk to a pro installer

If you plan on doing it yourself remember safety first, and read the instructions thoroughly.

Micro Hydro

If you have flowing water on your property with a sizeable drop in elevation or flow then count yourself lucky. Water flows 24/7 and will produce adequate power to easily run your household.

A small-scale micro hydro facility requires that a sizable flow of water and an adequate head of water be available without building elaborate and expensive facilities.

Small micro hydro plants can be developed at existing dams. By using existing structures, only minor work is required to be up and producing power.

Environmental benefits

Small-scale hydroelectric developments do not take up much space and they rarely cause significant flooding or require river diversions. It is the best form of power if you have the right facility.

Additional Components in a Solar, Small Wind System or hydro setup

Depending on your application, you will need additional equipment and materials to provide electricity to your

Batteries
The best batteries for a renewable energy system are deep discharge batteries that can be safely discharged a significant amount.

Inverters
These are required for converting DC battery power to AC household power. High quality AC is considered "true sine wave" or "modified sine wave" and is sufficient to safely power sensitive electronic equipment such as computers.
We have run our own for years this way.

Rectifier (maybe)
The opposite of an inverter, this device converts AC power to DC and is used when the AC power from an AC-generating turbine is needed for DC appliances or to charge batteries.

Battery Charger – If the generator does not have a battery charging output, a special battery charger is required.

Disconnect switches, circuit breakers, fuses
These are important for the safe operation of the system. They electrically isolate the system from the batteries and in some cases the batteries from the inverter.

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Monitoring System – Standard monitoring equipment usually includes a voltmeter and an ammeter.

What to do Now?

First let's go over what you now know.

You know how much energy consumption there is in your home, and better ways to conserve that energy.

Based on your consumption you can now size your renewable energy system to fit your needs.

You have done a site analysis to determine which system – solar panels, wind generators or micro hydro will best fit your needs.

Living Off The Grid Online Magazine

What remains is to get started!

We found that as soon as we made that first purchase of a solar panel that we became eager to learn more and to do more. We wanted our home to be run on solar and wind power, and that's how we started.

A great place to start, even if you can't start living off the grid right away is with purchasing energy efficient lighting and appliances.

You can find everything you need, including energy efficient large appliances at the Living Off the Grid website

Get going and you will be living off the grid in as little as two months.

By the way, keep track of your story, take photos and send them into us

Anything is possible living off the grid!

Legal stuff the lawyers made me say…