# Get Rid of the Grid Superpack

# Contents

# Top Ten Reasons to Put a Solar Power System on Your Home

Everywhere you look these days there is a story about 'going green'. And smack dab in the middle of all the hoopla about green living is solar energy. Our new president has promised to make it a priority for research and incentives. The folks in Silicon Valley are even on board, opening their huge checkbooks to invest in renewable energy. So should you? Probably the easiest way for you to get on renewable energy train is to install a solar power kit in your home. Here are 10 reasons why solar is a great option:

1. Incentives: Recently Congress lifted the cap on tax incentives for solar power systems, and extended the 30% credit. So if you spend $20,000 on a system, your tax bill will be reduced by $6,000 (.3 x 20,000). And if you don't have $6,000 in taxes (you lucky duck!) you can carry it over to the next year. Now states and utilities are getting into the act as well. Everything from rebates to tax incentives are being offered, and some of these can offset the cost of your system by as much as 50%! Check out the dsireusa.org website for information on incentives in your area.

2. Maintenance cost: Solar panel systems require very little maintenance over their life. Sometimes clearing and cleaning is necessary, and having an annual checkup by a professional is recommended. But most owners can expect to do very little for their panels over their lifetime.

3. Fuel Cost and Availability: Obviously sunlight is free. Fossil fuel prices are rising dramatically, and will probably rise even more sharply with carbon taxes and caps on the horizon. And the sun will probably be around showering us with its wonderful energy for another 5 billion years or so. With solar, knowing that your fuel source is infinite and free is pretty cool. And lets face it: money is green too.

4. Reliability: Solar panels have no moving parts, and therefore are not likely to break down. The process that makes them work (which is explained in a separate article) can be done day after day without major changes in efficiency. And they can improve the availability of your entire electrical system if you live in areas prone to utility blackouts.

5. Durability: Most panels these days come with a 20-30 year warranty. Can you think of anything that comes with even a 15 year warranty?! Some of the arrays that were created as part of the space race 50 years ago are alive and kicking to this day. Arrays have endured all kinds of weather and climatic changes and have proven to be extremely durable.

6. Quiet: Solar panels make little to no noise as they produce energy, something you and your neighbors can be happy about.

7. Safety: Photovoltaic cells are very safe and produce at such a low amperage that electrocution is extremely rare. They also are rare in that they produce power without fuel combustion, a very dangerous process whether its in your backyard or at the power plant.

8. Energy Independence: Knowing that you can produce your own energy, much like having your own vegetable garden, is very satisfying. And knowing that you are sending

less money, or maybe none at all, to a large conglomerate or supporting a violent nation is good for you, our country, and the world.

9. Low Pollution: Both the process of producing solar panels and producing solar energy is a low pollution process. Solar panels make up for the energy used to produce them in 2-4 years, and then produce energy for decades. They use mostly benign, non-polluting resources in the manufacturing process. Plus almost the entire array is recyclable, so when their life is over they can be broken down and used for something else.

10. That 'Green' Feeling: Perhaps the most powerful reason (other than the feeling of saving money) of all is knowing that you are DOING SOMETHING. You're helping clean up the planet, promoting independence, and most of all getting us further away from the destruction and pollution inherent in the use of fossil fuels. What else do you need?

For more free information on solar energy, education, and products, check out Home Solar Power.

# What Are Thin Film Flexible Solar Cells?

Solar energy and 'going green' are getting a lot of attention these days. Many people are talking about thin film solar cells, also called flexible solar panels. This article will give you a rundown on the various technologies out there, without getting too deep into the chemistry and physics of how they work.

Thin film cells are getting a lot of attention because they address the biggest issue with solar energy: cost. The development of this technology has take great strides in recent years because they are cheaper to manufacture than traditional solar panels. Thin film solar panels are what you would find in a solar calculator, and this technology is being expanded into panels for large residential and commercial use. Global Solar Energy, for example, recently installed a 750 kilowatt array that provides 25% of factory's power needs.

There several technologies that exist that fall under the thin solar heading:

**1. Amorphous or Thin Film Silicon.** This technology uses the same science that is found in the rectangular solar panels we are seeing more and more of in the world. Instead of using hard crystalline silicon that must be encased in tempered glass and aluminum frames like normal solar panels, the silicon is deposited on a flexible piece of metal or plastic and then coated. This technology is generally less efficient, but much cheaper to make. To produce the same amount of energy as a traditional solar panel, you would need 30-50% more surface area of thin film silicon solar.

**2. Cadmium Telluride.** This technology is less popular than thin film silicon for several reasons. While it is more cost-effective to manufacture, it is less efficient than silicon. Additionally, the materials in these cells tend to be toxic, leading to concerns about the manufacturing process and the long term environmental effects of the cells. Studies are being done as we speak to investigate the long term toxicity of cadmium telluride since the economics of the technology are very attractive. Typical efficiencies for these cells are

around 15%. This means that 15% of the total energy that fell on the cell was converted to electricity.

**3. CIGS.** CIGS is an acronym for 'copper indium gallium (di)selenide' (see why we call it CIGS?). CIGS cells have the most promise for bringing down the cost of solar since the economics AND efficiencies are very promising. In 2005, the National Renewable Energy Lab achieved a world record 19.9% efficiency for a CIGS cell. This means that 19.9% of the total energy that fell on the cell was converted to electricity. This is approaching the world record for a common solar panel of 24.7%. This very exciting because manufacturers anticipate the cost of mass-produced thin film cells to be around $1.00/watt. Common silicon solar panels we are used to seeing are close to $5.00/watt. Companies such as Shell, Nanosolar, and Honda are investing heavily in this technology. Nanosolar is particularly interesting in that is has the backing of Silicon Valley venture capital and the Google founders. They are in the process of building a massive manufacturing facility and claim that they will produce solar cells at 1/10th the cost of current cells. Very exciting.

For more free information and products, visit Flexible Thin Film Solar Cells.

# Advantages and Disadvantages of Thin Film (Flexible) Solar Cells

There has been a lot of buzz lately about thin film, also called flexible or foldable, solar panels. This is an emerging technology and could completely revolutionize renewable energy. Thin film solar most often uses CIGS (copper indium gallium (di)selenide) technology or amorphous silicon, which are much cheaper and easier to manufacture than the standard solar crystalline panels we're used to seeing. Let's brake down the different advantages and disadvantages of this new and exciting technology.

**Advantages:**

- **Cost.** Flexible solar is leading the way to cheap energy from the sun. Costs for this technology are dropping quickly and with the investment in research and development, these costs will continue to fall.
- **Application.** The biggest advantages currently with thin film solar is its numerous application options. Unlike traditional panels, flexible panels can be applied to a wide variety of surfaces. In addition to the traditional roof mounted design, these cells are being molded to cars, backpacks, clothing, and even windows. Some companies are even integrating the cells into things like roof tiles and siding, so your house will have solar in it, not just on it.
- **Technology Advancements.** Many large companies such as Shell, Honda, and Nanosolar are throwing all their research muscle behind thin film solar. This means that the technology will improve greatly over time, and some of the advancements are already coming to market.
- **Fewer Defects.** Because the manufacturing process is simpler, there are often fewer defects. The highly technical method of building traditional solar panels, sometimes compared to computer chip manufacturing, involves a lot of detailed soldering. This has been historically a place where the traditional panels experienced a lot of warranty issues. Not so with thin film. The process is closer to printing and therefore is subject to fewer defect issues.

- **Less Voltage Drop.** Electricity in most applications flows better when its cool. When thin film solar cells heat up they tend to loose less voltage than traditional panels.
- **Performance in Low-light.** Many thin film panels have better energy production in low-light and shading situations.
- **Durability.** Since the technology is fairly new, there are some questions about how long these cells will last. But many early-adopters have reported their cells lasting 15 years and more. These cells do not require the glass and aluminum casings of traditional cells because the materials within them are flexible and malleable, not brittle like crystalline silicon. This means they will likely take more abuse and last longer.

**Disadvantages:**

- **Efficiency Questions.** Efficiency of these cells has lagged anywhere from 50%-70% behind that of traditional crystalline cells. This is changing quickly however. In 2005, the National Renewable Energy Lab achieved a world record 19.9% efficiency for a CIGS cell. This means that 19.9% of the total energy that fell on the cell was converted to electricity. This is approaching the world record for a common solar panel of 24.7%.
- **Space Needed.** With the efficiencies currently available, you would need approximately 50% more room with thin film solar to produce the same electricity as a traditional solar setup.
- **Heat Retention.** Because thin film solar is usually applied directly to a surface, they can retain more hear. Traditional panels are generally installed with a standoff, meaning there is space between the panel and the supporting surface, allowing for air to cool the panels. Thin film solar may retain more heat, creating a balance act between this and its benefit of better performance at higher temperatures.

For more free information and products, visit Flexible Thin Film Solar Cells.

# Where Should I Install My Solar Panels?

Many people are embracing the green living revolution and installing solar panels on their home. One of the biggest issues facing these homeowners is where to put the panels.

Most people automatically assume the roof is the best place for the panels. There are many advantages of having the solar array on the roof:

- The roof often has the greatest unobstructed view of the sun throughout the year.
- The roof allows the consumer to get the panels out of the way.
- The panel mounting systems for roofs are generally pretty simple.

What most people don't know however is that a roof installation has several disadvantages.

- Often homeowners do not have a roof surface that faces south, the optimal direction for solar installations in North America.
- Roof angles may not be the same as the optimum solar panel angle, complicating installation.
- Installations on roofs, while simple mechanically, can be dangerous and hard to do for homeowners.

- Obstructions such as plumbing vents, air conditioning units, and trees can shade small parts of the panels, drastically reducing the efficiency of the array.
- Cleaning and snow removal is much harder when the system is roof mounted
- Changing the panel angle for seasonal adjustments is difficult.

One of the first tasks in deciding where to mount your panels is to determine just how much space you need. Today's crystalline solar panels (the most common panel on the market today) take about one square foot of space for every 10 watts they produce. For example, if you decided that you wanted about 2000 watts for your home, you would take 2000 W and divide it by 10 W/sq.ft., which would equal 200 sq.ft. This is about 14 feet by 14 feet square.

Now its time to look at your home or business where the system is needed. What angle does the roof have? The array should be at an angle from the horizontal (or flat ground) that is equal to the latitude where you live. For example, Boulder Colorado is at 40 degrees latitude, so panels installed there should be 40 degrees from horizontal. Many people have roofs at or near 12:12, which means that the roof rises 12" for every 12" in the horizontal. Therefore a 12:12 roof is at 45 degrees. For most US installations, somewhere near 35-45 degrees is adequate. Only in extreme southern or northern latitudes does the angle vary much from this range.

Of great concern in the design process is shading. Even small vents shading your panels can create big problems for your system. Often is preferable to alter the ANGLE of your system to avoid SHADING. If you're very serious about evaluating the shading on your potential site, you can purchase a Solar Pathfinder. This ingenious device will show you exactly what obstructions will shade your panels at what time of year. This device is an essential tool in a potential solar installer's toolbox. Something to keep in mind: trees grow. How tall will the trees around your property be in 10 years, when your panels are barely starting their functional life?

So what are the options if shading and roof angle isn't optimal? Often deck railings, porch covers, and even shed roofs are great for solar power centers. They are usually more accessible for cleaning and snow removal, and they have the added benefit of being more visible. Many consumers who are very proud of their clean energy contributions like guests to be able to see and touch the panels.

Ground mounted systems are great for people with ample space. This minimizes the danger of roof work and makes adjusting them for seasonal sun shifts easier. Many advancements have been made in ground-mounted tracking systems. These systems have a post that holds the panels up on a swiveling bracket. A heat-sensitive refrigerant that is contained in the outer frame of the unit heats up as the sun hits it, collecting fluid in this area, and then tilting the panel in that direction. The result is a silent, powerless unit that follows the sun across the sky. Very clever.

# Components of Solar Power Kits

By far the most popular solar power systems are grid-tied, sometimes called a utility-connected or intertie, systems. This is the simplest and least expensive way to start generating free renewable energy at your home. Solar power kits are generally comprised of the following components:

- **Solar Array:** This made up of the solar panels that generate electricity from the sun. The size of the array can vary widely and will depend on the customer's budget, consumption, and space considerations. The array can be installed on the roof, the ground, off of a deck or out-building such as a shed, or on a ground mounted tracking system. The tracking system uses a powerless system to tilt the array so that it faces the sun as it travels across the sky. The array should be placed in a position to minimize shading during the year.
- **DC Disconnect:** This is a basic disconnect switch so that the downstream systems can be serviced while the panels are generating electricity.
- **Inverter:** Solar cells generate direct current (DC) power. The systems in your home and the utility grid generally use alternating current (AC) electricity. The inverter takes the DC power from your array and turns it into AC power that your home can use.
- **AC Disconnect:** This is basic AC disconnect that isolates the entire solar array and the inverter. The DC Disconnect, Inverter, and AC Disconnect are usually placed near the utility meter, mounted on a wall away from high traffic areas.

After the AC Disconnect, the system usually ties directly into the main electrical panel for the home. The main electrical panel has a feed from the utility meter. If the solar units generate more electricity than the house consumes, the excess electricity flows back through the meter, turning it backwards, onto the electrical grid. Thanks to legislative measures over the last few decades, the utilities MUST buy this electricity back from you. The rates at which they purchase it from you vary from provider to provider.

Some utilities have started instituting Time of Use (TOU) charges for customers. During the day when air conditioning and industrial consumption is highest, utilities can have trouble keeping up with demand. So electric companies have started charging customers more during these times to encourage conservation. This creates another incentive for customers to install solar cells since these are also the times when they are generally not home and solar energy production will be at its highest. The utility will usually buy the electricity back at the higher rate during peak hours. For example you could produce electricity midday and sell it for $.20 per kilowatt-hour, and then buy it back at night for $.10 per kilowatt-hour. If the homeowner used less then they generate throughout the month, they would see a credit (and a check) instead of a bill.

We get a lot of inquiries about off-grid or stand-alone systems. These are recommended only when tying into the utility grid is not practical. Here are some of the advantages to having a utility connected system:

- **Initial Cost:** The initial cost of purchasing a system that would provide for a home's entire electrical needs can be pretty expensive. With variable climate and weather conditions in the US, the use of an off-grid power system requires a lot of batteries. And off grid systems generally require a backup energy provider, such as a propane generator, which adds significant cost and complexity to the system.
- **Operating Cost:** The operating cost of grid-tied systems is extremely low. Solar panels almost always have 20-25 year warranties and some of the panels manufactured for the space program in the 1950's are still operational. Batteries used in off-grid systems require regular maintenance and have a lifespan of 5-10 years. Backup generators also require significant maintenance and a reliable fuel source.

- **Reliability:** Line-tied systems are pretty simple and can have virtually no 'down time' where the customer will be without electricity. The complexity of battery/generator backup systems can lead to significant down time and can be frustrating for the system owner. A lot of times bad weather, which means there is little solar energy collected, makes generators and batteries perform poorly as well.
- **Flexibility:** Having both an alternative energy source and a utility source means you can install a system to meet your current needs, and then have the flexibility to increase the number of panels later.

There are generally two types of grid-tied solar power systems: Power Systems WITH Battery Back-up and Power Systems WITHOUT Battery Back-up.

**Power Systems WITHOUT Battery Back-up:** These systems are the most popular renewable energy system for homeowners because of their relative simplicity.
The **advantages** of these systems include:

- Cost effectiveness: when combined with net-metering systems payback times from 5-10 years are common
- These systems are relatively simple to design and install
- Overall system is more efficient because the battery efficiency is not a factor

Some of the **disadvantages** of systems that do not have battery backup:

- May or may not provide backup power in the case of grid failure
- Does not allow for as much power management

**Power Systems WITH Battery Back-up:** These systems are very useful for homeowners who experience frequent power blackouts. With ample sunshine, these systems give the customer more independence, while still having a system backup (the utility grid).
The **advantages** of these systems include:

- Can provide continuous power regardless of utility availability or weather conditions.
- These systems make it easier to manage your power production and storage.

Some of the **disadvantages** of the battery back-up systems:

- Increases the complexity of the system
- More components to install
- Increased initial price of the system
- Increased maintenance and operating cost of the system
- Decreased system efficiency due to the battery efficiency
- Environmental issues: The manufacturing and disposal of batteries involves chemicals and metals that most eco-minded consumers would rather avoid.

Battery back-up systems have to include the following components, in addition to those listed above:

- **Charge Controller:** The DC power from the solar panels must first enter the charge controller, which ensures that the batteries receive a proper charge and are not overcharged.
- **Battery Bank:** The battery bank requires as much as design consideration as the solar array. Considerations include the system voltage, inverter voltage, and capacity of the batteries. The daily consumption and how many days of electricity the customer wants to store affects the capacity.
- **Critical Loads Panel:** The inverter is usually tied into an additional panel to protect the system from excess amperage from the battery and solar system.

# 8 Great Things About Do It Yourself Solar Power Kits

Many do it yourself homeowners are trying to find ways to 'go green'. Energy efficiency and going green go hand in hand. If you've already made your home as energy efficient as possible, the next logical step is to start generating electricity yourself. The easiest way to do this is with solar energy. Thanks to advancements in solar technology and marketing, you can now purchase a solar power kit that can be up and running in a matter of days. Here are 8 great things you probably didn't know about these residential kits:

1. **Easy design.** There are many tools needed to design the ideal solar power system for your home. Fortunately, these tools are readily available and easy to use. The National Renewable Energy Lab has a tool called PV Watts on their website for determining how much energy a system would produce in a year in your area. Most kit manufacturers have similar tools and will walk you through the process if you like or simply design the system for you. It is important to remember however, that you must evaluate your home thoroughly and find the place most likely to get steady, unshaded sunshine throughout the year.
2. **Simplicity.** A grid-tied solar panel array is a relatively simple system. The panels are mounted on a system that is compatible with your home and the panels. Many of the mounting hardware manufacturers have videos on their websites on how to install their systems. Once mounted, the panels generally tie together into a gathering box, and then are wired to the inverter. The inverter turns the direct current (DC) electricity that the array generates into alternating current (AC) electricity that your home and the power grid uses. Then the system ties into your electric meter. Most utilities insist on making this connection to the meter and the grid, as they have to install a bi-directional meter so that it can spin backwards in the event you generate more electricity than you use. Many utilities recognize the importance of renewable energy and do not charge for this service.
3. **All Inclusive.** Solar kits are designed to be turn-key, meaning they are meant to be all inclusive. The wiring, hardware, and accessories are all included. Occasionally you may have to provide some small parts to complete the installation depending on your particular house.
4. **Use Friendly.** These systems of course include the most important part: instructions. Many companies recognize that home-owners are by far the largest market for solar panels. So they have created instruction manuals for installation and operation that are easy to understand for the average person. The systems also don't require special tools. Usually the basic tools that most do it yourself folks have (e.g. wrench set, pliers, drill, hand tools, ladder, etc.) are adequate. And most equipment rental businesses offer anything you need and don't have. It is important to enlist the help of a master electrician to test the system and ensure that the connections are made properly.
5. **Permit ready.** It is very important to get the proper permits for these installations. Local building departments are great resources for the information on best practices in your area. Most kit makers provide complete schematics and specifications that permit departments can use to approve your installation. Usually this is all that's needed to get the proper permits.

6. **Customized.** Are you looking to provide nearly all your home's power with solar? Or do you just want to light the shed in the backyard? Regardless of your needs, these systems can be scaled to meet your specifications. Solar kits can be used for lighting, security, remote power, telecommunications, and residential uses. Your kit maker can design a system for nearly any application.
7. **Expandability.** Don't have enough money to get it all done now? Luckily these systems are very 'modular', meaning you can start out with enough panels for today, and still add more components in the future as your needs grows.
8. **Incentives.** All solar power kits are eligible for some sort of incentive. The federal government has a 30% tax credit for renewable systems and most utilities and/or states have an additional incentive. In Louisiana you can get 80% of your system paid for through these programs. In California, almost 50% of the system can be paid for this way. The Database of State Incentives for Renewables and Efficiency (DSIRE) is a great resource for this.

So now that you know more about home solar power kits, its time to get started designing a system for you.

# Basic Principles of Solar Panels

Solar power and solar panels are getting a lot of attention as part of the solution to our energy crisis. Solar energy, also called photovoltaic energy, is undergoing rapid changes thanks to massive investment in research and development. This article will discuss the basic makeup of photovoltaics in hopefully easy-to-understand terms.

A solar panel is made of several photovoltaic cells. The cells are very thin, about $1/100^{th}$ of an inch thick and usually 3 to 4 inches square. These cells convert sunlight to energy by the photovoltaic effect (we will discuss this effect in detail in a later article). These cells do not require fuel and have a standard lifetime of 20-30 years.

Photovoltaic (PV) cells are assembled together to create a solar module. The module is what you are used to seeing as a panel. It has anywhere from 2 to 200 cells assembled together, encased in tempered glass and aluminum to make them weather resistant.

Like batteries, cells can be combined in series or in parallel to create larger and more specific voltages and amperages. For instance, four 1-volt/1-amp cells in series will combine for 4 volts, but the amperage will stay at 1 amp. By contrast, four 1-volt/1-amp cells in parallel will maintain 1 volt but have 4 amps of output. You can multiply the amperage by the wattage (in the example above 4 x 1) to get the watts generated. A watt is a measure of energy (think of a 40-watt light bulb).

Modules can be made in a many sizes and shapes to fit their application. Panels come in standard rectangular, triangular, foldable, and even thin-film rolls. This means they can be used in a wide variety of applications, from boats and rv’s to electric cars and space stations.

Modules are combined to create solar arrays. An array is a group of modules assembled together and designed to meet a certain electrical load. You’ve probably seen most arrays

mounted on the rooftops of homes. These arrays are designed to generate a certain amount of electricity over the course of a year.

Generally solar modules convert about 10-15% of the energy that strikes them into electricity. This means that for every 100 units of energy that actually hit the panel, only 15 of them actually enter the home as electricity. This is the biggest area of research now, as scientists recognize that significant advancements in solar efficiency will lead to cheaper solar energy.

Panels generate direct current (DC) electricity. Think of a garden hose that is simply turned on produces water in a steady stream. Most household electronics and the electrical power grid are designed to take alternating current (AC) power. Now imagine that the water of coming out of the garden hose is being turned off and on so quickly that it has a "pulse". This is done because AC power travels over long distances much more efficiently.

This means however, that the electricity coming out of the solar array must be converted to AC if it is going into your home. This is done with an inverter, which takes the DC power and makes AC power. The power is then ready to service your home, an electrical grid, or a device. Some devices (certain lights, batteries, special devices) use DC power and therefore do not need an inverter.

# How Solar Panels Work

Solar energy is getting a lot of attention these days. Its time to answer the question: how do they actually work? It is not obvious how a panel can convert the sun's rays into electricity without moving parts. This article will help explain the process in terms that hopefully anyone can understand.

The most basic definition of how solar panels work is that the sun strikes a certain material, it excites electrons and creates a current and voltage that can be used to power devices. Now let's delve a little deeper.

First, silicon is taken from the earth. Silicon is one of the earth's most abundant elements. It's found in sand and rocks of all types. You've probably heard of 'Silicon Valley', the hotbed of technology research and investment in California. It is so called because silicon is used in computer chips.

Silicon is a semi-conductor. Think of copper, a conductor, as in copper wires. Now think of rubber, an insulator, such as the coating on a copper wire. Silicon falls somewhere in between and is therefore called a semi-conductor. This property is exploited in computer chips and solar panels to handle tiny reactions that generate electrical currents. An electrical current is basically a "flow". Picture a wire as a tiny pipe and the current as the rate at which the "water" (in this case electricity) flows through the pipe.

But silicon by itself is not enough to create power from the sun. The silicon is grown into a very thin crystal-like wafer using pressure and heat. It is then coated with two different materials: boron and phosphorous. Boron is coated on one side, phosphorous on the other,

with a gap in between the two layers. Boron, when combined with silicon, is a positive material, but it wants to be neutral. The only way it can get neutral is to gain an electron, which has a negative charge.

Now enter phosphorous. Phosphorous and silicon is a negatively charged material, meaning it has extra electrons. But it wants to be neutral too! And how can it do that? By getting rid of electrons of course! And how will it get rid of them? That's where the good old sun comes in.

When sunlight strikes the cell, it gets those electrons all excited. Just think of the electron as a kid in his mom's arms as they approach the park. He just can't wait to get away from mom and onto the swing set. The electrons leave the phosphorous and go toward the positive boron, creating an electrical pressure as they enter the gap. This pressure must be released, and is through the wiring in the cell. This creates the flow, or current, we talked about earlier.

The cells are coated with materials to ensure the sunlight is absorbed and not reflected. The silicon wafers are wired together and encased in tempered glass and aluminum to prevent weather damage. These are called panels, and are then wired together to form an array. And that is the basic building block reaction of a solar panel.

# Doing an Energy Audit on Your Solar Home

Many homeowners are considering a solar power kit or solar panel system for their home. Solar power is a wonderful way to "go green" and produce clean, renewable energy. But before you do this you have to make sure your home is as energy efficient as possible. Many public utilities will require that you complete an energy audit before they will give you a rebate for installing solar panels. The California Solar Initiative requires everyone that is seeking a rebate to complete an audit before they even get solar installation estimates. Many utilities and states are now giving incentives for improving energy efficiency since the easiest way to save energy is to quit wasting it. This article will help you start an audit and evaluate your home to make sure you are saving as much energy as possible. Lets get started.

**The Power Bill**
To audit your energy consumption, first you should know what your consumption is. Take a look at your bill, it will tell you how many kilowatt-hours (kw-hrs) you use in a month. The average American home uses about 940 kw-hrs per month. How far are you above or below this? Make it a goal to reduce your power bill by 10-20% over the next six months. And when you achieve that goal, try to reduce your consumption by another 10-20%.

**Lighting**
One of the easiest way to be energy efficient is to use Compact Fluorescent Lights (CFL's). These bulbs use from 50-80% less energy than traditional incandescent bulbs. Plus CFL's last longer than traditional bulbs. Additionally solar garden, shed and security lights can eliminate the need to pay the power company to light your yard and out-buildings.

**Refrigerators & Appliances**
Walk around your house and just see what is running. Your refrigerator probably is running right now. Did you know your refrigerator runs more efficiently when its full? What a great excuse to buy more food! But really, if you can't keep it full of food, fill water jugs and keep them in the refrigerator. The less air that is inside the fridge, and therefore escapes when you open the door, the less it will have to run. And for your other appliances, check out the operating manual or the settings. Nearly every new appliance has some sort of energy-saving mode, are you using it? What about that empty freezer in the basement, does it need to be powered up all the time?

**Heating & Air Conditioning**
At what temperature is your thermostat set? Did you know adjusting it up in the summer or down in the winter just 4 degrees can reduce your electrical consumption by 20% or more? Wasn't Dad right when he used to talk about wearing a sweater around the house? You can also close the doors and vents to seldom-used rooms to prevent heating spaces that nobody occupies.

**Windows and Doors**
For the price of a happy meal you can weather strip an exterior door. With a caulk gun and a little paint you can prevent what Dad would have called "bought air" from leaving the house through cracks and crevices. Often just simply pulling tight and locking windows and doors will improve their efficiency. And if you want to get really efficient you can rent an infrared camera and see exactly where heat is escaping your home.

**Passive Solar**
Nothing is more powerful for heating your home cheaply than the sun. Passive solar is simply using your windows and the sun to heat your home. Just opening the shades to your home and letting the sun in, even during cold days, can drastically raise the temperature inside. And lowering them and closing them tight can prevent heat from escaping through the glass. True energy conservationists find themselves opening, closing, and adjusting window coverings throughout the day to adjust or maintain the indoor air temperature.

**Insulation**
Have you looked in your attic lately? Odds are you would be surprised at the condition of your insulation. You may be surprised to find there is none. Insulation is assigned an "R value", the higher the value the better. Aim to have R-50 or better in your ceilings, where heat rises and escapes most often. Throw an extra layer of insulation in your attic and you'll see the benefits on your power bill.

For more information on energy conservation, solar panels, and going green, visit our website.

# How Solar Panels Work in a Solar Power Kit

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**Solar Cells**

A solar panel is made of several photovoltaic cells. The cells are very thin, about 1/100th of an inch thick and usually 3 to 4 inches square. These cells convert sunlight to energy by the photovoltaic effect (we will discuss this effect in detail in a later article). These cells do not require fuel and have a standard lifetime of 20-30 years.

**Solar Panels & Modules**

Photovoltaic (PV) cells are assembled together to create a solar module. The module is what you are used to seeing as a panel. It has anywhere from 2 to 200 cells assembled together, encased in tempered glass and aluminum to make them weather resistant.

**Tying Them Together**

Like batteries, cells can be combined in series or in parallel to create larger and more specific voltages and amperages. For instance, four 1-volt/1-amp cells in series will combine for 4 volts, but the amperage will stay at 1 amp. By contrast, four 1-volt/1-amp cells in parallel will maintain 1 volt but have 4 amps of output. You can multiply the amperage by the wattage (in the example above 4 x 1) to get the watts generated. A watt is a measure of energy (think of a 40-watt light bulb).

**Sizes and Shapes**

Modules can be made in a many sizes and shapes to fit their application. Panels come in standard rectangular, triangular, foldable, and even thin-film rolls. This means they can be used in a wide variety of applications, from boats and rv's to electric cars and space stations.

**The Solar Array**

Modules are combined to create solar arrays. An array is a group of modules assembled together and designed to meet a certain electrical load. You've probably seen most arrays mounted on the rooftops of homes. These arrays are designed to generate a certain amount of electricity over the course of a year.

**Efficiencies**

Generally solar modules convert about 10-15% of the energy that strikes them into electricity. This means that for every 100 units of energy that actually hit the panel, only 15 of them actually enter the home as electricity. This is the biggest area of research now, as scientists recognize that significant advancements in solar efficiency will lead to cheaper solar energy.

**AC vs DC**

Panels generate direct current (DC) electricity. Think of a garden hose that is simply turned on produces water in a steady stream. Most household electronics and the electrical power grid are designed to take alternating current (AC) power. Now imagine that the water of coming out of the garden hose is being turned off and on so quickly that it has a "pulse". This is done because AC power travels over long distances much more efficiently.

This means however, that the electricity coming out of the solar array must be converted to AC if it is going into your home. This is done with an inverter, which takes the DC power and makes AC power. The power is then ready to service your home, an electrical grid, or a device. Some devices (certain lights, batteries, special devices) use DC power and therefore do not need an inverter.

# Energy-Efficient Appliances and Lighting for Green Homes

This article will teach you about energy-efficient lighting and appliances that are great additions to your solar-powered home.

Many people are considering a solar-power kit or solar-panel system for their home. This is a wonderful way to save money, produce clean energy, and "go green". But before you do this you have to make sure your home is as energy-efficient as possible. The less energy you use, the greater impact your solar-power system will have on your wallet and the planet. This article will teach you about energy-efficient lighting and appliances.

**Be an Energy Star**

One of the best things you can do is to start putting energy efficiency high on your requirements when shopping for new appliances. Look for the ENERGY STAR logo. This is a government program intended to help consumers find the most energy efficient units. This program also puts the average consumption on each unit so that you can compare two appliances side by side.

**Drying and Cooking**

Generally creating heat with electricity is less efficient than creating heat by burning gas. Heating with electricity requires that the electrical current heat a coil, which then gives off heat. Gas appliances burn gas and discharge the heat directly to its intended use. This means that for cooking and drying, the best bang for your buck is with gas appliances. You'll notice with gas appliances that your clothes tend to dry quicker and your food cooks faster.

**Washing Machines**

With the emphasis on energy efficiency in the last few years, high-efficiency (HE) washers have gained in popularity. Many HE washers use 70% less water in each load. They use a side load feature, instead of top load, which means less water is needed since the clothes spin through the water sitting at the bottom of the drum.

Conventional top-load washer need to fill the drum up with water for the clothes to get wet. The HE units spend less time and energy filling the tub, draining the tub, and rinsing the clothes. It also means there is less weight for the drum to spin, saving energy. In arid areas, some water companies are offering rebates for water efficient appliances. Remember, saving water and saving energy go hand in hand.

**Power Strips & Electronics**

Most electronic devices draw a "phantom load" of up to one-third of their operating power. This means that even when your DVD player is technically off, it is drawing electricity. This electricity is often intended to allow remote controls to work (if your DVD player was completely off the remote would not work).

This may not sound like much, but if every electronic device is drawing a little power 24 hours a day this can add up. The best way to get rid of this waste is to get a power strip for each area of the house that has several of these devices (e.g. the home office, the entertainment center, the kitchen). At the end of each evening, and as you leave for work, just make a habit of going around and shutting off the all the power strips.

**Lighting**

By now you've probably heard of Compact Fluorescent Lights (CFL's). These lights can use up to 80% less energy than conventional incandescent light bulbs. Remember how electricity uses a current through a coil to generate heat? Conventional light bulbs work much the same way. You can see the coil in an old incandescent light bulb. With CFLs, a gas is heated to generate light, using far less electricity and in most cases lasting much longer.

These lights should be standard issue in every home these days. Just make sure to get the low-mercury bulbs. And don't forget, solar garden and security lights can handle virtually any outdoor lighting needs you have.

**Disposal**

When getting rid of your old appliances, don't forget about the environment. Many appliances, especially refrigerators, contain harmful chemicals and gases. Call your local waste management company for proper methods of disposal for older units. Even better than disposal is recycling your old fridges, stoves, and washers. Many companies will come and take them off your hands for a minimal charge, and they strip down the metal components for scrap and rebuild parts that can be reused. Another great way to recycle: Craiglist or your local classified ads. Many first time home buyers, landlords, and dormitories take old appliances and use them.

# Tips on Sizing a Solar Panel PV System to fit Your Budget and Home

This article discusses the financial aspects of sizing a solar panel system for your home.

With a new U.S. president and a new outlook on renewable energy, many people are looking at solar energy as an option for powering their home. Many people are attracted to the energy savings and good feelings of solar, also called photovoltaic or PV energy. In this article we will discuss the financial aspects of designing a system for your home.

**The Power Bill**

Before you determine what size system you want, you should take a look to see how much you're using (we also suggest you conduct a full energy audit to reduce energy waste in your home). To get started, take a look at your utility bill. You will notice it tells you variety of things, the most important being how many kilowatt-hours (kw-hrs) you used last month. It may also tell you how much you used in the last 12 months, how much you used a year ago, and how much you used this year to date. It should also tell you how much you are paying per kw-hr, it is usually in the range of $.08-$.12/kw-hr. This information will be used later in our calculation.

**The Power Company**

Next, make a call to the power company for some information. Ask if they offer any rebates or incentives for grid-tied PV power systems installed in their service area. This means that the system will be tied into their grid and they will buy any excess power your system generates. In some areas of the country, the utility will pay for half of your equipment and installation. Some utilities and municipalities also have financing options to help homeowners. The website Dsireusa.org can help you find out more about incentives in your area.

**The Tax Man**

The federal government has a 30% tax credit for residential solar power systems. This credit has no cap. For example, lets say you were calculating your taxes for one year and you determined that you paid $10,000 in taxes for the year from your paycheck. If you bought a $15,000 PV system and took the 30% credit, .3 x $15,000 = $4,500. You would receive a refund check for $4,500 from the IRS, on top of any other refunds you may have coming. You could receive up to the $10,000 you paid in taxes for your solar power system, meaning you would pay no tax and have cheap, clean energy. And many states have state tax incentives as well. Check out Dsireusa.org for more information on tax incentives.

**Solar Power Example Calculation**
Here's an example budget calculation for a typical home. Lets say you look at your power bill and you are using 500 kw-hrs per month, or about 6000 kw-hrs per year, and your power costs $.10/kw-hr. Now we have to make an assumption about the size of the system. We'll start with a simple 2000 watt PV system to get started. At approximately $10/Watt installed, this system would cost about $20,000 without incentives. However you determine that your utility has a $3/watt rebate. So, $3/watt x 2000 watts = $6000. Then you have the federal tax incentive of 30%, .3 x $20,000 = $6,000. So you are actually paying $20,000 - $6,000 -$6,000 = $8,000 for your system.
Using the solar calculator tools on sites like Solarsphereonline.com or Findsolar.com, you determine that a 2000 watt system, based on where you live and how you install the system, will generate 5,000 kw-hrs per year. At $.10/kw-hr, you are saving 5,000 kw-hrs/yr x $.10/kw-hr = $500 per year by generating power with the PV array. If you divide $8,000 by the $500 savings, you can see that your system will pay for itself after 16 years. This is good because most systems will last at least 30 years.

# Understanding Solar Power and Utility-Connected Kits

A big consideration in installing a solar power kit is to decide how you will connect to the grid. Here are some terms you should be aware of before you get started.

Thousands of people are installing solar panel systems on their homes these days. They are attracted to clean energy for the lower power bills, good feelings, and tax incentives they bring. One of the biggest considerations in installing one of these systems is to consider how you will connect to the grid if you choose to do so. Your solar installer or electrician can help with this, but there are some terms you should be aware of before you get started.

**Net Metering**
Net metering is a fancy way of saying that your meter can spin backwards. When you install a solar power kit on your home, you can often generate more electricity that you use at times. This is especially true if you are away from home during the day and most of your electronics are off. This is when your system will generate the most energy, since the sun is at its highest and brightest.

Your system, for instance, could be generating one kilowatt, but your home might only be using .25 kilowatts. The meter would spin backwards, and .75 kilowatts would be fed into the grid. In this case the grid is acting as a battery system, essentially storing your energy until you need it. When you use energy, usually at night when the sun is down, your meter will spin forward again.

The bill you receive at the end of the month will be 'net' your consumption and your production. Thanks to Federal laws pass in the 70's, utilities must buy your energy back from you. The only downside is that the rates are often not the same. For instance you may be paying $.10/kilowatt-hour, while the utility may only pay you $.06/kilowatt-hour. The lower rate is often called the 'avoided cost' or wholesale rate. This means that the utility is buying your power at a reduced rate since it still has to install and maintain the power grid to transport your excess energy to other users.

**Time-Of-Use**
Time-of-use is something that has come in that past decade or so as the demand for power has risen and the construction of power stations has not been able to keep up. Remember the 'rolling blackouts' in California of a few years back? This was due to peak demand, usually occurring during the day when industry consumption and air conditioning are at their peak, outstripping supply. The blackouts would be phased in over areas to avoid a massive grid shutdown for a long periods of time.

Because of these blackouts, which surely made for angry customers, the utilities are looking for ways to discourage usage during peak periods. One of these methods is time-of-use charges. Under this program if you use a kilowatt at noon it would cost more than if you use a kilowatt at 8pm.

This is where solar power comes in. Since solar produces the most energy during the day, this can help the grid meet this supply shortage. And many utilities recognize this fact and will pay you an increased rate for the energy you produce during the day. So if your utility is considering time-of-use charges, you should ask if that means that they will pay, not just charge, an increased rate.

**Interconnection Agreement**
As you probably know, the power grid is an incredibly complex system. The utilities deliver the power to your home at a certain voltage and amperage which maximizes the efficiency of the production and consumption of electricity. So, you can't just throw up some panels and then plug it into an outlet, hope the power company buys it back, and everything will be fine.
There are very strict rules about what kind of power the utility will take, and the interconnection agreement will define this precisely. Generally you have to turn your solar energy, which is direct current (DC), to alternating current (AC) and match the voltage of the grid. This is all done with the inverter on your solar power kit, but the utility may have certain guidelines about the type and brand of the inverter.
The interconnection agreement will also detail initial and then yearly inspections and the power rates we discussed earlier. Generally it is advisable to talk to your power company very early in the process, thoroughly read the interconnection agreement, and understand what is expected of a grid-tie system. Since your utility may have rebates and incentives for renewable energy anyway, it is a great idea to get them involved from the beginning.

# Easy Solutions for Powering Small Electronics Around Your Home

In this article we'll talk about your options for simple solar panel systems for powering smaller devices and the advantages and disadvantages of each option.

Solar power has received a lot of attention as one of the answers to our energy crisis. The fact that solar panels provide energy from a clean and free source, the sun, makes it a viable option. But many homeowners are asking: what sort of system would work for me? Well of course that depends on your situation and what you are looking to get out of solar

energy. Let's talk about your options for small simple systems and the advantages and disadvantages of each option.

**Integrated Solar**
This is probably the smallest of all photovoltaic systems. These can be found where the solar panel is built right into the appliance that it is powering. For instance calculators, garden lights, fountains, flashlights, and many other small electronic devices are powered by the sun.

**Advantages of Integrated Solar Power**

- Portability. These units often can be moved easily and since they are powered by solar they don't require power cords.
- Maintenance Free. Maintenance is virtually nonexistent and they do not require expensive fuels.
- Batteries. These units have an internal battery which lasts much longer than the common battery we're used to.

**Disadvantages of Integrated Solar Power**

- Scalability. General these units are small and the power they require is minimal. For larger appliances that consume more energy having integrated solar panels is not practical.
- Part Replacement. Integrated products usually are hard to take apart and fix. For example, if the battery quits working you may just have to replace the entire unit.

**Direct Solar**
This is the simplest way to get power from the sun's rays. Direct solar simply feeds the energy that is collected by a small array to an appliance or pump without a battery. The system usually consists of a small panel, a mounting mechanism, and the pump or appliance.

Advantages of Direct Solar Power

- Cost. These systems usually are fairly inexpensive since they don't require batteries.
- Installation. Direct units are relatively easy to install as long as the area has ample sunshine. Since power cords are not required, almost anyone with a few tools can install them.
- Remote Capability. Homeowners and business owners love these systems for their water features and well pumps that can fill tanks or ponds during the day when the sun shines and then shut off as soon as the sun sets.
- Maintenance Free. Maintenance is virtually nonexistent and they do not require expensive fuels.

**Disadvantages of Direct Solar Power**
**DC Power. Solar panels produce direct current (DC) power and many appliances require alternating current (AC) power.**

- Storage. Since these systems don't have batteries, they don't run when it is cloudy or at night.

**Solar-Battery-DC Systems**
Many DC systems can be powered with small panels and battery storage systems. These systems will consist of a solar panel, mounting system, battery bank, charge controller and the connection to the electronic device. The charge controller ensures that PV units do not overcharge the batteries.

Advantages of Solar-Battery-DC Systems

- Storage. These systems can store the sun's energy for use at night or on cloudy days.

- Remote Capability. These systems are great for lighted signs, fountains, out-buildings and pumps that need to work regardless of sunshine and where access to power is an issue.
- Lighting and Pumping. Since lighting and pumping are very popular tasks for photovoltaic systems, there are special high-efficiency pumps and lights made exactly for these applications.

**Disadvantages of Solar-Battery-DC Systems**

DC Power. Solar panels produce direct current (DC) power and many appliances require alternating current (AC) power.

- Cost. Batteries can add significant cost to the installation depending on how much storage you need.
- Maintenance. Batteries require regular maintenance and need to be replaced more often than solar panels.

If you are thinking about a PV power system for your needs, you should contact a solar professional. They can custom design a solar power solution for almost any application and location.

# Three Ways Solar Power Kits Can Help You Go Green

Solar power is a great option for almost any home. In this article we will talk about the various options for powering homes and remote cabins with green energy.

There are many ways to power your home solar panels and solar power kits. These systems can fit nearly any size home, demand, and space requirement. In this article we will discuss three different kinds of photovoltaic (PV) systems and the advantages and disadvantages of each.

**Off-Grid Solar Dependent Systems**

These systems are usually found in extremely remote locations where electricity and fuel sources are hard to come by. These systems consist of:

- Solar panel array: a combination of solar panels that are sized according to the cabin's electrical consumption. The higher the consumption of electricity, the larger and more expensive the array must be.
- Charge controller: this takes energy from the solar array and feeds it into the battery bank, while ensuring that the batteries are not over-charged (which would damage the batteries).
- Battery bank: this is specially designed to fit both the solar array and the needs of the home. For instance you might need a larger battery bank if the area you are in experiences frequent cloudy days. The battery bank would have to store several days worth of energy to account for lack of sunshine.
- Inverter: the solar panels and batteries produce DC power and most appliances require AC power. The inverter does the job of turning the DC power into AC power for your home.

**Advantages of Off-Grid Solar Dependent Systems**

- These systems are great for remote cabins, cottages and villages. They allow people to live in areas where they would not normally be able to live. They also provide power to third world villages that would probably never have power otherwise.

- There is relatively little maintenance of this systems. The batteries will require the most attention and will have to be replaced before anything else.
- The cost of these systems, while not cheap, easily beat the costs of constructing a power line to remote areas 9 times out of 10.

**Disadvantages of Off-Grid Solar Dependent Systems**

- There is no means of getting back up power should the system go down due to weather or malfunction.

**Hybrid Solar-Generator Systems**

Most often, off-grid solar installation are supplemented with a backup generator. This system has the same components, with the addition of these things:

- Generator: often powered by gas, oil, or propane, these units are essentially a combustion engine that turns an electric generator. This generates DC power that is fed into charge controller in the same fashion as PV power.
- Wind generator: these systems are gaining popularity for their ease of use, low maintenance, and low initial cost. They can be wired directly to the batteries in many cases as most of them have an internal charge controller. Some even have built in inverters so they can be tied into grid-tied homes directly.
- Micro-hydro: great for homes near flowing water, these systems have come a long way in the last few years. They can be tricky to install, as they consist of a turbine that is mounted in a river or stream. The water turns the turbine and generates electricity, which is fed into the charge controller.

**Advantages of Hybrid Solar-Generator Systems**

- These systems are ideal for off-grid, remote locations. They can be designed for varying weather conditions and consumption, and the homeowner has the added peace of mind knowing that there is a backup generator in case the sun doesn't shine.

**Disadvantages of Hybrid Solar-Generator Systems**

- These systems require a reliable secondary fuel source, whether it be propane or wind. Often these things are hard to come by in remote areas.
- The increased complexity of the system can often make installation difficult.
- Maintenance is heavier on these systems since they usually involve gassing and oiling a combustion engine.

**Grid-Tied Solar Systems**

This by far the most popular PV system. Since the vast majority of homes in the US are connected to the electrical grid, this system probably makes the most sense for homeowners. The system can have batteries, but most often consists of the panel array, inverter, and several breakers and disconnects. The homeowner must also be aware of these items:

- Interconnection Agreement: this is a legal document from the power utility outlining the details of your grid-tied system. This will tell youhow to tie it in and when they will inspect it.
- Net Metering: this allows you to sell your excess power back to the utility.

**Advantages of Grid-Tied Solar Systems**

- These systems are far simpler and easier to install than off-grid applications.
- The grid acts as the battery, so if the solar array goes down or the sun is down the grid will keep the lights on.
- The cost for these systems is lower since the batteries and charge controllers are not necessary.
- Excess power can be sold to the utility to offset the cost of the system.
- Utilities often have rebates and incentives for homeowners installing PV systems which can offset the cost of the system.

**Disadvantages of Grid-Tied Solar Systems**

- Obviously this is not an option for people that don't have an electrical grid nearby.

# Frequently Asked Questions About Heating Your Pool With The Sun

Did you know that a solar pool cover can actually allow you to use your pool earlier in the year and use it well into the cold months?

Its spring time and many homeowners are starting to think about opening up their pools for the season. Did you know that a solar pool cover can actually allow you to use your pool earlier in the year and use it well into the cold months? If you live in a sunny area, this could be a great way to get more out of your pool, start harnessing the sun's energy, and go green!

**How Do They Work?**

These pool covers have two features that allow to work efficiently. First, they absorb the sun's heat and rays with a network of air pockets. These pockets appear to be very similar to the bubble wrap you use for protecting valuable items when moving. The air and plastic bubbles absorb heat from the sun and then transfer it into the water through an efficient bottom layer.

The bottom layer also performs the second function of cover. This layer acts as sort of a one-way street, allowing heat from the outside, while trapping the heat that is in the water. This is done with a space-age, UV-resistant material. This way the heat that is already in your water does not escape.

**Can They Save Me Money?**

Yes, solar pool covers can save you money. They can do this in a couple ways. Most importantly they lower the use of electricity or gas to heat the water. By trapping the heat already in the water and adding heat to the water when the sun shines, the cover reduces the work that the existing heater has to do.

They also prevent water evaporation. This means you'll have to add water to the pool less often, saving money off your water bill and conserving our most precious natural resource.

**What Time Of Year Are They Used?**

Generally they are used just about anytime the sun shines. They are best in climates that experience abundant sunshine, but have cool temperatures in the spring and fall. In these climates, the cover can extend the swimming season by weeks and even months.

**Are They Expensive?**

In short, no, solar covers are not expensive. For a typical 12'x24' underground pool, the cover itself will cost around $300-$500. This is slightly more than a comparable plastic pool cover. But remember you'll be saving money on your power and water bill as well. Typically a solar cover will pay for itself in just a few seasons.

**Are They Hard To Use?**

These covers roll in and out in the same fashion as the old fashioned plastic covers. The solar cover is slightly thicker than the old version, so the reel that is used to roll them up may need to be slightly larger. Every other aspect of the cover is the same as a normal pool cover.

# How Much Solar Power Can I Afford?

Tips on Finding a Solar Panel PV System to fit Your Budget and Home

With a new president and a new outlook on renewable energy, many people are looking at solar energy as an option for powering their home. Many people are attracted to the energy savings and good feelings of solar, also called photovoltaic or PV energy. In this article we will discuss the financial aspects of designing a system for your home.

**The Power Bill**
Before you determine what size system you want, you should take a look to see how much you're using (we also suggest you conduct a full energy audit to reduce energy waste in your home). To get started, take a look at your utility bill. You will notice it tells you variety of things, the most important being how many kilowatt-hours (kw-hrs) you used last month. It may also tell you how much you used in the last 12 months, how much you used a year ago, and how much you used this year to date. It should also tell you how much you are paying per kw-hr, it is usually in the range of $.08-$.12/kw-hr. This information will be used later in our calculation.

**The Power Company**
Next, make a call to the power company for some information. Ask if they offer any rebates or incentives for grid-tied PV power systems installed in their service area. This means that the system will be tied into their grid and they will buy any excess power your system generates. In some areas of the country, the utility will pay for half of your equipment and installation. Some utilities and municipalities also have financing options to help homeowners. The website Dsireusa.org can help you find out more about incentives in your area.

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The federal government has a 30% tax credit for residential solar power systems. This credit has no cap. For example, lets say you were calculating your taxes for one year and you determined that you paid $10,000 in taxes for the year from your paycheck. If you bought a $15,000 PV system and took the 30% credit, .3 x $15,000 = $4,500. You would receive a refund check for $4,500 from the IRS, on top of any other refunds you may have coming. You could receive up to the $10,000 you paid in taxes for your solar power system, meaning you would pay no tax and have cheap, clean energy. And many states have state tax incentives as well. Check out Dsireusa.org for more information on tax incentives.

**Example Calculation**
Here's an example budget calculation for a typical home. Lets say you look at your power bill and you are using 500 kw-hrs per month, or about 6000 kw-hrs per year, and your power costs $.10/kw-hr. Now we have to make an assumption about the size of the system. We'll start with a simple 2000 watt PV system to get started. At approximately $10/Watt installed, this system would cost about $20,000 without incentives. However you determine that your utility has a $3/watt rebate. So, $3/watt x 2000 watts = $6000. Then you have the federal tax incentive of 30%, .3 x $20,000 = $6,000. So you are actually paying $20,000 - $6,000 -$6,000 = $8,000 for your system.

Using the solar calculator tools on sites like Solarsphereonline.com or Findsolar.com, you determine that a 2000 watt system, based on where you live and how you install the

system, will generate 5,000 kw-hrs per year. At $.10/kw-hr, you are saving 5,000 kw-hrs/yr x $.10/kw-hr = $500 per year by generating power with the PV array. If you divide $8,000 by the $500 savings, you can see that your system will pay for itself after 16 years. This is good because most systems will last at least 30 years.

# Sizing a Solar Panel System to Fit Any Budget

So much as been made of the new energy economy and the green revolution that many folks have questions about solar power. Many people would like to install a solar power kit, also called a photovoltaic (PV) system, on their home. But most of them don't know how much these systems cost and how much they can afford. This article will help you determine if a solar power system is in your budget. We'll start with the questions you need to ask and answer.

**How Much Power Do I Use?**
The first task is to determine just how much energy you are using. See our related articles on energy audits to reduce energy waste. Next, look at your power bill. You should see your monthly and yearly usage. This information will be helpful in determining just how much solar energy you really need. You should also note how much your power us costing you in dollar per kilowatt-hour ($/kw-hr).

**Are there Rebates and Tax Credits?**
The short answer is 'YES!' There are hundreds of programs around the country to encourage people t install solar power systems on their homes. The federal government has a 30% tax credit for solar and wind systems. Contact your local power utility for information on rebates that they offer. In some parts of the country the power utilities are offering to pay for nearly half the system. Add this to the federal incentive and you might have 80% of your system paid for by others.

**What Size System Should I Get?**
This question is hard to answer for you. Most people start by trying to cover a percentage of power that they use with solar. Many people start with 25% to 50% of their total power. With the tools you can find on SolarSphereOnline.com and Findsolar.com, you can determine just how large of a system would be need to generate some or all of your power with renewable energy.

If you assume that an installed system will cost about $10/watt, you can estimate a rough budget for the project. For example, if you start with a 1,000 watt system (which is nice place to start for a lot of homeowners) it would cost about $10 x 1000 = $10,000 for the labor and materials. Remember, there are plenty of incentives out there. So if you had a $2/watt rebate from the utility and took the 30% federal tax credit, your actual system cost would be $10,000 - ($2/watt x 1000watts) - (.30 x $10,000) = $5,000. So you could spend the money you saved on something else for your house or even better get a bigger solar power system!

**Can I Do a Little Now and Add More Later?**

One of the best things about solar and wind energy is that they very expandable. You can put in a few panels now, monitor their performance, and then add on to the system as your needs and budget allows. It is generally better to start out knowing you are going to expand later, so that you can plan your space and equipment usage better.

**What's the Next Step?**
Its alwasy good to talk to a solar professional to evaluate your home for solar panel suitability. There are numerous sites on the internet that can direct you to local, insured, and experienced PV installers.

# How Solar Panels Can Power Your Home

There are many ways to power your home solar panels and solar power kits. These systems can fit nearly any size home, demand, and space requirement. In this article we will discuss three different kinds of photovoltaic (PV) systems and the advantages and disadvantages of each.

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- Inverter: the solar panels and batteries produce DC power and most appliances require AC power. The inverter does the job of turning the DC power into AC power for your home.

**Advantages**

- These systems are great for remote cabins, cottages and villages. They allow people to live in areas where they would not normally be able to live. They also provide power to third world villages that would probably never have power otherwise.
- There is relatively little maintenance of this systems. The batteries will require the most attention and will have to be replaced before anything else.
- The cost of these systems, while not cheap, easily beat the costs of constructing a power line to remote areas 9 times out of 10.

**Disadvantages**

- There is no means of getting back up power should the system go down due to weather or malfunction.

**Hybrid Solar-Generator Systems**
Most often, off-grid solar installation are supplemented with a backup generator. This system has the same components, with the addition of these things:

- Generator: often powered by gas, oil, or propane, these units are essentially a combustion engine that turns an electric generator. This generates DC power that is fed into charge controller in the same fashion as PV power.
- Wind generator: these systems are gaining popularity for their ease of use, low maintenance, and low initial cost. They can be wired directly to the batteries in many cases as most of them have an internal charge controller. Some even have built in inverters so they can be tied into grid-tied homes directly.
- Micro-hydro: great for homes near flowing water, these systems have come a long way in the last few years. They can be tricky to install, as they consist of a turbine that is mounted in a river or stream. The water turns the turbine and generates electricity, which is fed into the charge controller.

**Advantages**

- These systems are ideal for off-grid, remote locations. They can be designed for varying weather conditions and consumption, and the homeowner has the added peace of mind knowing that there is a backup generator in case the sun doesn't shine.

**Disadvantages**

- These systems require a reliable secondary fuel source, whether it be propane or wind. Often these things are hard to come by in remote areas.
- The increased complexity of the system can often make installation difficult.
- Maintenance is heavier on these systems since they usually involve gassing and oiling a combustion engine.

**Grid-Tied Solar Systems**
This by far the most popular PV system. Since the vast majority of homes in the US are connected to the electrical grid, this system probably makes the most sense for homeowners. The system can have batteries, but most often consists of the panel array, inverter, and several breakers and disconnects. The homeowner must also be aware of these items:

- Interconnection Agreement: this is a legal document from the power utility outlining the details of your grid-tied system. This will tell you how to tie it in and when they will inspect it.
- Net Metering: this allows you to sell your excess power back to the utility.

**Advantages**

- These systems are far simpler and easier to install than off-grid applications.
- The grid acts as the battery, so if the solar array goes down or the sun is down the grid will keep the lights on.
- The cost for these systems is lower since the batteries and charge controllers are not necessary.
- Excess power can be sold to the utility to offset the cost of the system.
- Utilities often have rebates and incentives for homeowners installing PV systems which can offset the cost of the system.

**Disadvantages**

- Obviously this is not an option for people that don't have an electrical grid nearby.

For more information on solar power kits and solar panels, visit our website.

# 5 Things you Should Know About Solar Tracking Systems

As a result of the green energy movement and increased renewable sources of power, like wind energy, biomass and hydroelectricity, solar power systems have gained more demand. One way to become more efficient when running a solar energy program is to use a tracking base. Here is an in-depth look at a few things you should know about running a PV system:

1. Tracking Pros

Because tracking arrays receive more peak sun-hours, energy production can be improved with them. This allows a smaller array to be installed, shrinking the required array footprint - a benefit for sites with limited space.

Kits with wide-open solar access (shade-free from dawn to dusk with low horizons) can benefit the most from a tracking array, wringing every last electron from the sun as the year progresses.

The energy gained during early morning and late evening hours can be significant - especially during long summer days - when, at many northern latitudes, the sun rises in the northeast and sets in the northwest.

2. Best Applications

Extra power is only beneficial if you can use it, sell it, or store it as it is produced. A grid-corrected system with a wide open sun window can be a good candidate for a tracked array since every kilowatt-hour gets used. In net-metered situations this home kit grid is credited to your utility bill.

Another good candidate for a tracking array is an off-grid system that has daytime summer-dominated loads.  Water-pumping systems are also ideal candidates for PV-direct tracked arrays.

3. Basic Installation of Solar Power Kit

Tracking arrays, like all pole-mounted arrays, are like big sails: Set several feet above the ground, they can experience significant wind-loading. To keep them in place, arrays are usually mounted on large poles (6 to 8 inches in diameter, or even bigger for taller poles) which must be set in large concrete footers. Tracker components can be heavy, often tipping the scales at more than 200 pounds. Often, they'll need to be placed with a crane, backhoe bucket, or some other mechanical means.

When installing module home-run wiring, leave lots of wire length from the modules to the junction box on the pole. This will ensure that when the tracker is in its furthest positions, the cables are not pulled too tight.

4. Installation Options

Electronically controlled trackers have an optical sensor that needs to be mounted at the top of the array. Also, a tracker controller needs to be mounted on the drive and powered either by the battery bank or AC power (if available).

In either case, a power line needs to be appropriately planned for and run from the power source to the controller. Although the controller can be powered directly from the PV system (PV array), this option is discouraged because there's no power available from the PV array after sunset. This means that the tracker must wait until the next morning to turn back to face the sun.

During the summer months, the optical photovoltaic sensor can get confused as to which direction it should return, since it will end up pointing northwest in the evening. Tracker rotation must be limited to 180 degrees to avoid this confusion. However, this does limit the energy gain the tracker can yield in the summer months, since the suns azimuth angle exceeds 180 degrees.

5. Green Money

The decision to invest in tracking solar power systems is a personal one based on your budget and your willingness to deal with possible maintenance and repair issues. In the right circumstances, a solar power tracking systems can save you money up-front and keep you on track to greater energy production and efficiency.

# How Solar Tracking Systems Work

Solar power systems are an investment both financially and environmentally. A PV system will save money on electricity and ensure a greener future. The one drawback with solar is that most system are fixed whereas the sun is continually changing positions in the sky. However, with the use of solar tracking systems this loss of energy can be largely mitigated.

But what are solar tracking systems? Put simply, these systems when applied to photovoltaic power kits track the sun, and cause the panels to rotate to receive sunlight for as long a possible. This increases your power output by as far as 30 to 50%, though the amount can be significantly less than that depending on the photovoltaic tracking system you use and your location. Of course this energy generated does not take into account the amount of power the tracking system itself uses, but it's minuscule compared to the additional power you'll be gathering from your sun-powered home kit.  There are also power-less systems that use gas-filled tubes to move the trackers.

Despite all the benefits in utilizing a tracking system with your sun-powered panels, there are some considerations that must be taken into account. While the amount of additional energy generated during the summer is immense, when it comes to winter, when the sun moves less broadly and the most electricity is utilized in the home, it is little better than a fixed sun-powered system. It should be noted though that if you store or sell the additional

electricity generated in summer, you should have enough addition electricity or funds to either have additional electricity in winter regardless or purchase additional power from a third party. What's more, though photovoltaic kits with tracking systems do generate more power, they are also more complex and run the risk of breaking down, as does any moving machinery. If you don't believe that the additional power gathered is worth the maintenance or cost of someone else maintaining it, then perhaps a PV system with tracking isn't for you.

That said, the power generated by such a tracking system in comparison to a standard PV system is usually more than enough to off set those few complications, the possibilities of utilizing such power opening up all sorts of possibilities. Storing and selling power has already been covered, but if that's of little interest to you you're more than welcome to simply go with a smaller array, as the extra power gathered should cover the amount lost from less panels. This means that tracking systems can make putting a PV kit in a limited space a viable possibility, good news for anyone who doesn't have a lot of land. What's more, even if you only install solar power to power a single device, a tracking system will greatly increase the length of which that device can perform. For instance, if you hook your tracking free solar panels up to a water pump, it would only run when the sun is close to being directly overhead the panels. With photovoltaic systems that do have tracking, the water pump could run from sun up to sun down.

A PV home kit with a tracking system, while more complex, can gather power for a far longer time than one without. Whether this is worth the additional maintenance and cost is up to the individual user.

# Is Solar Power Right for Me?

With all the attention give to renewable energy and the green revolution, many people are asking if solar power is right for their home or business.  Here are a few questions to answer to see if solar is right for you.

**Do you live in a reasonably sunny area?**  About 50% of the US is what solar experts would call 'moderate' for exposure to the sun.  This includes the Midwest, Northeast, and upper Northwest.  These areas, while not ideal, do have pretty good exposure to the sun's rays during the spring, summer and fall.  And the panel technology is getting better and better at producing energy on cloudy and semi-cloudy days.

Much of the rest of the country could be called 'good' or 'great' for solar power.  These areas include California, Texas, Florida, the Southeast, the desert Southwest, and the Rocky Mountain states.  These areas have relatively few cloudy days and the southern latitudes mean the sun is higher in the sky and therefore more energy reaches the ground.

Areas in the great lakes area and Alaska have limited sun exposure and are therefore usually poor candidates for solar power.  These areas are often great candidates for wind power however, which will covered in another section.

**Do you have an area with good southern exposure and minimal shading?** Most people think of solar and immediately think of glass panels mounted on a roof. There is a good reason for that as this is the area that usually has the most sun exposure and the least opportunity for shading. The area should have great southern exposure with few obstacles. If there is an area on the ground that suits this purpose, there are plenty of mounting options for the ground.

The best way to determine if your roof or ground is right for photovoltaic panels is to take a picture of the south-facing area with a digital camera at 5 times throughout the day. Start early morning, then mid morning around 10, at noon, mid-afternoon around 2 and then about 5pm. This most effective if you do this in March or September, but anytime will do for our purposes. Now compare the photographs to each other. Do you see one particular tree, chimney, or obstacle shading the area consistently over the day? Is one time of day better than another? Can you move the system over a few feet and avoid the shifting shade? Obviously the less shade the better off your system will be.

**What incentives are there in your area?** Fortunately local, state, and the federal government have realized that we cannot go on burning fossil fuels. So they have instituted, along with power companies, a wide variety of rebates, feed-in tariffs, and tax breaks for solar power systems. To make sense of the ones in your area, first call your power company. Chances are they have a help desk set up just for renewable energy questions.

Next, talk to your accountant. The federal government has a 30% tax credit for renewables. Many states have tax credits too. Your accountant can help you determine just what this means for your wallet when factoring in your income and tax liability. Finally, consult the DSIRE.ORG database of incentives. There are most likely incentives for renewables and energy efficiency improvements in your area.

**How much can I afford?** Ok, so you know how the incentives, how much your bill is, and an appropriate area for the system. Its time to figure out how much you can afford. Let's use an example. You determine that you can spend $5,000 on a system. You also determine that between the local power company (30% rebate, which is common) and the federal tax credit (30%) that 60% of your system will be paid for. That means that you only have to pay for 40% of the system, which means you can actually spend $5,000/.40 = $12,500 on a system. Now remember, you may have to pay the full $12,500 up front, but you will get your money back.

So, how much do these systems cost? Well it varies by location and installation, but a good general rule of thumb is around $10/watt installed. So if you had $12,500 to spend, $12,500/$10/Watt = 1,250 watt system you can get. This is a great starting point for most folks. If you configure your initial system correctly, you can add onto it as time goes on.

Are you a contractor or a skilled do-it-yourself homeowner? You can probably install the system yourself with some training, the right solar power kit and the help of a master electrician. You can get most kits for around $5.50/watt, so if you take your original budget $12,500/$5.50/watt = 2,250 watt system, so you can almost double your system capacity by doing it yourself. Which leads to our next question.

**Are you as energy efficient as you can be now?** There are no two ways about it: solar power is expensive. To maximize a solar power system's effectiveness, you need to reduce your consumption. There are a few very easy ways to do this. Start by looking at your power bill and notice how many kilowatt-hours (kw-hrs) you are using in a month. Now remember the acronym L.A.W., and make it the law in your house! It stands for Lights, Appliances, Waste.

For **lights**, you've probably heard about compact fluorescent lights, or CFL's. Many power companies are actually giving these away. They use about 20% of the power that traditional bulbs use and last a lot longer. You can use LED lighting as well, which use even less electricity and last even longer. The price for these is rapidly coming down too.

For **appliances**, remember less is more. If your refrigerator is often empty, fill up milk jugs with water put them on the fridge. This will improve the efficiency of the fridge as the water will retain the cool temperature better than air. Only runt he dishwasher, washing machine, and dryer when they are full. Hang your clothes on a clothes line to dry. And when purchasing new appliances, spend the few extra dollars for the Energy Star performers. The money you save can pay off that extra cost in a matter of months, plus many utilities have rebates in place for efficient appliances. They even have LED plasma televisions coming out now that use a fraction of the energy that older sets do.

Finally, stop the energy **waste**! How many families leave the TV on from the minute they get home until bed time, even if no one is watching. You probably have light on in the yard or the garage that stays on constantly. What about that empty freezer in the basement? Unplug it! Do you really need to crank the stereo while you're vacuuming? I bet you'd hear it better with an energy-sipping iPod and earphones.

Try moving the thermostat by one degree up or down (whichever way will save you money) every two weeks for two months and see if anyone notices. Chances are they won't. And if you if get really serious you can plug all your electronics into power strips (aren't they all already?!) and turn those strips off at night. Every appliance that has a remote control draws electricity even if you think its off.

Try these tips for a couple months and compare your previous power bill to your current. If you institute all of these practices, you'd probably see saving of 30-50%. This means lower bills, and a smaller, cheaper solar power system will suit your needs.

**Can I do this by myself?** How much you can or can't do really depends on your skill set and ability to learn. Grid-tied solar power systems are actually fairly simple. The four major components are the panels, the mounting system, the inverter, and the wiring. Anyone with basic carpentry skills, safety equipment, and a proper power kit can mount and install the panels. The wiring and inverter installation are a little trickier. For these items we suggest using a certified electrician to guide you.

Most of the power kits now come with instructions and drawings. These are useful for installing the system and getting the permits necessary to start the work.

# Economic Payback on Solar Power Systems

If you're a reader of our blog, you are no doubt looking for more ways to live green. You've probably considered installing a solar power system on your home so you can start producing renewable energy. One of the most commonly asked questions about solar is 'When it will pay for itself?'.

If you were to just go out and buy a system, install it, and then count the energy savings, most systems would pay for themselves in about 40 years. Unfortunately thats also how long you can expect most solar panels to last. So, recognizing this and the need for alternative energy sources, governments and utilities have started to offer rebates and credits for renewable energy systems. In some areas, such as Louisiana, California, New Jersey, and Colorado, you can get as much as 80% of your system paid for through rebates. This obviously brings your payback time way down and makes it much more feasible.

Let's walk through a typical solar rebate scenario. Let's say that we're going to spend $20,000 on a system, including equipment and installation. This would pay for about a 2,000 watt, or 2.0 kilowatt, system. This would be a great starting place for most homes. Now, we know that we can get a 30% tax credit from the federal government for a photovoltaic (PV) system. We then proceed to look at the DSIRE.org website to find out about other incentives. We learn that our local utility offers a $3/watt rebate for PV. We investigate further and find out that the state will credit us $1000 on our property taxes for a new system.

| | |
|---|---|
| System cost, installed | +$20,000 |
| Federal credit (30% x $20,000) | -$ 6,000 |
| Utility rebate ($3/watt x 2,000 watts) | -$ 6,000 |
| State property tax rebate | -$ 1,000 |
| System cost after incentives | $ 7,000 |

Ok! This is looking pretty good! Now, how much will we save on our power bill? This is a trickier question, and one that has to be answered by a solar expert that has some information on our home. But for our purposes, lets say that we live in the midwest and have a south-facing roof. A 2.0kW system under these conditions would produce somewhere around 3,500 kilowatt hours of power per year. Now, looking at our power bill, we determine that our power costs $.12/kilowatt hour. So our system will produce 3,500 kw-hrs per year that we wont need to purchase and therefore we will save:

3,500 kw-hrs/yr x $.12/kw-hr = $420 per year power savings

Then we'll take the $7,000 we spend on the system and divide by the $420 in savings:

$7,000 system cost / $420 power savings per year = 17 years

So it will take about 17 years to pay off the system. A couple things that you need to keep in mind, though. For one, if President Obama institutes a cap and trade system as he has promised, the price of electricity will go up significantly. This will help our payoff time come down. Also, we can increase the efficiecny of our panels and therefore produce more electricity, if we adjust them for seasonal shifts of the sun and keep them clean. The resale value on your house will go up. Plus, you'll have that green feeling knowing you're producing clean, renewable energy for decades to come.

Now if you had a $100 power bill before the system, what would it look like after? The $420 is an annual savings, so if we take the 420 divided by 12 we have a $35 monthly savings, and our monthly bill would now be $65.

# Advantages and Disadvantages of Wind Power

So you're considering alternative energy, but don't know which kind to choose. You know that there are advantages and disadvantages to every kind, but who is going to spell it out for you? Here is a comprehensive list to the pros and cons of utilizing wind power as an alternative energy source for your home.

Advantages of Wind Power

Affordability Factor

Let's face it. Most people nowadays don't get alternative energy just because they love the environment. They seek alternative energy because it’s practical and cheaper in the long run. Who doesn't want to save cash? As it turns out, wind generators are relatively affordable and allow you to save on your energy bill. Systems generally start at around $400.

Easy to Install

Most of us are not electricians, technicians, or electronics specialists so we usually have to pay someone to do our dirty work. Fortunately, wind powered systems are typically easy to install.

Low Maintenance

No one wants extra work. Our days are long and hard enough as it is. Wind generators are generally low maintenance and are easy for most people to handle.

Round-the-Clock Generation

Unlike solar power, wind power is fairly constant. That means that even if you aren't using power, you're still generating it. Plus, some utility companies will let you sell back your extra energy.

Incentives and Rebates

Depending upon where you live, the government will provide you with tax credits or money in order to buy back any extra energy you've produced.

Disadvantages of Wind Power

Yes, you knew they had to come, didn't you? While wind power is easy and affordable, it has some problems with reliability. Take a look at our list below to see why harnessing wind power might not be the best option for you.

Uneven Energy Source

A small percentage of the population lives in a place that is always windy. So what happens when you don't have wind? You could, of course, go back to regular electricity to fuel your everyday needs - although that's a quite counter-productive alternative.

Few Places are Good for Wind

Wind generators are easy to install, yes, but you can't just put them in any old place. You have to put them where they will catch some wind. However, maybe your roof is blocked by a tall building next door and little wind gets past it? These are things to consider before you just run out and buy a generator.

Local Codes and Zoning

Unfortunately, you might just live in a place that won’t allow it. Sometimes homeowner associations or municipal zoning forbid the use of alternative energy generators on your property. Sadly, there's no way around this obstacle.

More Wind = Difficult Installation

Remember how one of the advantages of wind power is easy installation? Well, in order to have a good generator, it has to be in a place that has a lot of wind. That generally means it has to be high. This also means it may be difficult to install, so consider contacting a specialist.

# Incentives for Home Solar Power Systems

Uncle Sam is continuing to make it easier for homeowners to include solar energy as a viable, and affordable, means of powering their homes. Not to be outdone, the majority of states are also devising ways to encourage their residents to "switch on" to renewable energy, many times through electric companies. Renewable energy includes leveraging the power of the sun. Here are some examples of how both forms of government are attempting to do so.

## Rebates Toward Solar Power Systems

With the adoption of the Energy Policy Act of 2005 and the subsequent Energy Improvement and Extension Act of 2008, Americans are now eligible for a 30% rebate through the Federal Government toward a residential solar power system. In addition, there is now no limit to the amount that can be claimed toward the cost of a photovoltaic system. In the past, the amount was restricted to $2,000. The rebate currently covers both the cost of the materials and the labor. For example, a PV system with a cost of $25,000 would be eligible for a $7,500 rebate. Along with their normal tax forms, residents would use IRS Form 5695 to earn their rebate.

## Property Tax Financing

Another attempt at making solar power attainable for the everyday homeowner is a program that allows the cost of the PV to be covered by property taxes over an extended period of time. In most case, this payment plan lasts for twenty years. If the home is sold before that period is up, the solar power system, and whatever tax liability remains, go to the new owner of the home. The program is usually funded by municipal bonds. Many cities in California have incorporated this program, as well as some cities in Colorado, Maryland, and Louisiana.

## Renewable Energy Credits

Many energy companies are implementing programs that enable residents with a photovoltaic system to "sell" the extra electricity they obtain back to their energy companies. While most do not physically write checks to their customers, they do extend energy credits to them. Green Mountain Energy in Texas andXcel Energy are examples of energy companies who actively participate in these types of programs.

## Feed-in Tariffs (FiT)

As an extension to the process of buying back energy, the state of California and the city of Gainesville, Florida have begun enacting feed-in tariffs (FiT). California electrical company, Southern California Edison, requires that clients sign a long-term contract for 5, 10, or 15 years, but the price is adjusted based on the time of day of the power generation. For example, for a system producing power throughout the day, a 15-year contract signed withSCE would earn about 15 cents per kilowatt-hour on a summer weekday, while a system generating power from 8 a.m. to 6 p.m. (such as a solar power system), would earn about 22 cents per kilowatt-hour under the same circumstances. Overall, the tariffs range from 8 to 31 cents per kilowatt-hour. However, residents earning the tariff cannot participate in other state incentive programs.

# What to do After You Install a Solar Power System on Your Home

You have installed a solar power system in your home. Now what? With your new system in place, it is time to figure out how much you are saving, reassess the suitability of your new sun powered system, and of course, brag about your energy savings and environmental savvy to anyone who will listen!

## Immediate Benefits: Comparing Your Savings and Power Production on Your Power Bill

Before you put in your PV panels, you will have spent a good deal of time learning about your power usage and your energy costs. When you are installing home solar systems, the amount of energy you use, as reflected on your electric bill, determines the size of the solar power system you need to invest in. Now that your system is in place, it is time to redo the math to see how you are doing. Are your photovoltaic panels providing an adequate amount of power to your home? Has your energy usage changed at all? And perhaps most importantly, just how drastically has your energy bill decreased?

Everyone loves saving money – and lots of it – of course, so comparing your before and after power bills is good for the soul. There is a more important reason to carefully examine your energy usage and cost right after you install your sun-powered energy system. Keeping a close eye on these factors ensures that the system you have is adequate for you and that you are getting the maximum benefit from having solar paneling in your home. If you find there is room for improvement, now is the time to consider an upgrade.

## Changing Energy Needs: Adding on to Your System

Even with the most careful planning possible, you never really know if you are putting in the right size PV panel system until you actually start to use it. Maybe you are still relying on "the grid" a little more than you would have liked. Maybe you did not take into consideration that your growing family will have growing energy needs, and you are already operating at max output for your system size. For cash flow reasons, you can always add more solar panels over time as your budget allows, but if you see a need to upgrade and can do it right after your initial installation, go for it. Not only will you get the maximum benefits right away, but many companies offer reduced pricing for larger purchases. Your installer may extend the discount to you if you upgrade shortly after installation.

## Spread the Word: Brag about Your System

Now it's time for the fun part! Chances are, you installed a solar powered energy system in your home to save money and to do your part for the environment. Now you can convince others to do the same. Brag a little bit about the huge drop in energy costs that you are experiencing. Remind people how good it feels to make a smart decision for the

planet. Let people know how painless the transition to sun-powered energy has been. Bringing in new converts to the solar power movement is good for everyone.

# What is a Solar Pathfinder?

Green is in. It has always been here, it just seems that in the recent past more and more companies and individuals seem to be working towards a 'greener' lifestyle, with solar power and its attendant abilities foremost among them. One product that complements this advance in public awareness is the Solar Pathfinder.

Put simply, the device (which is non-electronic in nature) allows the user to calculate the total amount of solar energy that a specific point will receive in a full year, taking into account shading from nearby buildings or plant growth. This is done by using the reflection of surrounding shadows and shading on the panoramic clear plastic dome that covers the instrument, under which is a replaceable paper diagram of the sun path with specific daily figures on it for a full solar year, which when the shading has been traced onto the paper sun path (through the slots on the dome sides itself) will allow users to calculate the exact amount of solar energy that point will receive. With this information, placement of solar arrays and panels can be precise to the area itself, allowing for corrections if a specific area is not fulfilling the power production requirements, etc.

Solar power generation calculation is just one use, however. Architects, for example, may use the instrument for solar calculation, but also for more mundane uses, such as the need to plant more trees in an area to have better shading in high summer. It could be used to decide on the exact angle of a buildings placement, with regards to solar movement throughout the year. In industries such as landscape management the device will be of great use, as different plant's have different light requirements. Plants potted in ZZZ month and planted in YYY month may not get enough sunshine, or some may get too much for their proper growth cycle. With the Pathfinder, the number of guesstimates regularly used for these projects would be reduced to zero, thus eliminating replanting costs. Recreational industries such as golf will also benefit form the use of this tool when determining how much tree trimming they will need.

While all the major functions can be achieved by hand, the software available (Solar Pathfinder Assistant) will be of great use to professionals that will utilize it on a regular basis, which allows the user to input photographs instead of tracing on the sun path diagram. The availability of a tripod mount will allow for easier use when taking multiple readings, and the protective casing with its in depth user manual will be of use to everyone. The full package includes the case, padding, reflective transparent dome, the instrument itself, latitude specific sun path charts defined by the purchaser and the base section.

# Deciding If Your Home Is Right For Solar Panels

If you're trying to reduce your energy consumption and go green, you've no doubt considered installing solar panels or a solar power kit on your home. There are a few things you should consider before calling a contractor or thinking about installing a system yourself. To get the most out of your system you'll need to ensure you have the proper site. Let's talk about what goes into site suitability for photovoltaic systems.

**Where Do You Live?**

Obviously there are good and bad areas of the country for solar panels.

The sunny southwest, From Texas to Southern California, has the best sun exposure in the US.

Other great places are the Rocky Mountain state of Utah, Colorado, and Nevada and the Southeast states of Florida and Georgia which have ample sunny days.

The Midwest and South are considering 'good' but generally have rainy, overcast winters.

The Great Lakes States and the Northeast are considered not great for solar, but in some cases systems can still be productive.

Obviously places in the Caribbean and Hawaii are outstanding candidates for solar power as well.

**Where Can You Put The System?**

When most people think of solar, they think rooftops. The roof is usually best but there are other things to consider. You want your site to have the following characteristics:

Southern exposure: this will allow the panels to be exposed to the sun for largest portion of the day.

Shade-free: even shade from small objects like roof vents can significantly decrease the output of a system.

Close to the power meter: the closer the panels are to your home and the meter the lower your power losses in the cabling will be.

Out of the way: while the system isn't really dangerous, they do create high voltage and therefore should be in a safe place away from high traffic areas.

If you don't have a suitable roof area for the panels, don't worry, there are plenty of ground mounting options. You can also use a shed or detached garage as long is its reasonably close to the house. Don't forget that you'll need to account for seasonal shifts in the sun's angle to make sure your panels don't receive shade in the winter.

**What Angle Should They Be?**

The angle of the panels should be equal to the latitude of your site. So if you live in Boulder, CO, where the latitude is about 41 degrees, the panels should be at an angle of 41 degrees from horizontal. If you're not sure what your latitude is, check out this latitude map of the US. You can approximate your latitude, it does not have to be exact. If you're roof doesn't match the latitude exactly, getting within 10 degrees with suffice. Any more and you should consider a tilted mounting system, which will add to the cost but will pay for itself in added power production.

**How Much Room Do I Need?**

A good rule of thumb is the 0.10 rule. This means that for every watt you'll need 0.10 of a square foot for the panels, mounting, wiring, and enough area to be able to work around the system. So, if you decide you need 3,000 watts:

3,000 Watts x 0.10 = 300 sq.ft

conversely if you have 500 square feet of roof that is unshaded and has nice southern exposure, you can take this divide by 1/10. As you can see this means you have room for approximately 5,000 watts of solar:

500 sq.ft. / 0.10 = 5,000 watts

Pretty easy right?

**To Track or Not to Track?**

Tracking systems actually aim the cells at the sun as it crosses the sky from dusk to dawn. A tracking system can increase production of a system by as much as 40%. These systems are expensive though, and are really only feasible when the system can completely track the sun across the sky from dusk to dawn. So the site should have these characteristics:

Low horizons: Sites in canyons or next to mountains usually won't work.

No shading: Heavily forested areas generally won't work.

Clear area: Since the system moves, you'll want the ground around to be clear.

Another consideration is the incentives and rebates. If you don't get incentives for power production, just installed watts, the incentives won't reimburse you for the expense of the tracker.

Armed with this information, you should be able to determine if your home or business is suitable for a system. The next step is determining just how much you can afford.

# Using Solar For Remote Power Needs

Solar power gets a ton of attention as one possible answer to our energy needs. The fact is that using the sun's energy just makes sense for our future. But utilizing solar power is still out of reach for most homes and businesses, and probably will be for a couple more years. One great application for photovoltaics right now: remote power. There is no better option for powering electronics in a location with little or no access to traditional power sources. Let's talk about what goes into system design and applications for photovoltaics in far off locales.

**Determining Usage**

As with any electrical installation, you first need to decide just how much power is needed. This is especially critical with PV since it most likely will be the only power source. We'll need a conservative estimate of the amperage, voltage, and the time of usage to size the system. When doing this, don't forget that most devices have a spike in the amperage upon start-up. Some devices use five times their operating amperage briefly when starting.

**AC, DC or Both?**

Most electronic devices are built to take AC power since that is what our grid provides. Since solar generates DC power, we often need to use an inverter to convert DC to AC. If we can avoid this, we'll save both the expense of the inverter and anywhere from 5-20% of the power that we would lose in inversion. Often times the expense of using DC devices is offset by the savings on an inverter and reducing the wattage of solar panels. Using AC and DC electronics increases the complexity of the install but can be accomplished with proper design.

**Critical or Non-Critical?**

When designing a system one of the most critical factors is what we call 'days of autonomy'. This translates to how long the system would run if there was no sunshine. This is important because going from one day of autonomy to three days of autonomy would triple the size and expense of the system. Usually the days of autonomy depends on whether the system is critical or non critical. An example of a critical application might be a traffic warning light or a communications system.

For either case, you must take into account local weather patterns and determine what a likely scenario is for days without sunshine. For critical applications we might double or triple that time. In non-critical instances we might not add any days of autonomy depending on budget. For most part of the US, in semi-critical applications (ie lighting, security, signage) we would plan for 3-4 days of autonomy.

**Mounting and Enclosures**

How the system is installed is important since most of these systems will need to operate with minimal maintenance. Generally smaller systems need pole mounts and battery enclosures to keep the weather out. Sealed or AGM batteries are preferred in these systems since they don't require maintenance or ventilation. Another design consideration is wind load, snow load, and hail damage, since the remote locations are often exposed to extreme weather. Many remote solar power kits now come with the electronics, solar panels, and enclosures in one complete unit that can be transported to the site ready and set up in very short amount of time.

**Typical Applications**

You can size a solar power system to match any application. That's one of the great things about solar is that it can be scaled for any project. But for most part there are some good ways to use the sun for your remote power needs. Here are a few:

*Electronic Monitoring.* Weather stations and water monitoring stations are perfect uses for PV and usually can be powered cheaply and reliably. Oil field monitoring is another area that is perfectly suited for remote power solutions.

*Lighting.* With the advances in LED and CFL lighting fixtures nearly any lighting setup can be powered with solar now. More and more we will see traffic, parking lot, and street lights powered with PV.

*Small Moving Parts.* Smaller moving parts that have intermittent use such as gate and garage openers can be powered by the sun. It is advisable to have a manual override so in case of power failure you can still get in or out.

*Communications.* Cell phone and communications repeaters are increasingly using PV as systems they are being installed in more and more remote locations. These can often be coupled with wind generators since they tend to be installed in high places.

*Computers and Modems.* Most computers and modems now use very low wattage and can be custom made for DC systems.

*Small Volume Pumping.* A 'direct solar' system can be designed to pump during sunny hours and then store the water using tanks, instead of storing the electricity with batteries.

*Security Cameras and Recording Devices.* If you've ever though about putting a camera in a far corner of your lot to monitor those pesky prowlers, you've no doubt wondered how you would get power to the spot. Now with a simple pole mounted panel and battery box you can power the camera, motor, and recoding device.

*Cabins and Cottages.* Remote homes can now be powered fairly easily with solar. The system should be designed for the owners usage patterns, but its best if heating, cooling, and refrigeration can kept out of the electrical circuit. Propane refrigerators, wood stoves, and natural cooling techniques will keep power systems simple and affordable. These system almost always need a backup as well, such as a gas generator.

# Living Off Grid For Dummies

Hello, my name is Kriss Bergethon and I am a solar system designer and sell solar power kits to homeowners and contractors. Since this is my first post for Renewable Energy World I thought I'd do a quick introduction and talk about my baptism by fire in solar.

**Off Grid or Off Our Rocker?**

A few years back, we grew tired of the city and noise and hassle that came with it. We decided that the life we wanted was in the mountains. We fell in love with an area that had phenomenal views, a lake nearby, and was close to a skiing community. One

problem: no power. Not only was there no power, but there was no water, sewer, or <GASP> high speed internet. In fact the only real utility that existed was phone lines, and those are soooo 1996, right?

But there were other houses in the neighborhood running on solar and small wind generators and we naively thought 'How hard could it be?'. With the help of friends, family, and a builder that had built in the neighborhood, we felt we had the perfect house for us. We are not rich folks by any means, but we felt we had a comfortable home that we could grow into a little. We had 16 batteries, 1300 watts of solar, 300 sunny Colorado days per year, and a propane generator backup. This would be easy right? Just wash the clothes on sunny days! Piece of cake.

**Oh, You Mean We Need Sunshine?**

We chose to move into our home in December of 2007. And that just happened to be the winter that our little hamlet would break the record for snowfall in one year. We figured out in a hurry that our panels didn't run on snowflakes. Go figure. We had 3 solid months of snow, 6-12 inches EVERY DAY. Even the toothless old timers with the long beards had never seen anything like it.

And worse, our builder had suggested a forced air electric furnace for our modular home to save money. Big mistake. Since there was no sunshine, and since we decided we like the pigment of our skin to be decidedly un-blue, we were running off the generator. When it wasn't breaking down, freezing up, or getting overcome with snow, it was burning through $1800 worth of propane per month. Did I mention we're not wealthy people?

The worst part was that when we ran out of propane, which was about every 15 days, the propane truck couldn't get to us. Being isolated and at the end of the road, which seemed so attractive just a few months ago, the snowplows couldn't get to us until late afternoon. And as soon as they did plow, we'd promptly get 12 more inches of snow, sealing off our isolated little home from the propane man and his apparently not-snow-ready truck.

**Altitude Adjustment**

So this is the part of our life where we got used to setting the thermostat to 50 degrees, warming up by shovelling endless amounts of snow, and sleeping under enough blankets to cover a jumbo jet. Good times. And actually, they were good times. My wife and I grew closer, learned a ton about our new home, and became conscious of every watt that flowed out of the system.

We learned that EVERYTHING need to be on power strips. Even the garage door openers. When the sun did shine, we learned to milk every drop of heat from it to help heat the home by opening shades. And when there was no sun we shut the blinds tight and hunkered down. We opened and closed the shades so often the neighbors probably thought we were sending Morse code. If we had known Morse code we would have said 'Bring soup!'.

We learned that since we had a well pump drawing power out of our system, that wasting water meant wasting power. We eventually got a wood burning stove and took advantage

of the acres of already-dead trees not far from our home. We learned that there is a major difference in power used in different light bulbs. And we learned that we really didn't need to watch as much TV as we thought.

**Finally: Bliss**

So, with some painful lessons, a little cash, and a lot of patience, we live very comfortably now. We consume approximately 150 kw-hrs per month of electricity, compared to the typical American household that uses more than 1,000. We use about 500 gallons of water per month, whereas some families use that in a day. I don't say these things to brag or toot my own horn, I say these things as a reformed waster that is trying to help others change their habits and become conscious of their energy consumption. And the bet part is I get to help people do just that every day! And hopefully this industry, this blog, and the people that read it can spread the word. I look forward to sharing my experience and learning from yours. Thanks for reading.

# Eight Cool Things About Solar That Just Might Change the World

Rapid changes in the solar power sector are fueling a green energy revolution. With so much emphasis on solving the global warming puzzle, technology in solar is advancing very quickly and may be the answer we've been looking for. Let's take a look at how this industry is changing so quickly.

**1. Solar Panel Prices Are Coming Down - And Fast**

The biggest detractor for solar in the past has been simple: it was just too expensive to be practical. Coal generated power was as much as 90% cheaper than solar power. But with the massive investment in production capacity, coupled with the global economic slowdown, prices on solar panels have come down anywhere from 10%-30% in the last 6 months. This means that many projects that were borderline before are now feasible. And the trend appears to be gaining steam. Prices on Sharp solar panels, for instance, have been lowered 3 times since May, bringing their cost into the $4/watt range. Just last year they were closer to $5/watt.

**2. Solar Film Will Drive Prices Even Lower**

Companies such as FirstSolar, Nanosolar, and Sharp are quickly bringing solar film, also called thin-film solar, to market. We've been promised this amazing technology for years and it seems its finally here. Thin film is manufactured in a way that is similar to printing, and the product often comes in a roll. This is a much more efficient way of producing cells than the traditional solar panel, which was made in a process similar to microchips. We are seeing initial pricing on this new technology in the $1 to $2/watt range.

### 3. Efficiency is Getting Better

Solar efficiency is the measure of power produced versus the sun's energy that hits the panel. In the past any efficiency over 15% was seen as good, and approaching 20% was great. Now such panels as SunPower's are regularly achieving 22%. That means more bang for buck and more energy produced for every square inch of panel installed.

### 4. Thin Film Efficiency is Better Too

Solar film is levelling the field on efficiency. Thin film traditionally had efficiencies in the 10% area, roughly half the efficiency of crystalline panels. While that measured quantity has trended up slightly, industry professionals are finding that actual production is higher. This is because the film produces better in diffuse light and partially shaded conditions than panels. In one project in Israel, installers recently found that the thin film solar only required 25% more surface area compared to crystalline panels to produce the same energy. This means that actual efficiency is probably closer to 15% for film.

### 5. Utility Scale Solar is Blossoming

Utility scale solar is PV power for the masses, brought to you through your traditional power lines. Usually the power plants are located in desert areas with ample sunshine. They often use a technology called concentrated photovoltaics (CPV) that uses mirrors, tracking devices, and advanced solar panel technology to squeeze (almost) every drop of energy from sunlight. Due to new federal rules on depreciation, generous tax credits, and technological advances, utilities and investors can install these systems profitably. In the next 5-10 years we will probably see the record for largest CPV installation broken several times over. Projects in Colorado, California, and Arizona are already under way and will vie for the nation's largest when complete.

### 6. Power Is Getting More Expensive

While this isn't necessarily good news, it's certainly overdue. Until we wrap the true environmental cost of producing carbon into the cost of electricity, our environmental picture will not improve. Whether we do that through cap and trade, a carbon tax, or another way, it means that power is going to cost more in the short term. This increased cost will encourage energy efficiency and drive improvement in the production, transportation, and storage of electricity. It will also make solar power look more attractive.

### 7. Research Will Only Fuel the Revolution

Speaking of innovation, research and development will change the industry in ways we're not even aware of yet. Our wonderful university research programs are driving tremendous changes in the industry. Energy has become a focus of federal and industry dollars, much the way telecommunications and information technology was in the last decade. College programs now emphasize energy efficiency in all aspects of design and engineering, and integrating solar in buildings, vehicles, and even clothing have become the norm. It seems like every week we hear about a breakthrough in solar panels, thin film solar, and battery technology in our university research programs

### 8. Massive Investment Will Incubate the Next Energy Stars

One sure sign of change to come is when Silicon Valley venture capital gets involved. These funds are only interested in investing in sectors that are rapidly growing and can make gobs of money in a short time. So when you hear they are investing billions of dollars in photovoltaic technology, and a new deal seems to be coming every week, you can bet there are big things on the horizon. These prognosticators may not be right all the time, but you can bet they don't throw their money away at weak prospects. The same guys who made huge bets on Google, Yahoo, and Netscape are now putting their chips on the energy sector, and specifically solar power.

# Teaching Kids About Solar Power

I had the opportunity several times this year to speak to schools about renewable energy and specifically solar power. This is always enlightening and fun for me, and provides a way to give back to the community. And as with any new endeavor, I tend to learn more than I teach. Here are some things I picked up from these recent sessions:

**Kids Are Learning This Earlier Than You Think**

One of the sessions was for a sixth grade science class. They already knew so much about the subject I ended up skipping half my speech. I started asking the group 'Where does all energy come from?' thinking they would have no idea that all forms of our energy really start with the sun. They knew all about it. They knew that you can harness electricity and heat from the sun. I was blown away by how much the kids knew. The teacher told me that is now part of most middle school science curriculum.

That doesn't mean that we should assume they know a lot about the subject, but this topic is definitely on their radar. We are breeding a generation of kids that know about energy in a way I was never formally taught. And the best part: I did the speech in a small rural town who's only industries are coal mining and coal-fired power plants. Most of their parents probably make a living in the coal business. But the kids knew about solar and it excited them.

**Solar Power is Intuitive For Kids**

For most kids, telling them that the sun gives off energy is like telling them their oven can cook a pie. It's natural to them. Most kids never see

power plants or coal mines or transmission lines. What they do see, nearly every day, is the sun. And accidentally looked right at it and they've had sunburns and they can feel just how powerful it is. So telling them we can use it to produce energy is easy.

Of course explaining how sunlight actually turns into electricity is tricky. I like the birthday party analogy that goes something like this: There is a birthday party in a room at your friends house. Everyone is behaving and having a nice time, just sort of milling

around and talking quietly in one room. Then someone starts blaring music, gives all the kids a bunch of sugar and turns up the heat in the room. What happens then? Well the kids burst out of the room start running all over and spread their energy into every part of the house and the yard outside. So the first room is the solar panels, the kids are electrical charges and the sugar, music, and heat is sunlight. You can fill in the rest. Of course for the high school kids I told them it was prom and somebody spiked the punch and started playing hip hop. You get the idea.

**There Are Great Demonstration Tools Out There**

Analogies only get you so far and eventually you have to show them how it works. Fortunately there are some cool kits out there that can help you along (full disclosure: I sell kits like this on my website). The most effective in my experience for teaching solar power to kids is the Solar Electric House Kit. This is small affordable kit that has a thin film panel that will power a small fan and an LED. The fan is great for showing how direct/indirect sunlight matters as it slows down and speeds up as the sun's angle changes. The LED can be used to show the importance of energy efficiency. And the since the kit does not come with the house itself, the kids can get creative with recycling (a used shoe box is perfect). One class even incorporated some clear plastic and a thermometer to demonstrate solar heating and passive solar concepts.

For smaller kids there are some cool solar toys out there. There are race cars and motorized animals that they can assemble, which is fun in itself. Then they get to see, plain and simple, when there is sunlight on the panel (the party's on!) the toy moves. Take away sunlight, no movement. This stuff is fun and an easy way to demonstrate solar power.

**Make Them Into Energy Police**

At the end of each session I like to give them an assignment to take home. Its not homework so much as an excuse for them to boss their parents around. I show them an incandescent bulb and a CFL bulb and tell them to home and count how many of each they can find. Then they can explain to their parents why they need CFL and LED bulbs in every fixture. There also other simple things they can do like closing doors to unused rooms, locking windows, and turning down the thermostat little by little. Energy Star has a great website for kids that empowers them to take charge at home and hopefully whip some wasteful parents into shape.